



SERBIAN GOVERNMENT
MINISTRY OF EDUCATION, SCIENCE AND
TECHNOLOGICAL DEVELOPMENT

PROCEEDINGS

SPEECH AND LANGUAGE 2019

7th International Conference on Fundamental and Applied Aspects of
Speech and Language

Editors

Miško Subotić
Slavica Maksimović

Belgrade, Crowne Plaza
01-02 November, 2019

Patrons:

Ministry of Education, Science and Technological Development – Republic of Serbia

Organizers:

Life activities advancement center - Serbia

The Institute for Experimental Phonetics and Speech Pathology “Đorđe Kostić” - Serbia

Organization:

Organizing Committee, IEPSP, LAAC Secretariat, Gospodar Jovanova 35, 11000 Belgrade, Serbia. Tel./Fax: (+381 11 3208 544, +381 11 2624 168)

e-mail: iefpg@iefpg.org.rs web: <http://www.iefpg.org.rs>

Publisher:

Life Activities Advancement Center

The Institute for Experimental Phonetics and Speech Pathology “Đorđe Kostić”

Cosmoanelixis - Prenatal and Life Sciences

Electronic version on publication

Editors: Miško Subotić, Slavica Maksimović

Circulation: 500

ISBN: 978-86-89431-39-1

Scientific Board

President:

M. Sovilj (Serbia)

Vice Presidents:

D. Popov (Bugarska)

M. Subotić (Serbia)

Members:

G. Brikman (Israel)

R. Bjeljac Babić (France)

G. Garyev (Russia)

B. Gerazov (Makedonia)

S. Golubović (Serbia)

M. Stepanovna Gončarenko (Ukraine)

S. Gudurić (Serbia)

O. Gouni (Greece)

J. Grigorjevs (Latvia)

V. Delić (Serbia)

R. Dragičević (Serbia)

S. Jovičić (Serbia)

Đ. Koruga (Serbia)

A. Kostić (Serbia)

L. Nazarenko (Ukraine)

N. Nedeljković (Serbia)

V. Popova (Bulgaria)

Lj. Rakić (Serbia)

M. Rakočević (Serbia)

D. Raković (Serbia)

M. Sečujski (Serbia).

T. Tarner (Netherlands)

H. Tivadar (Slovenia)

M. Čukić Radenković (Serbia)

G. Škarić Varošaneć (Croatia)

D. Zec (SAD)

Organizational Board

President:

S. Maksimović (Serbia)

Vice Presidents:

S. Đoković (Serbia)

S. Punišić (Serbia)

Members:

T. Adamović (Serbia)

V. Đorđević (Serbia)

Lj. Jeličić (Serbia)

V. Nenadović (Serbia)

M. Panić (Serbia)

M. Rakonjac (Serbia)

M. Stokić (Serbia)

Z. Šarić (Serbia)

M. Vojnović (Serbia)

Secretariat:

J. Bojović (Serbia)

V. Žikić (Serbia)

S. Fatić (Serbia)

N. Stanojević (Serbia)

CONTENTS

PLENARY LECTURES

DNA or Nurture in Formation of the Personality: Is all accounted in this discussion?	
G. Brekhman, K. Brekhman	12
Nikola Tesla as a Case Study for Quantum-Holographic Correlations of Individual and Collective Consciousness: Creative and Spiritual Implications	
D. Raković	17
Speaking Through Our Eyes©2019	
J. Turner, T. Turner, O. Gouni, G. Brekhman, D. Rakovic	27
Speech Personality, Individuality and Uniqueness of Human Voice	
D. Popov	34
Electrophysiological Correlates of Reading in Adults With Dual Literacy	
M. Sovilj, Lj. Jeličić, M. Stokić	39
Challenges in the Application of Telepractice	
R. Bilibajkić, M. Subotić	43
Innovations in Bulgarian Child Syntax	
V. Popova	47
The Applicability of Phonetic Perceptive Tests for Speech Therapy and Practice	
H. Tivadar	55
Современное Развитие Лингво - Педагогических Технологий	
М.С. Гончаренко	62
The Mathematical Alphabetical Systems Originating the New Paradigm	
G. Dlyasin	69
The New Alphabetical Paradigm: From the System of Society Further Everywhere	
G. Dlyasin	78
Materiality of Speech as a Virtual Component of Human Existence	
Sh. Tashaev	100

How the Advent of Machine Learning Transforms Speech Technologies M. Sečujski, T. Nosek, S. Suzić, D. Pekar, E. Pakoci, B. Popović, V. Delić	105
Percepcija govora u nepovoljnim komunikativnim uslovima: savremeni pogledi S. Jovičić	114
Specifičnosti jezičkih poremećaja kod traumatskih povreda mozga M. Vuković	124
ORAL PRESENTATIONS	
Prosodic Text Rhythm And Comic Effects: The Possibility Of Correlation V. Vasileva	134
New Knowledges on Genetic Continuity and Linguistic Continuity of the Serbian Language D. Djordjevich	148
Individual or Group Verbotonal Phonetic Correction – Which One Is Better? A. Dobrić, M. Haičman	169
Error Correction in the Foreign Language Classroom: Why, When, How? A. Toledo	178
The Inherited Form Of 22q11.2 Deletion Syndrome: Speech Impairment And Delay In Language Development M. Rakonjac, M. Vujovic, G. Cuturilo, M. Stevanovic, M. Sovilj, D. Drakulic	185
The State of Oral Practise in Dysphasic Children A. Veselinović, M. Marisavljević, J. Nikolić	190
Attachment In Children With Autism Spectrum Disorder M. Marisavljević, D. Zečević, A. Veselinović	195
Attitudes and Opinions of Students in the Subject Knowledge of Nature I. Pavković, I. Ristić, I. Stanković	205
Graphomotor Abilities In Children With Specific Language Impairment M. Đorđević, J. Nikolić, S. Đorđević	212
Application of Neurofeedback Treatment in Children with Specific Language Impairment M. Tešić, I. Stanković, S. Todorović	217

The Use of Neurofeedback in the Treatment of ADHD -Review of Papers D. Zečević, M. Tešović, S. Fatić	228
Attitudes of Pupils of Elementary School Age Towards Learning and Teaching Contents From Subject Knowledge of Nature in Inclusive Teaching Context I. Ristić, I. Pavković, A. Milošević-Vasiljković	235
Effects of Multimodal Treatment on Attention in Children with ADHD V. Plecevic, S. Djokovic	242
The Impact of Medication During Pregnancy on Fetal Development M. Tešović, I. Bogavac	248
Gender Effect on Reading Performance in Elementary School Children N. Stanojević, S. Fatić, M. Mitrović	254
Characteristics Of Developmental Abilities In Young Children M. Janić, M. Stokić	258
Orthomolecular Psychiatry – The Importance of Nutrition and Micro-Nutrients in the Improvement of Mental Health T. Antin Pavlovic, B. Stankov	266
Nivoi opštenja od biomolekula do noosfere – novi uvidi L. Šurlan	271
Adaptive Endfire Microphone Array for Ambient Noise Suppression in Speech Therapy Treatment by KSAFA-D Device Z. Šarić, M. Subotić, R. Bilibajkić	277
The Peer Relations of Students with Special Educational Needs in University: The Sociological and Cultural Aspects to Importance of Speech and Language Interactions M. Drossinou Korea	289
On the Basic Mechanisms of Language Strategies in Childhood O. Sizova	299
Perception of Speech Sounds' Pronunciation Quality Based on The Acoustic Features S. Punišić, R. Bilibajkić, M. Vojnović, M. Subotić	305
The Importance of Preschool Hearing Screening T. Adamović, S. Maksimović, M. Vojnović	314

Detection of Lateral Sigmatism using Support Vector Machine R. Bilibajkić, M. Vojnović, Z. Šarić	322
Specific Protocol for Hearing Assessment in Preterm Babies B. Mikić, M. Nikolić, A. Jotić	329
Sleep - a Multifunctional Phenomenon: Memory Consolidation and Protective Effect with Respect to Psychosomatics T. Bojić, Z. Matić, S. Mandić-Rajčević, I. Soldatović, Lj. Čvorović, Z. Rašić Milutinović, A. Vuckovic, A. Kalauzi	337
Perinatalni riziko faktori u disharmoničnom razvoju i u razvoju komunikacije J. Ibolya	342
Assessment of the Quality of Spoken Voices Using Information Technologies D. Furundzic, S. Punisic, M. Subotić	349
Accented Vowels in Serbian Language M. Vojnović, R. Bilibajkić	358
Duration of Utterance in Developmental Verbal Apraxia V. Đorđević, M. Panić, V. Žikić	367
Characteristics of Auditory Information Processing in Children with Specific Language Impairment Lj. Jeličić, I. Bogavac, I. Veselinović	372
Risk Factors at Birth and Their Impact on Prelingual and Early Lingual Development in Prematurus V. Đorđević, M. Panić, N. Stanojević	377
Physiology of Speech and Sleep-Converging Evidences about the Core Pathophysiological Mechanism of Chronic Tinnitus Z. Matić, S. Mandić Rajčević, I. Soldatović, Lj. Čvorović, Z. Rašić Milutinović, A. Kalauzi, T. Bojić	384
Development of Linguistic and Cognitive Skills in Children with Scholastic Skills Disorders V. Žikić, M. Panić, S. Golubović	394
Speech and Language Development in Children with Developmental Dysphasia J. Nikolić, M. Đorđević, A. Veselinović	401

Examining The Effects Of Speech And Language Treatment On The Of Symptoms Which May Be Indicators Of The Presence Of Autistic Spectrum Disorder	
S. Maksimović, M. Marisavljević, T. Adamović	406
The Influence Of Genetic Conditions On Increasing Risk Of The Speech-Language Pathology At Children	
M. Rakonjac, I. Bogavac, M. Stokić, M. Vujović	416
Language Lateralization During Auditory Perception in Left-handed Children	
S. Fatić, N. Stanojević, M. Stokić	423
Evoking Lexical Units In Children With Specific Language Impairment And Irregular Patterns Of EEG Activity	
S. Đorđević, M. Đorđević, I. Bacić	428
Salience and Situatedness in Croatian Sign Language	
D. Posedi, R. Geld, D. Tomić	435
The Impact of Group Psychotherapy Workshop on the Emotional State	
V. Kljajević, D. Sovilj	443
Communication Of The Deaf Employees	
I. Mitrović Đorđević, V. Todorović	450
Risk Factors Prevalence in Children with Speech and Language Disorders	
I. Bogavac, M. Tešović, Lj. Jeličić	455
Alexia Without Agraphia - Case Study	
G. Tomić, J. Nikolić, S. Punišić, M. Subotić, J. Zidverc-Trajković	459
Использование пренатального дозированного звукового воздействия для оценки состояния плода и прогнозирования дезадаптации новорождённого	
Л.Г.Назаренко, Л.А.Гук, И.А.Семеринская	464

Plenary lectures

DNA or Nurture in Formation of the Personality: Is all accounted in this discussion?

Grigori Brekhman, Katerina Brekhman
Interdisciplinary Clinical Center Haifa University,
Integrative Research Institute EANW, Israel

ABSTRACT

Entering into a polemic, which is the main thing in what makes us who we are: nature or nurture, the authors indicate that this happens against the background of the constant interaction of genes and the environment, starting from conception. Consideration of this phenomenon from the perspective of multifactorialness reveals the significance of circumstances (environmental, social, psychological) under which the birth and formation of the personality occurs, as well as the role of emergentness in maintaining the integrity of the individual.

Keywords: Nature or nurture, birthing, genetic system, ecological and social environment.

1 INTRODUCTION

Until last time the polemics not abates: what is the main thing that **makes us who we are: Nature or nurture? Genetics or upbringing?** Meanwhile, researchers overlook (they don't know, do not guess or ignore) the essential factors associated with birth and other events of life.

The initial reason for discussing the topic was the acquaintance with the recently published monograph of the English geneticist and psychologist Prof. Robert Plomin (the Institute of Psychiatry, King's College, London) "**Blueprint: How DNA Makes Us Who We Are.**" This book is a significant contribution to the discussion that has begun since long-standing times: what affects more on the formation of personality: genes or upbringing,

Sometimes this discussion acquired a political connotation. In the Soviet Union, genetics was once branded as "... a corrupt girl of imperialism" And Prof. Plomin admitted that he had not published this book for 30 years, fearing that he would be considered a Nazi, because in his monograph he claims that the *genes* are *determine our personality*.

Commentators on this book view some of the author's findings as provocative, capable of fueling fierce debate. Which actually happened. Researchers of this issue are forced to admit that many children, if not most, live with their biological parents and it is very difficult to understand what they inherited genetically and what they received as a result of upbringing and the influence of environmental factors.

In our correspondence with Prof. Plomin we gave such an example.

The mother of three children, a very intelligent, educated woman, told that her children are completely different in their character.

The eldest son is kind, her support, understands her very well, he is ready to come to her aid at any moment, studies well, is sociable, friendly, contact, his mood is, as a rule, optimistic.

The middle child - a **daughter** - "it's always problems", peculiar, does not listen to advice, does what she pleases, dresses extravagantly, has conflict in her family, and at school she constantly doesn't get well relationships with her comrades and teachers, always you stumble upon "no, I don't want, I won't", her mood is often lower: everything is bad.

The youngest son is a family favorite, the minion, but occasionally shows instability of mood, a high degree of resentment, up to hysteria.

“How can we explain such a difference in the characters of children?” - she asked me. At my request, the interlocutor reported on events that occurred during pregnancies: The **eldest son** - was born from a desired pregnancy shortly after marriage. **Daughter** - born of an unplanned and unwanted pregnancy, her husband and relatives dissuaded her from abortion. **The youngest son**, being in the uterus, together with her suffered all the hardships, unrest of repatriation, was born already in Israel. In this case, we can conclude:

The genes are the same. Parents and parenting style are the same. Only the conditions surrounded the woman and determined her emotional and psychological state during pregnancy was different. It can be assumed that those were what that were reflected in the characters, thinking and behavior of her children. This confirms the opinion of prenatal psychologists: prenatal experience may be more significant for a person's life than his genetic predisposition and upbringing after birth.

Prof. Plomin immediately responded:

“Dear Prof Brekhman, I'm glad that you found my book stimulating.

About your case study, why do you say the genes are the same for the three siblings?

Siblings are 50% different genetically so that genes could readily account for the differences between them. In contrast, the evidence for long-term effects of prenatal environments is quite weak. Best regards, Robert Plomin”

Prof. Plomin's answer created an ambiguous situation: how to explain to the venerable scientist that he has very weak knowledge about prenatal psychology, but he allowed himself such a careless statement about it?

And this is at the time when we are celebrating the 100th anniversary of the first works that opened the mental life of the child before birth, and by now many independent studies have been carried out, thousands of articles and hundreds of books summarizing the results of these studies have been published, which undoubtedly showed the influence of prenatal factors on the thinking and behavior of the individual, his mental and physical health, and during his subsequent life after birth.

But even more piquant - the geneticist Plomin completely ignored the successfully developing new area of genetics - **epigenetics**, which shows how the content of the gene system is replenished without moving the genes (without mutation).

We made an initial conclusion, which seemed to follow logically from the observation described above, but immediately stated that such a conclusion was traditional, but, alas, illusory, and we proposed the second conclusion:

The second, unplanned, unwanted pregnancy (against the backdrop of a changing socio-psychological situation) has repeatedly caused a woman a surge of negative emotions, a state of *distress* (according to Selye), which (as is known) is accompanied by serious neuropsychic reactions, hormonal, immune, electrolyte and other changes in the body. These changes indicate the involvement in distress of certain systems, organs, cells with their components, including genes, as well as possible changes in their molecular, atomic structures.

If in our reasoning we go beyond the scope of medicine and psychology and touch on some principles of quantum mechanics, the theory of particle-wave dualism of matter, wave genetics, then it is right to assume the appearance of a peculiar (distorted) informational wave field of a pregnant woman. It permeates and envelops her and her child. This may contribute to the inclusion of epigenetic processes that change the content of genes and their function of both the mother and her child.

Therefore, we could assume that the second child - the daughter - was born with a large information load in a different socio-psychological environment, with a changed parenting style, which was very different from what the first child had.

The desirability of a third pregnancy and the birth of a child could hardly completely eliminate or smooth out the changes in this woman's gene system, but they brought new aspects to the educational atmosphere of the family. This was manifested in the thinking and behavior of the third child-boy, who turned out to be a carrier of genes whose contents differ from those of the first boy.

For the third child (I remind you: having suffered with the mother before birth - all the hardships of moving to another country - problems of preparations, learning a new language, new living conditions,

climate, etc.), the socio-psychological and genetic status of the mother and the situation in the family were also different. Relocation is a stress similar to losing a husband (death, divorce) or work, and can cause an unborn child the genetic and psychological problems, which after birth can manifest in the form of autism spectrum disorders and even autism. This was shown by Prof. D.Beversdorf with his team (Ohio State University, USA).

The third conclusion. The given example confirms the well-known postulate that life is a *dynamic process*, and, alas, is not always controlled.

And the second postulate, which is not always taken into account: *any phenomenon is a multi-factor process*, and we can never be sure that we know all the factors that participated in the implementation of this phenomenon. Sometimes an example makes the speaker's thought clearer, so I will give only one description from my obstetrician area.

We know about such a pathology as the encircling the umbilical cord around an unborn baby. Ask any obstetrician about the reason, and he will immediately answer: this is due to the increased motor activity of the child in the uterus. And it is true. But not all.

As the researches showed the increased activity of the child is the result of the emotional state of the mother, her increased anxiety and close emotional connection with her child (B. R. H. Van den Bergh et al., Leuven University, Belgium)

This can be the personal anxiety recorded in the woman's genes, and any event (which the other person will not notice) causes her to increase feelings of anxiety or even fear.

The increased anxiety may be also the result of external psycho-traumatic circumstances that threaten her life or individual integrity. And this can be the result of various conflicts within the family or in society as a whole - due to political, social, economic processes, etc.

At the same time, we will not lose sight of environmental processes.

A.L.Chizhevsky(1970), the founder of helio-biology, showed that periodic tension in society can be a reaction to a change in the geomagnetic field in a particular region of the Earth, which in turn may be the result of a state of solar activity. He also established the influence of solar activity on climatic and social processes on Earth, on natural disasters, catastrophes, epidemics, wars, revolutions.

You will be right if ask: why do you mention the encircling of the umbilical cord here? And the answer may be unexpected for someone.

A strong inverse correlation relationship was found between the annual averages of the frequency of entwining of the umbilical cord of a child and the Wolf numbers reflecting the state of solar activity ($r = -0.866$, $p < 0.001$) (Nazarenko, Semerinskaya 2012). The same authors found in pregnant women with entwined umbilical cord fetus an increased level of anxiety, aggressiveness, irritability, emotional lability, unfavorable social family status, negative attitude to pregnancy and to unborn child, etc. That is, not in itself solar activity causes increased motor activity of an unborn child and its entwining with an umbilical cord, but it effect on especially sensitive members of human society and, coincidentally with pregnancy and with a certain gestational age.

That is, not in itself solar activity causes increased motor activity of an unborn child and its encircling with an umbilical cord, but it effect on especially sensitive members of human society and, coincidentally with pregnancy and with a certain gestational age.

But will their children have consequences?

My discovery of this aspect is connected with the drawing of one woman who turned to me with her psychological problem. To better understand the issue, I asked her to sketch out her problem schematically.

She depicted schematically a house, next to it is a tree, around which a snake coils. As I worked with her, and subsequently with others like her, born with an entanglement of the umbilical cord, the regular signs began to clear up: difficulties in forming relationships with close people, in the team (frequent job changes), increased level of anxiety, resentment, revenge, problems with a sense of humor, another. In the course of our research, severe stressful situations were found that affected their safety or integrity as an individual, sometimes the degree of stress was associated with the psychological characteristics of women (increased personal anxiety) or their negative attitude to pregnancy, its undesirability on various socio-

psychological reasons. But the reason for turning to a psychologist was often the fear of snakes, the appearance of their frightening images in dreams, frightening, interfering with sleep (Brekhman 1998).

So, we have traced the multifactorial path of the emergence of psychological problems in a child born with a tight umbilical cord entanglement around the neck .

The fourth summary. To the above should be added the following. We traditionally consider the appearance of each phenomenon as a result the influence of something factors. But at the same time, we do not take into account the protection by child of his "Whole-Self" (according to J&T Turners) from certain influences, which outwardly could be considered as his resistance.

What are we talking about?

From the moment of conception, a new person (Whole-Self) has individual characteristics that distinguish him from his father and mother. And this new Whole-Self (I repeat) from the standpoint of quantum mechanics, wave genetics, etc. - has special unique amplitude-frequency characteristics of wave component of genes, cells, organs, and the bio-field as a whole. And these characteristics are a way of life and self-defense of a new individual. They protect the unborn child, for example, from the psychological reactions of the mother in the event of her experiences during stressful situation or increased personality anxiety, when she reacts violently even to minor events or to her thoughts.

We can say that from the moment of conception, a new individual exhibits the “**phenomenon of emergentness**” - the appearance of a new quality that each of his parents did not have.

An outwardly noticeable manifestation of such protection, or perhaps better, resistance, is the *increased motor activity* of an unborn baby, which can lead to the entanglement of the umbilical cord, a change in his position or presentation (for example, breech presentation), and even miscarriage or premature birth. This is a manifestation of a kind of dialogue between a mother and an unborn child.

After birth, a manifestation of resistance is a rejection of mother's breast, crying for the slightest reason, vague painful manifestations, selective mutism, and subsequently a negative attitude to the proposals of mother or other persons, a violation of communication, language and speech.

In the process of growing up, an individual demonstrates a peculiar look at relationships with people around him in the form of sociability and goodwill, unusual hobbies, or, conversely, pathosocial behavior, envy, homosexuality or bisexuality, aggression and violence, and other negative qualities that fill the society with problems and return to him corresponding attitude of its members.

2. DISCUSSION AND CONCLUSION.

According to the laws of the genre, in the conclusion of the article it needs to return to where we started, in this case, to a discussion with Prof. Plomin. Our views on the role of genes in the formation and functioning of personality coincide on a number of points:

a) indeed, the genes of the parents determine that the child is birth as a human, b) the genes provide the formation, development and functioning of cells, organs and systems,

c) with the genes of the father and mothers are connected our ability to think, perceive and generate ideas as people;

d) a large memory bank of data accumulated by our ancestors as a result of the most vividly experienced events also comes to person and participates in formation his thinking and behavior, the inclinations and talents, and special character traits

But ... singing praises of the genes, one should not forget about the world around, whence the current information processed by their emotions and thinking comes to these genes located in every cell of the body, including the eggs of both the mother and father.

After conception throughout the entire period of intrauterine life and birth, already the cells of a new forming individual with the help of the mother and the surrounding world begin to perceive and remember, accumulate their own information, alas, without filtering it.

After birth, as person develops and ripens, the perception of the surrounding world by the brain and the senses of the individual, his thinking and emotions is turned on, which adds information to the gene system using the epigenetic function inherent in genes.

All this multifactorial nature of the external influence and the internal individual resistance (from conception to adulthood) is controlled only a little. And this applies to mental and physical qualities in the form of a tendency to diseases involving the organs of speech, hearing, and vision.

The recently discovered epigenetic ways of replenishing the information of the gene system, demonstrate the wisdom of Nature, which until a certain time was hidden from the human mind, and meanwhile, **the Gene system** is the same constantly functioning system as the nervous, respiratory and others, tracking the state of a person and adapting the function of his organs to changing environmental conditions.

This is a kind of disagreement with scientists who are categorical in their statements: either genes or parenting, as well as the fact that genes are unchanged from birth. In contrast, we could say:

To the fact that we are who we are - we owe ***constant active interaction of genes and the environment, starting from the moment of conception.***

Acknowledgement. We are thanks to Nikol Volchkov for the help in the preparation of this article to the publication in English.

REFERENCES

- Robert Plomin. Blueprint: How DNA Makes Us Who We Are. Kindle Edition. 2017.
- Beversdorf D.Q. et.al. Timing of prenatal stressors and autism. J Autism Dev Disord. 2005 Aug;35(4):471-8.
- Van den Bergh, B.R.H., et.al. Antenatal maternal anxiety and stress and the neurobehavioural development of the fetus and child: links and possible mechanisms. A review. Neuroscience and Biobehavioral Reviews, 2005. 29(2), 237–58.
- Van den Bergh, B.R.H. Developmental programming of early brain and behaviour development and mental health: a conceptual framework. Developmental Medicine and Child Neurology, 2011. 4, 19–23.
- Chizhevsky A.L. Earthly echo of solar storms. M.: Publishing House “Thought” 1976. 368s. Rus
- Nazarenko L.G., Semerinskaya I.A. Mechanisms for the formation of cord entanglement around the fetus. Women's Health. 2012. 5 (71): 22-25. Rus
- Nazarenko L.G., Semerinskaya I.A., Belyaev S.G. Birth of a child with cord entwined: a view from the position of heliobiology. Tauride Medic-Biological Bulletin. 2012. 15 (2): 153-157. Rus
- Turner JRG, Turner-Groot TGN Prebirth Memory Discovery in Psychotraumatology Int. J. Prenatal and Perinatal Psychology and Medicine, 1999. Vol.11(4):154-159.
- Brekhman G.I. Encircling the Neck of the Unborn Child with the Navel-String and the Fear of Snakes. Int. J. Prenatal and Perinatal Psychology and Medicine. 1998. 10(2):175-180.

Nikola Tesla as a Case Study for Quantum-Holographic Correlations of Individual and Collective Consciousness: Creative and Spiritual Implications

Dejan Raković

Faculty of Electrical Engineering, University of Belgrade, Serbia
rakovicd@etf.bg.ac.rs

ABSTRACT

Nikola Tesla's visions and inventions realized in his controlled altered states of consciousness are proposed as manifestations of his meditative insights through macroquantum correlations of individual and collective consciousness, with significant quantum-holographic creative-educational and psychosomatic-spiritual implications. On the one hand, they can provide guidelines for a deeper understanding of the quantum-holographic framework of holistic control of creativity and education – based on a mentally-focused increase of macroquantum correlations between individual and collective consciousness. On the other hand, they can provide guidelines for a deeper understanding of the quantum-holographic framework of holistic control of psychosomatics and spirituality – based on a mentally controlled systematic reduction of macroquantum correlations of individual and collective consciousness. In a wider context, Tesla's overall research can be an inspiration for reconsidering global educational / informational / political goals – with a reorientation to holistic subtle actions for solutions of the global risk society. *Keywords:* Nikola Tesla, Hopfield-like neural-networks quantum-holographic framework, quantum-holographic primal source, normal & altered states of consciousness, individual & collective consciousness, macroscopic quantum correlations, integrative medicine & transpersonal psychology, creativity & education, psychosomatics & spirituality.

INTRODUCTION

Nikola Tesla is undoubtedly the greatest inventor in the history of electrical engineering, and what makes him especially fascinating was his unusual mental control of creative visions [1]. Regarding Tesla's extraordinary creative experiences in his altered states of consciousness (categorized in his time as nonphysical phenomena) – Tesla's conviction *"when we start to study nonphysical phenomena, we will progress more in ten years than we have for centuries"* then becomes clearer. In this context, it seems that Tesla's legacy for the new millennium is introspective evidence of his transpersonal creative communications, with fascinating possibility of his meditative eidetic control & increase of macro-quantum correlations with the quantum-holographic primal source of collective consciousness. (cf. Fig. 1(a)). It could serve as an extraordinary case study for understanding biophysical basis of both transpersonal psychology & control of creative processes, based on subtle interplay of normal & transitional & altered states of consciousness in meditation & sleep, and may help in developing future strategies for education [2-4].

These phenomenological insights could also provide additional understanding of our Hopfield-like neural macroscopic *quantum-holographic / quantum-gravitational (QHQG)* theoretical framework for quantum-informational transpersonal psychosomatics, based on systemic decrease of quantum entropy & macro-quantum correlations of acupuncture system / individual consciousness & collective consciousness (cf. Fig. 1(b)), which may help in developing future strategies for integrative medicine & transpersonal psychology; and in wider context, Tesla's whole research & life could also provide an inspiration for reconsideration of global educational / informational / policy goals – with reorientation towards holistic gentle actions for solutions of the global risk society [3,4].

The paper is organized as follows. Section 1 introduces the motivation for studying introspective evidence of Tesla's transpersonal creative communications in his meditative altered states of consciousness. Section 2 considers implications of creatively-entangling quantum correlations of individual & collective consciousness, while Section 3 considers implications of the spiritually-disentangling quantum correlations of individual & collective consciousness. Section 4 presents discussion on wider trans-generational support of our QHQG theoretical framework of psychosomatic integrative medicine & transpersonal psychology, while Section 5 concludes on significance of this framework for understanding holistic control of creativity & education and importance of integrative medicine & transpersonal psychology. Appendix provides additional notes on macro-quantum phenomena in biology, medicine & psychology, based on our QHQG theoretical framework for holistic psychosomatics & transpersonal psychology, including implications on fundamentals of quantum informatics & proposed experimental tests as well.

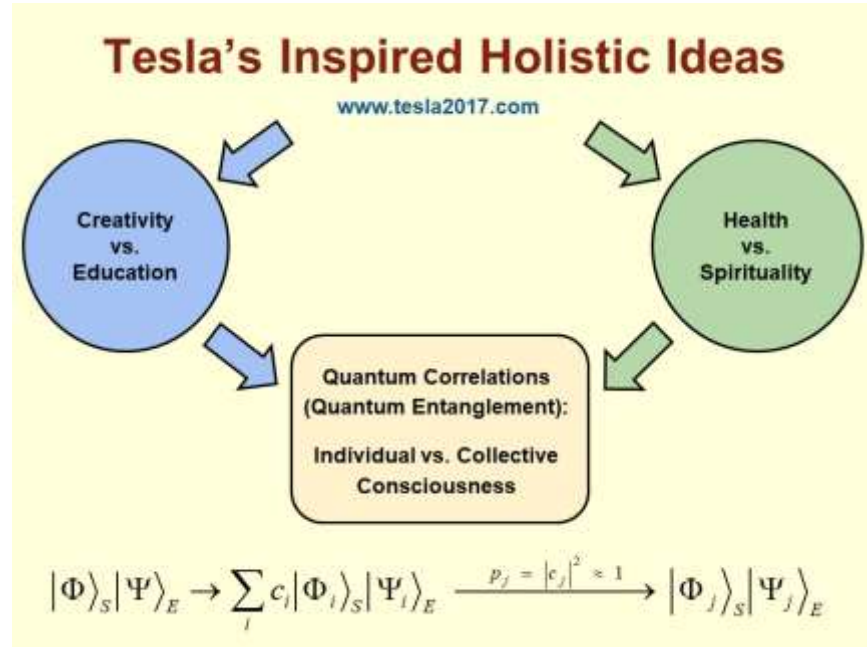


Figure 1. (a) Symbolic representation of *mentally controlled-directed increasing* of macro-quantum correlations of interacting individual consciousness (S) and collective consciousness / environment (E) in *transpersonally-entangling creative phases* (left-hand side of the image and formula above, with previous mental increase of the focused weight contribution c_j and subsequent (practically non-stochastic) classically-reduced selection of this dominant weight contribution c_j); and (b) Symbolic representation of *mentally controlled-systemic decreasing* of macro-quantum correlations of interacting individual consciousness (S) and collective consciousness / environment (E) in *transpersonally-disentangling spiritual phases* (right-hand side of the image and formula above, with previously systemic mental decreasing of almost all weight contributions c_i and subsequent (practically non-stochastic) classically-reduced selection of the remaining dominant weight contribution c_j (related to mentally-embedded address on the founder of the corresponding mystical tradition)).

CREATIVE IMPLICATIONS OF QUANTUM CORRELATIONS OF INDIVIDUAL & COLLECTIVE CONSCIOUSNESS: TESLA'S PATH OF MENTALLY CONTROLLED DIRECTED TRANSPERSONAL ENTANGLING

Tesla's introspective analyses may provide *a direct clue* for deeper understanding of QHQG *theoretical framework for holistic control of creativity & education – based on meditation insights & carefully guided & increased macro-quantum correlations of individual & collective consciousness* [2-4], as will be elaborated below.

During his stay in Budapest (1881/1882), in looking for employment after leaving his engineering studies, Tesla was beset by his need to detach the commutator from the machine [1]: *"I started by first picturing in my mind a direct current machine, running it and following the changing flow"...* His incessant thinking produced a complete nervous breakdown... The breakdown quickened and sharpened his perspective a hundredfold... His pulse fluctuated from very low to 260 beats per minute... His physical state had completely deteriorated... [By his incessant meditative efforts Tesla presumably had *awakened his kundalini vital energy* in the base of spine [2-5], which abruptly opened his *doors of perception*, usually causing permanent psychosis in persons mentally unpurified previously, but Tesla succeeded to recover owing to his *pure soul*, and subsequently a series of his incredible *meditative inventions* began (in state described in Patanjali's Yoga Sutras as *Ritam Bhara Pragya*, '*when mind perceives things as they are*' [5]) (Author's note).]... After nearly a year of unsuccessful treatment, during repeating walks with his colleague Szigeti in the City park, Varosliget, he was regaining his strength. On one occasion, during a walk in the park toward the end of February, Tesla looked at the setting sun, and began to recite the glorious passage from Goethe's Faust [...] *"As I uttered these words, the idea came like a flash of lightning... and in an instant the truth was revealed. I drew with a stick on the sand the diagram of my motor... secrets of nature which... I had wrested from her against all odds and at the peril of my existence... See, how smoothly it runs. No commutator, no brushes, no sparking. As the current in one coil decays, in the adjacent coil it increases, coil after coil, creating new magnetic rotating fields and pushing the shaft continually... In less than two months, I evolved virtually all the types of motors and modifications of the system now identified with my name... it was a mental state of happiness as complete as I have ever known in life. Ideas came in an uninterrupted stream and the only difficulty I had was to hold them fast."*

Tesla was absolutely convinced in similarity of scientific and artistic ideas [1]: *"They are coming from the same source."* This viewpoint is similar to Plato's, but Tesla did not come to that speculating philosophically, as he had experienced the world of ideas from the boyhood: *"When a word was spoken to me the image of the object it designated would present itself vividly to my vision and sometimes I was quite unable to distinguish whether what I saw was tangible or not ... Sometimes it would remain fixed in space though I pushed my hand through it..."* [Quantum hologram [2,4], in Tesla's quantum-coherent stationary altered states of consciousness? (Author's note)]... *Then, instinctively, I commenced making excursions beyond the limits of the small world of which I had knowledge and saw new scenes. These were at first very blurred and indistinct, and would flit away when I tried to concentrate my attention upon them, but, by and by, I succeeded in fixing them; they gained in strength and distinctness and finally assumed the concreteness of real things. I soon discovered that my best comfort was attained if I simply went on in my vision farther and farther, getting new impressions all the time, and so began to travel – of course in my mind. Every night (and sometimes during the day) when alone, I would start my journeys... [Astral journeys [2-5], in Tesla's quantum-entangled non-stationary transitional states of consciousness? (Author's note)]... I have been practicing this until my seventeens, when my thoughts turned to inventions seriously."*

Our QHQG *theoretical framework* also imply that quantum-holographic hierarchical parts carry information about the whole (which resembles the Hindu relationship *Brahman / Atman*, as a whole and the part which contains information about the whole [2-5], pointing to subtle *fractal coupling of various hierarchical levels* in Nature [6,7], and to *origin of the amazing creativities* (with Tesla & Mozart as extraordinary case studies [2,8]!). It also suggest *two modes of knowledge*, according to the coupling strength consciousness-body-environment [2-5]: *weakly-coupled direct mode* (in the *out-of-body spiritual-*

creative *quantum-entangled non-stationary transitional states of consciousness & quantum-coherent stationary altered states of consciousness*, like prayer, meditation, daydreams, lucid dreams, creative insights...) & *strongly-coupled indirect mode* (in *bodily* perceptively-rationally mediated *classically-reduced stationary normal states of consciousness*, like sensory perception, logic and scientific reasoning...) – with conditions of mutual transformation.

In the context of *Tesla's extraordinary creative insights & inventions* (directly visualized in his consciousness with the details of the functioning of the devices, without any application of Maxwell's electromagnetics!), it is interesting to consider the *possibility of controlling creative processes within our QHQG theoretical framework* [2-4,9]. They predict the *transpersonal properties* of the psyche in the short-lasting *quantum-entangled transitional states of consciousness* (with subsequent *classically-reduced stationary extrasensory perception of the previously focused mentally-addressed out-of-body complementary environment*, cf. Fig. 1(a) as well, which may also be *Jung's archetype of the problem-with-solution at the level of quantum-holographic collective consciousness*, which raises associations on *Tesla's mental inventions & Plato's world of ideas* too).

After returning of the displaced consciousness upon the body, in order that *transpersonally acquired information ascends to the level of normally conscious state*, it is necessary to overcome two filters [2-4,9]: *acupuncture system / nervous system threshold filter* (which requires *emotional colouring* of the solving problem) & *frontolimbic amplification filter* (which requires *emotional-thinking priority* of the solving problem). According to our investigations, all mentioned conditions might be realized in quantum-coherent stationary state of *waking meditation* (by entering in this prolonged altered state of consciousness, with mental addressing on the solved problem) – which *Tesla* has been doing by *persistent mental focusing* on the solving problem as described in Introduction!

On the other hand, during the *sleep state* the mentioned conditions might be realized in quantum-entangled non-stationary transitional states of *falling asleep* & quantum-coherent stationary states of *REM-sleep* (with previous *intense concentration* on the solving problem before sleep & *subsequent amplification* of the obtained classically-reduced answer in the form of symbolic dream, which should be then *correctly interpreted* in the context of personal internal symbolism) – *widely applicable* even to meditation-non-trained persons [2-4,9]. Of course, for solving conceptually complex *scientific problems* it is necessary to be an *expert* in the corresponding field, in order to *scientifically rationalise a solution* representing scientific shift.

The same might be applied to *artistic creative experiences* & their subsequent *artistic expressions* (*Mozart as extraordinary case study* [8]!), while very *art-works* then behave like *mental addresses of archetypes* being in contact with artists in mentally-addressed transpersonal communications during the acts of creation [2-4,9]. Then *deep artistic experiences of the public* might have strong *spiritual notes* too, through *spontaneous mental addressing of the artistic public on the masterpeace & emotionally-induced excitation into transitional state of consciousness*.

Finally, this could similarly be extended to *deep spiritual experiences of the believers* with their *mental addressing on holy icon / relic* & *emotionally-induced excitation into transitional state of consciousness* [2-4,9].

SPIRITUAL IMPLICATIONS OF QUANTUM CORRELATIONS OF INDIVIDUAL & COLLECTIVE CONSCIOUSNESS: MYSTIC'S PATH OF MENTALLY CONTROLLED SYSTEMIC TRANSPERSONAL DISENTANGLING

Tesla's introspective analyses may provide *an indirect clue* for deeper understanding of our QHQG *theoretical framework for integrative medicine & transpersonal psychology by imposing healing boundary conditions – based on methods & techniques for decrease of quantum entropy & macro-quantum correlations of acupuncture system / individual consciousness & collective consciousness* [4,9-15], as will be elaborated below.

Additionally, if put in the theoretical context of the fundamental *holographic principle* [16], according to which any 3D physical system is *isomorphic* to the holographic information embedded on its 2D surface, then *quantum-holographic informational content of a body* could also be contained in *corresponding surface layer of vital energy of the astral-mental body (aura)*, as has been stated in various traditions [5,17,18] - in accordance with our extended QHQG theoretical framework for psychosomatics and proposed close relationship of the acupuncture system and consciousness (supported by meridian psycho-energy therapies as well, with rapid elimination of traumas, phobias, allergies and other psychosomatic disorders, by simultaneous emotional-involved intensive visualization of psychosomatic problems and tapping / touching on prescribed acupuncture points [9,19])!

According to our QHQG theoretical framework, *spontaneous transpersonal communications*, with exchange of information in transitional states of consciousness, would have *negative psychosomatic-spiritual effects*, giving rise to *global trans-generational increase of psychosomatic loads* on the level of quantum-holographic network of *collective consciousness* – which might represent the *sin / karmic engine of history*. *The only phenomenon which decreases these loads might be all-forgiving prayer to ourselves & others* (relatives, enemies, decided) – *probably via simultaneously vacuum-excited spiritually-purifying new macro-quantum portions of vital energy* (similarly to spiritually-excited & mentally-channeled Ayurvedic, Qigong, Reiki and modern experiences of local & transpersonal healing [9-15]!) *in prayer-related persons* – as *(decoherence-like) quantum-gravitational non-stationary indeterministic purifying interventions in unitary intrinsic quantum-holographic stationary evolution of collective consciousness!*

In the context of the *predestined trans-generational cosmic quantum hologram of collective consciousness*, in a deep psychotherapeutic terminology the possibility of its *optimization by spiritual purification* would be reduced to *dis-entangling / un-binding from almost all levels of individual & collective consciousness*, and consequently to *full re-integration of the higher Self* – by its *re-union with spiritual primal source* (with previous mentally controlled systemic decreasing of macro-quantum correlations of individual & collective consciousness, cf. Fig. 1(b) and Appendix in ref. [4]). This might leave most room for *free will & influence on future preferences* – making the role of every person *indispensable* due to influence & concern for *collective mental environment!*

Our QHQG theoretical framework implies the *generally poor informational rationalization* of any direct quantum-holographic spiritual / religious *mystical experience* (as the problem of quantum theory of measurement, related to the reduction of the implicate order of the quantum-entangled (quantum-holographic) non-stationary superposition of two-partite states into the particular explicate order of the corresponding measuring classically-reduced stationary one-partite states). And might help us understand that all our partial rationalizations (classically-reduced mappings!) are still an approximation of the fundamental-holistic reality (quantum-holographic territory!), *which differ from tradition to tradition* [17]. On the other hand, *the consensuses of the mystics of the same tradition on a similar partial rationalization of mystical experiences* could be understood as *part of the same dominant-channeling trans-generational contextual heritage of members of the same tradition* (because we are not born as so-called *tabula rasa*, as being indicated by the aforementioned contemporary experiences of experiences of different traditions [17] and hypno-regressions [20] as well).

This is close to experiences of numerous *shamanistic tribal traditions*, with beliefs that the *genuine* (quantum-holographic) reality is represented by *lucid dreams*, and that (classically-reduced) waking state

is lie / illusion (*maya*, as stated in the *traditions of the East*). So *science might be closing the circle, by re-discovering two different modes of knowledge* and setting its own *epistemological limitations* too [2-4,9-15] – as preserved for millennia in *shamanistic tribal traditions* [17,18], or as concisely described by *Patanjali* more than two millennia ago, pointing out that mystical experience (*samadhi*) is "*filled with truth*" & "*above inference and the scriptures*" [5], or as formulated at the beginning of the last century by *Berdyayev* as the difference of two modes of knowledge, *prayer-mediated "comprehension of affairs invisible"* & *rationally-mediated "comprehension of affairs visible"* [21]!

In addition, the necessity of direct quantum-holographic coupling of individual & cosmic collective consciousness in an observation of the implicate order might need weak out-of-body quantum-communication coupling consciousness-environment, i.e. previous *reprogramming of all psychosomatic loads* (cleansing of the possessive or hedonistic emotional-mental sinful / karmic connections with world – which as loading *mental addresses* would give rise to quantum projections of the mentally-channelled tunnelled consciousness upon the out-of-body environment, and thus to classically-reduced *out-of-body extrasensory observing* of the mentally-addressed environment). In this context the efforts of mystics of all traditions to *purify consciousness / soul via spiritual practice* (prayer, meditation...) and thus to reach their *final eschatological goal* (Kingdom of God, nirvana...), i.e. *post-mortem salvation of soul* (non-bounded sin-free / karmic-free) by *re-union (re-ligare / yoga)* with the *supreme God* [22] might appear reasonable!

Finally, *several-millennia controversy about post mortem evolution of the soul* [17] is probably related to an *interpretative epistemological level* of transpersonal transfer of mentally-addressed loads within the existing generation and further generations via network of collective consciousness, with possibility that particular strong conflicts transferred as "ego-states" leave a strong impression of previously lived lives [9]; but what is the *ontological spiritual reality* – could remain *permanent controversy* of all these principally limited attempts of *human rationalization* [22].

DISCUSSION ON WIDER TRANS-GENERATIONAL IMPLICATIONS

In this section we present discussion on wider trans-generational support of our QHQG theoretical framework of psychosomatic integrative medicine & transpersonal psychology, coming from various traditions.

In the context of the above *proposed mechanism of prayer (which intrinsically non-unitary sets the necessary new boundary conditions without mutual mentally-loaded addresses, cf. Sect. 3)* - it can really be said that an *all-forgiving prayer* represents a biophysical basis for the optimization of (*quantum*) *holistic global psychosomatics of collective consciousness* (and complementary incoming individual and collective events) [9]! Let us add that both traditional and modern experiences of local and transpersonal energy healing [15] (by spiritually-excited and mentally-channeled new macro-quantum portions of vital energy and their subsequent mentally-channeled transfer), indicate that *meditative visualization imposes new (decoherence-like) quantum gravitational boundary conditions* (but, in contrast to prayer, *it would not eliminate simultaneously all mentally-loaded addresses, and would balance energy-informationally only one particular client*; therefore, in such situations, it is necessary to do *circular meditative-healing visualization from all meta-positions involved in the existing conflict, thus eliminating simultaneously all mentally-loaded addresses*)! Hence, in the context of our QDQH theoretical framework, *spiritual prayer / meditation practices represent non-unitary source of free will at the level of collective consciousness*, which evolutionary *increases the responsibility of every individual and the whole human race* [4,9-15]!

It is hereby also instructive to mention *Buddhist* interpretation of *karma*, which occurs not as a *result of our spontaneous reaction* to the current situation in life, but as a *result of the latter justification of our conscious reactions against the others* in this situation [23]! In the context of the above mentioned *quantum-holographic predestined life programs* (and experiences of various traditions [17] and post-hypnotic regressions [20]), this is fully justified because we all (*non-consciously*) *react to current conflicting-encoded life-situations* (several hundred miliseconds before we become aware [24]!), but immediately afterwards we have a chance to (*consciously*) *permanently untangle the existing trans-generational conflict*

by *penitent-all-forgiving prayer*. This might be possibly the reason for *Christianity* to insist on *repenting and forgiving*, as anything else would enhance the existing mental / emotional personal loads and enlarge evil in the world, dismissing an individual and humankind from the final spiritual ideal of sinless state of individual and collective consciousness!

Bearing in mind the role of a mentally loaded contents in the *post-mortem spiritual evolution of the soul* of the dying (let us mention transpersonal collective levels of consciousness of *Bardo levels* in Tibetan tradition [25] or *aerial toll house* in Christian tradition [26]) - this implies importance of prayers for soul of the deceased with ability not only to *influence its spiritual evolution*, but also *trans-generational preferences for individual and / or collective future offspring* (with possibility of even *retroactive-nonlocal trans-generational dis-entangling / un-binding of mental / emotional conflicts*, as suggested by *experiments with prayer* [27] - bearing resemblance to quantum delayed choice experiments [28], and pointing additionally to quantum roots of consciousness)!

In the context of *trans-generational* cosmic quantum hologram, although on the level of collective consciousness everything is *quantum-holographically predestined* - as suggested by experiences of different spiritual traditions [17] and post-hypnotic regressions [20] as well - they also suggest the possibility of *optimizing life-programs by spiritual purification*. In particular, let us mention Hawaiian *ho'oponopono* tradition with *remarkable reprogramming of the life situations by contextual repenting and forgiving ourselves* [29]; or South American *ayahuaska* and Nigerian *Abiku* traditions with *fascinating spiritual diagnoses and extensions of the predestined-short-life programs* [15]; or *fascinating world bestseller of Anita Moorjani* [30] on *spiritual changing her life program* with return from clinical death and after a few weeks *spontaneous healing of terminal phase of cancer*; or contemporary spiritual teaching of *Bruno Groening* with *incredible healing channel* remained open after his death [31], *in optimizing both individual and collective life programs*! [This greatly contributes to our understanding that even *most difficult psychosomatic disorders have their roots in the energy-information blockages*, and that *healing begins by removing them* - first lovingly to ourselves, accepting ourselves and forgiving ourselves, which is then manifested by love to others and acceptance of others (e.g. by spiritually dis-entangling / un-binding repentant-forgiving prayer [9,10])!]

CONCLUSION

Regarding presented Tesla's extraordinary creative experiences in his meditative states, his conviction "when we start to study non-physical phenomena, we will progress more in ten years than we have for centuries" - *represents Tesla's legacy for new millennium & path to QHQG primal source* - revealing possibility for control of macro-quantum correlations of individual & collective consciousness. Thus, Tesla's introspective analyses may provide a clue for deeper understanding of *QHQG theoretical framework for holistic control of creativity & education* - based on meditation insights & subtle interplay of normal & transitional & altered states of consciousness - in carefully guided & increased macro-quantum correlations of individual & collective consciousness.

Also, Tesla's introspective analyses may provide a clue for deeper understanding of *QHQG theoretical framework or integrative medicine & transpersonal psychology by imposing healing boundary conditions* - based on methods & techniques for decrease of quantum entropy & macro-quantum correlations of acupuncture system / individual consciousness & collective consciousness.

In wider context, Tesla's whole research may also provide an inspiration for *re-consideration of global educational / informational / political goals* - with re-orientation towards holistic gentle actions for solutions of global risk society - suggesting necessity of *grand synthesis of two modes of knowledge* in the framework of our *extended QHQG paradigm*, and thus helping future strategies to *achieve & maintain a state of complete physical, mental & social well-being on near & large scales*.

APPENDIX

In this Appendix we shall outline additional notes on *macro-quantum phenomena in biology, medicine & psychology*, based on our *QHQG theoretical framework* for holistic psychosomatics & transpersonal psychology & related long standing open problems of biophysical nature of acupuncture system & consciousness & qi / prana / vital energy / uncreated light, including implications on fundamentals of quantum informatics & proposed experimental tests as well. This is in line with increasing interest in macro-quantum informational trends in biology, bioresonant quantum-informational medicine technologies, cognitive science & consciousness studies, all the way down to quantum-informational roots of the universe (cf. Appendix in ref. [3], and refs. therein).

Notes on Quantum Biology

Ad.1. It should be noted that *a number of macro-quantum phenomena in biomolecules & open biological cells* might be accounted within our *QHQG theoretical framework* – related to mechanisms of quantum-holographic projection of the healing boundary conditions in the energy-state space of the acupuncture system / (individual & collective) consciousness of the patients on the lower *quantum-holographic hierarchy* all the way down to the cellular & biomolecular levels, thus changing the *expression of genes* in morphogenesis – as a very important feedback element of *bioinformatics* (so-called "*downward causation*") (cf. footnotes 5 and 6 of Appendix in ref. [3]).

Ad.2. It should be added, that *quantum nature of water* (and its fundamental quantum-informational nature as Hopfield-like quantum-holographic neural network), with its numerous memory attractors, might also *mediate in coupling* quantum-informational intra-cellular & extra-cellular biochemical reactions (this being the possible quantum-informational basis of *homeopathy* & some intriguing *field-mediated experiments*) (cf. footnote 7 of Appendix in ref. [3]).

Notes on Quantum Medicine

Ad.3. Our *QHQG theoretical framework* for psychosomatics implies necessity to focus on *origins of many psychosomatic problems on underlying prenatal trans-generational levels* – with their roots in the energy-information *blockages at different levels of consciousness* (caused by trans-generationally-predestined stressors such as fear, frustration, anger, hatred ...) – while *healing* would begin by their *integration* with healthy core of personality, through unconditional *spiritual & forgiving acceptance of ourselves & our environment* (cf. footnote 8 of Appendix in ref. [3]).

Ad.4. As *there is no out-of-cosmic environment that triggers the non-unitary decoherence* of the quantum-entangled non-stationary state of "cosmic-field-collective-consciousness" & "complement-cosmic-particle-environment" – *the proposed mechanism of prayer* (probably via simultaneously vacuum-excited spiritually-purifying new macro-quantum portions of qi / prana / vital energy / uncreated light) *might impose (intrinsically, non-unitary!) necessary boundary conditions without mutual mentally-loaded addresses in prayer-related persons*, as a *source of free will* at the level of *collective consciousness* (cf. footnote 9 of Appendix in ref. [3]).

Notes on Quantum Psychology

Ad.5. On the same traditional line, it should be pointed out that many *transpersonal esoteric concepts associated with consciousness are phenomenologically well known* (as repeatedly experienced by "holy men" of different spiritual traditions) – and their physical explanation should be sought on the very border of the current scientific paradigm (cf. footnote 10 of Appendix in ref. [3]).

Ad.6. Psychotherapeutic experiences from *post-hypnotic regressions provide systematized messages* that our major life lessons & opportunities are lying in the spiritual sphere *in order to optimize the otherwise predestined life-programs* – and their physical explanation might be sought within our *QHQG theoretical framework* (cf. footnote 11 of Appendix in ref. [3]).

Notes on Quantum-Gravitational (Bio)Informatics

Ad.7. According to our QHQG theoretical framework of consciousness & psychosomatics, *physical explanation of transpersonal phenomena without space-time barriers* (even practically incorporated in psychosomatic energy-correction) – presumably might be sought in invited combination of *quantum-gravitational-like transitional states of consciousness & Principle of equivalence & objective reduction of quantum wave function* (cf. footnote 12 of Appendix in ref. [3]).

Ad.8. Within our QHQG theoretical framework of consciousness & psychosomatics, *explanation of the long standing open problems of the physical nature of psychosomatic acupuncture system & consciousness, including exotic transpersonal aspects of qi / prana / vital energy* (essentially important for our functioning according to Eastern traditional medicine) – should presumably be sought on deeper quantum-gravitational level as well (cf. footnote 13 of Appendix in ref. [3]).

Notes on Proposed Experimental Tests

Ad. 9. Mapping of field-related collective consciousness in *meditation-guided creativity tests on small & large scales*.

Ad.10. Mapping of field-related collective consciousness in *post-hypnotic regression tests on small & large scales*.

Ad.11. Optimizing of field-related collective consciousness in *prayer-disentangling tests on small & large scales*.

Ad.12. Testing of decreasing quantum entropy of acupuncture systems in *acupuncture-based & consciousness-based anti-stress treatments*.

Ad.13. Testing of increasing quantum correlations of healers' & healees' acupuncture systems in *transpersonal anti-stress treatments*.

Ad.14. Testing of healers' quantum-exotic vital energy & out-of-body extensions of acupuncture channels in *transpersonal anti-stress treatments*.

ACKNOWLEDGEMENTS

This paper is partly financed by the Serbian Ministry of Education, Science and Technological Development, Project No. 178027 (coordinated by Life Activities Advancement Center (LAAC), Belgrade). I am also grateful to Steve Mehl, American retired clinical psychologist and longtime TM practitioner, for sharing his personal experience and ancient Vedic knowledge on the deep level of consciousness called Ritam Bhara Pragma (described in Patanjali's Yoga Sutras and literally meaning 'when mind perceives things as they are'), supporting in his recent correspondence my theoretical insights into Tesla-like deep origins of creativity.

REFERENCES

- N. Tesla, *My Inventions: The Autobiography of Nikola Tesla*, Hart Brothers, Williston, 1983, the original six-part series was published in *Electrical Experimenter Magazine* in 1919.
- D. Raković, "On nature and control of creativity – Tesla as a case study," in: D. Karabeg, J. Park, eds., *Proc. 2nd Int. Workshop on Knowledge Federation*, Dubrovnik, Croatia, 2010, CEUR-WS.org/Vol-822, 2011; and refs. therein.
- D. Raković, "Tesla's legacy for new millennium: Path to quantum-holographic primal source", *Int. Congress Nikola Tesla 2017: Disruptive Innovation*, Belgrade, 02 July 2017, Invited lecture, and refs. therein; Preprint available: http://www.dejanrakovicfund.org/radovi/2017_TESLA_Ple.pdf
- D. Raković, "On extended quantum-holographic framework for control of macro-quantum correlations of individual and collective consciousness", in: B. Reljin, S. Stanković, eds., *Proc. 14th NEUREL*, IEEE Serbia & Montenegro Section, Belgrade, 2018, paper S2.5.

- Swami Prabhavananda, Ch. Isherwood (tr.), *The Yoga Sutras of Patanjali. How to Know God*, New American Library, New York, 1969.
- M. Rakočević, "The universal consciousness and the universal code", in: D. Raković, Dj. Koruga, eds., *Consciousness: Scientific Challenge of the 21st Century*, ECPD, Belgrade, 1995, pp. 264-282.
- G. G. Dlyasin, "Alphabetic systems generating the new paradigm", in: M. Sovilj, M. Subotić, eds., *Proc. Speech & Language 2019*, LAAC / IEPSP, Belgrade, 2019, Invited lecture, in press.
- F. Holmes, *The Life of Mozart Including his Correspondence*, Chapman & Hall, 1878, 211.
- D. Raković, *Integrative Biophysics, Quantum Medicine, and Quantum-Holographic Informatics: Psychosomatic-Cognitive Implications*, IASC & IEPSP, Belgrade, 2009; and refs. therein.
- D. Raković, "On quantum-holographic bases and frontiers of integrative medicine and transpersonal psychology: Psychosomatic, epistemological, and spiritual implications," in: G. Brekhman, M. Sovilj, D. Raković., eds., *Proc. 1st Int. Congress on Psychological Trauma: Prenatal, Perinatal & Postnatal Aspects (PTPPA 2015)*, LAAC / IEPSP, Belgrade, 2015, pp. 59-72; and refs. therein.
- D. Raković, "On quantum-holographic and trans-generational implications for child development," in: J. R. G. Turner, T. G. N. Turner, O. Gouni, eds, *Prenatal Psychology 100 Years: A Journey in Decoding How Our Prenatal Experience Shapes Who We Become!*, A publication of The International Journal of Prenatal & Life Sciences, Cosmoanelixis, Athens, 2018, Ch. 7, pp. 283-310; and refs. therein.
- D. Raković, "On extended quantum-holographic framework for consciousness and free will: Round trip from science to spirituality", to be published in: J. R. G. Turner, T. G. N. Turner, O. Gouni, eds., *Proc. Int. W-S Congress "Whole-Self Approaches in Psychology & Medicine"* (13-14 Sept. 2019, Grootebroek, NL, Invited tutorial, preprint); and refs. therein.
- D. Raković, "On bioresonant pattern-qua-attractors and healing boundary conditions within quantum-holographic psychosomatics," in: B. Reljin, S. Stanković, eds., *Proc. 13th NEUREL*, IEEE Serbia & Montenegro Section, Belgrade, 2016, pp. 9-13; and refs. therein.
- D. Raković, "Quantum-informational bases and frontiers of psychosomatic integrative medicine," in: B. Reljin, S. Stanković, eds., *Proc. 12th NEUREL*, IEEE Serbia & Montenegro Section, Belgrade, 2014, pp. 105-110; and refs. therein (similar Plenary lecture presented at: *7th Europ. Congress for Integrative Medicine (ECIM 2014)*, Belgrade, Serbia, 10-11 October 2014).
- In: D. Raković, S. Arandjelović, M. Mićović, eds., *Proc. Symp. Quantum-Informational Medicine QIM 2011: Acupuncture-Based & Consciousness-Based Holistic Approaches & Techniques*, QUANTTES & HF & DRF, Belgrade, 2011; and refs. therein.
- L. Susskind, J. Lindesay, *An Introduction to Black Holes, Information and the String Theory Revolution: The Holographic Universe*, World Scientific, Singapore, 2005.
- M. Eliade, H. S. Wiesner, I. P. Couliano, *The Eliade Guide to World Religions*, Harper, San Francisco, 1991.
- M. Talbot, *The Holographic Universe*, HarperCollins, New York, 1991.
- R. J. Callahan, J. Callahan, *Thought Field Therapy and Trauma: Treatment and Theory*, Indian Wells, 1996.
- M. Newton, *Journey of Souls*, Llewellyn, Woodbury, 1994.
- N. Berdyaev, *Philosophy of Freedom*, Logos Ant, Beograd, 1996; Serbian translation from Russian (1911).
- P. Vujićin, "States of consciousness in esoteric practice," in: D. Raković, Dj. Koruga, eds., *Consciousness: Scientific Challenge of the 21st Century*, ECPD, Belgrade, 1995, pp. 89-136.
- D. Panajotović, *Buddhism: Guide to Theravada Buddhism*, Udruženje srpskih izdavača, Belgrade, 2011, in Serbian.
- D. C. Dennett, *Consciousness Explained*, Little Brown, Boston, 1991.
- W. Evans Wentz, *The Tibetan Book of the Dead*, Oxford Univ, London, 1968.
- Father Seraphim Rose, *The Soul After Death*, St. Herman of Alaska Brotherhood, Platina, 1988.
- L. McTaggart, *The Intention Experiment: Using Your Thoughts to Change Your Life and the World*, Free Press, New York, 2007.
- J. A. Wheeler, "Law without law," in: J. A. Wheeler, W. H. Zurek, eds., *Quantum Theory and Measurement*, Princeton Univ Press, Princeton, 1984, pp. 182-213.
- J. Vitale, I. Hew Len, *Zero Limits: The Secret Hawaiian System for Wealth, Health, Peace, and More*, Wiley, Hoboken, 2007.
- A. Moorjani, *Dying To Be Me: My Journey from Cancer, to Near Death, to True Healing*, Hay House, Carlsbad, 2012.
- M. Kamp, *Healing the Spiritual Way Through the Teachings of Bruno Gröning*, Monchengladbach, Germany, 1999.

Speaking Through Our Eyes©2019

Jon RG Turner, Troya GN Turner, Olga Gouni,
Grigori I Brekhman, Dejan Rakovic

ABSTRACT

As attendees at this congress know, speech & language are the most effective, elegant & comprehensive means by which human beings are able to communicate with each other. This paper illustrates some thoughts on our next most important ability - communication through our eyes. Philosophers have said that the eyes are *the mirror of the soul* and that *humans make soul connections through the eyes*. We share some research on how emotions are telegraphed through the eyes. Looking in each other's eyes offers such amazing possibilities for future of relationships. We offer some examples of speaking eyes. Then there are eyes in the fingertips of the visually impaired. At birth, our eyes are opened to a lifetime of evolutionary adventures. At death there is the 'curtain down' for the final act of life – the release of the last breath and the closing of the eyes. Meanwhile, here's looking at you!!!!

Keynote: My friends who have eyes do not see
And those who have ears do not hear
Helen Keller

Helen Keller was an American author and educator who was blind and deaf and whose education using her fingertips in earning a Bachelor of Arts Doctorate from Radcliffe College inspired those including wounded soldiers with similar disabilities.

Preface: This paper is posing questions on origins of non-verbal communication,
and mapping of the outer world onto our inner world (of our consciousness) -
followed later by symbolic and verbal mapping...

Prof. Dejan Rakovic

Sparkling Eyes

In proposing this paper Troya and I had an eye to seeing a lighter view. This was inspired by speaking with a young woman who had eyes that sparkled like diamonds. She was our waitress in June ⁽²⁰¹⁹⁾ at the 98th Birthday Dinner of Troya's mother at a Chinese Restaurant. Our waitress was a young woman who had the most amazing sparkling eyes we had ever seen. We asked her name. She said it was *Diamanta* which is Dutch for *Diamond*. Then she explained that before she was born her mother and father had wanted a boy. But, at her birth she had such sparkling eyes her father said, "her eyes are sparkling like diamonds so we have to name her *Diamanta*!"

Diamanta inspired us to share with you about *Speaking Through Our Eyes*. It could be that her sparkling eyes were sending her parents a mischievous message such 'Fooled you!!!'

This paper illustrates some thoughts on the next most important ability of communication - our eyes. Philosophers have said that *the eyes are the mirror of the soul* and that *humans make soul connections through their eyes*. We share some research on how emotions are telegraphed through the eyes.

We share thoughts, ideas and emotions by articulating them with words. Our eyes are the next main way human beings telegraph emotions. Interestingly, on June 18th ⁽²⁰¹⁹⁾ NBC TV and CNN aired stories describing how dogs have the ability to manipulate humans with their eyes. All dog lovers know that 'puppy dog eyes' are usually all it takes to forgive a chewed-up slipper or to coax out one extra chewy treat.

<https://www.nbcnews.com/nightly-news/video/the-evolution-of-puppy-dog-eyes-62188613610>

Researching this paper we had not intended it to be such a serious approach as Helen Keller's words highlighted by Olga Gouni in her amazing book *Soul Days*. Keller's words in that book were in answer to Olga's hypothetical question:

How do we and the world turn a blind eye? Olga's observation:

Our true challenge is to expand and open our eyes to see each other. Nothing less than looking into each other's eyes can touch our hearts and heal our spirits while anxiety melts away! Nothing less can free our hearts so that we can act with love!

My eyes and my ears are my sensory channels for information and contact; two of our most crucial windows on the world. They can open up to embrace the sight of a safe, beautiful, full of blessings existence or shut down to block entrance of threat in my life; the coldness in a look; anger, rejection or pain in the voice. When I experience the latter, I may avoid the pain from the existence-threatening energy that invades me through my eyes and ears, but I will distort the nature of the data that gets to me and I distort the qualities of my core essence, leading me away from my true (my Whole-Self), from the truth, from love, from my heart. I don't see! I don't hear! I don't understand!

Looking to the eyes, *Whole-Self Prebirth Psychology* offers a duel question:

When and where do the eyes begin to speak?

The answer to *when* is at the moment baby opens her or his eyes at birth. Witnesses describe being astonished by the intensity they observe in the eyes of some babies at this moment of emergence into life. They describe such emotions as: calmness with clarity; inquisitiveness; all shades of emotions ranging from love to anger to hatred. *Whole-Self Prebirth Psychology* suggests that some of the more gazes may be reaction from hormones that had been expressed in mother's body and passed through the umbilical cord to the little body she was growing in her womb for baby to use from her/his birth. *Whole-Self Prebirth Psychology* has shown when mother experiences a trauma during pregnancy her baby is born with her/his mother's 'trauma trance'. This emotion is what we see in baby's emotive eyes at birth.

Where do the abilities to express through the eyes come from?

Whole-Self Prebirth Psychology has hypothesized, and as has been scientifically confirmed by Prof. Dr. Grigori I. Brekhman, that in the 9 months of gestation, baby's consciousness is energetically in communication, on the same frequency, with her/his mother's consciousness - mother's mind and emotions - her bio-energetic field or aura animating her body to which baby's new consciousness has become energetically attached. During gestation, baby's developing consciousness is in bio-energetic symbiosis being educated by mother's thoughts and emotions. This state of prebirth symbiosis being so, at birth, baby's eyes reflect the most charged emotion mother was experiencing during her pregnancy.

An example of an increasing pathology in eyes of newborns is autism. Prof. Brekhman says that autism can be diagnosed as early as the on the third day after birth; the signal being that the child does not look into her/his mother's eyes.

Prof. Brekhman's optimistic prediction about *bonding and attachment*:

In my opinion: a visual contact at the birth confirms the presence of a well-formed, before birth bonding, and makes it possible to predict a good attachment for mother and baby in future.

Avoidance of Eye Contact: An Early Sign of Autism

Early detection and treatment has been declared critical to autism, putting more emphasis on the early identification of the red flags of autism. Early identification of autistic behavior in the first 12 months of infancy enables on-time application of effective therapy, such as *applied behavior analysis (ABA)*, which significantly helps in the treatment of autism. Parents must be educated about the suggestive symptoms of autism, since they are the first ones who can identify them. Infants who avoid eye contact with their parents mostly end up with a diagnosis of autism. This sign falls under the "social skills" category of autism and is regarded as a red flag.

Pediatricians can further evaluate the eye contact problem by observing and asking parents about the following infant behavior traits:

- The baby tends not to look at parents.
- The baby fails to recognize familiar faces.
- The baby does not cry when parents leave them.
- The baby does not show anxiety with strangers.
- The baby tends to gaze out of the corner of the eye.
- The baby has problem following objects visually.

[https://www.special-learning.com/article/avoidance of eye contact an early sign of autism](https://www.special-learning.com/article/avoidance-of-eye-contact-an-early-sign-of-autism)

Recognizing father's voice

Brent Logan, a pioneer in *Prenatal Stimulation*, describes how witnesses were astounded when a newborn turned his eyes across the room with a look of recognition of his father's voice who had just spoken.

<http://www.brillbaby.com/early-learning/experts/brent-logan-1.php>

Science News from research organizations November 29, 2017 University of Cambridge

Eye contact with your baby helps synchronize your brainwaves:

Making eye contact with an infant makes adults' and babies' brainwaves 'get in sync' with each other -- which is likely to support communication and learning.

When a parent and infant interact, various aspects of their behavior can synchronize, including their gaze, emotions and heartrate, but little is known about whether their brain activity also synchronizes - and what the consequences of this might be.

Brainwaves reflect the group-level activity of millions of neurons and are involved in information transfer between brain regions. Previous studies have shown that when two adults are talking to each other, communication is more successful if their brainwaves are in synchrony.

Researchers at the Baby-LINC Lab at the University of Cambridge carried out a study to explore whether infants can synchronize their brainwaves to adults too -- and whether eye contact might influence this. Their results are published in the *Proceedings of National Academy of Sciences (PNAS)*.

<https://www.cam.ac.uk/research/news/eye-contact-with-your-baby-helps-synchronise-your-brainwaves>

Michel Odent's report on the importance of eye contact within an hour of birth to open the communication DNA packet in mother's brain which informs her about mothering and in baby's brain about love, compassion & empathy.

In his book *The Scientification of Love* Odent shares E. Vurpillot's research that:

The newborn infant cannot accommodate its eyes to different distances and seems to be programmed to have a comparatively clear vision of objects that are at a distance of about 1 foot. (The approximate distance between baby's awakening gaze and mother's wonder.) This suggests the importance of the eye to eye contact at the beginning of the mother-baby relationship. It is notable that the high level of noradrenaline released by the baby just before birth which probably facilitates olfactory learning tends to dilate the pupils, so that, when the birth is relatively uninterfered with, the newborn has big eyes and large pupils. It is as if baby was giving a signal to the mother. Finally, even the sense of sight, which may appear as less primitive - or most intellectual - of the senses, is probably involved in the mother newborn interaction.

Corinna Most of the *Center for Academic Research and Training in Anthropogony* "to explore and explain the origins of the human phenomenon" wrote:

Maternal Infant Eye-to-Eye Gaze

Visual following and visual fixation are among the earliest intentional behaviors produced by human infants, and the most salient visual stimuli for an infant in the first months of life are faces and, in particular, eyes. This is likely to be especially true for human babies, because of the strong visual contrast between our white sclera and darker iris. Eye-to-eye contact in humans starts to appear already in the infant's 4th week of life, and there is a dramatic increase in face fixations between 5 and 7 weeks. While it is almost certainly lacking any kind of true social relevance for the infant at this point, it is a strong bonding interaction between mothers and infants. Amount of eye-to-eye contact has been experimentally increased by having mothers imitate their infants, suggesting that this behavior is indicative of the quality of the mother-infant relationship. Sex-differences in eye-contact behavior have been found in 12-month-old infants, with females making more eye contact with males, and fetal testosterone levels being inversely correlated to amount of eye-contact behavior produced. In populations with developmental disorders, infants with Down's syndrome begin making eye-contact later than normal infant, but then sustain it for longer periods of time, while infants with ASD tend to avoid eye-contact altogether.

<https://carta.anthropogeny.org/moca/topics/maternal-infant-eye-eye-gaze>

While there is variance about when eye contact begin in baby's the *Journal of Advanced Nursing* (1981) Nov. 6 (6): 455-9 in Brazil is more in line with Prof. Brekhman and Dr. Odent, writing that eye opening of the newborn at and up to 20 minutes after birth it refers to *The National Center for Biotechnology Information (NCBI)* which is part of the *United States National Library of Medicine (NLM)*, a branch of the *National Institutes of Health (NIH)*.

Early eye contact between mother and baby is considered important in the attachment process between mother and baby.

How soon after birth is it possible for eye contact to occur?

How soon after birth will a baby open her/his eyes spontaneously?

Where is the baby physically at that time?

Is hospital labor ward routine conducive to early eye-to-eye contact between mother and baby?

Discussing these questions with midwifery colleagues, it became apparent that we were unable to answer with any degree of certainty, the question

"How soon after birth will a baby open his eyes spontaneously?"

It was felt that "most babies open their eyes at or very soon after birth".

How soon was "very soon" ?

Did all babies open their eyes soon after birth?

Were there any observable influencing factors? Is so, what were they? In this study of 104 babies, 30 babies opened their eyes at birth, and the remainder, except three, opened their eyes ranging from within 1 minute of birth to within 20 minutes of birth (20 minutes being the time limit set for the study). Some babies were observed to open their eyes momentarily only the very first time, keeping their eyes open longer subsequently. PMID:

PubMed US Natonal Library <https://www.ncbi.nlm.nih.gov/pubmed/6915048>

Psychology Today Mark Matousek on *Ethical Wisdom* Posted Apr 8, 2011

The Meeting Eyes of Love: How Empathy Is Born In Us

The mother's eyes are the refuge where children confirm their existence.

You learn the world from your mother's face. The mother's eyes, especially, are a child's refuge, the mirror where children confirm their existence. From the doting reflection of its mother's eyes, a baby draws its earliest, wordless lessons about connection, care, and love, and about how being ignored - which every

child is sooner or later - makes the good feeling disappear. The mother's gaze, or the father's (if he is the primary caretaker), determines more than you might realize about how you come to see yourself, your place in the world, and the moral nature of people around you. "The meeting eyes of love," novelist George Eliot called this all-important connection. According to Dan Siegal, a psychologist who specializes in early parental bonding, every child yearns for, and must have, this eye contact for healthy emotional development to occur. Siegal, who founded a new field of research known as *interpersonal neurobiology (IPNB)*, has proved that the mother's gaze plays a critical role in how we develop empathy.

<https://www.psychologytoday.com/us/blog/ethical-wisdom/201104/the-meeting-eyes-love-how-empathy-is-born-in-us>

Now, of particular interest for this Speech & Language Audience we bring you the words of Brynn D. Rhodes, M.S., CCC-SLP from AllinaHealth Posted July 17, 2016.

Eye contact helps babies learn to talk

Sure, those much-anticipated first words are still many months away. But communication begins long before those first words around the first birthday. The early nonverbal forms of communication - *eye contact* and *joint attention* are vitally important for laying a solid foundation for language to develop.

Eye contact is an early predictor of language skills

First, an infant develops the ability to focus her/his eyes on a face. As early as four days old, a newborn recognizes his mother's face. The best way to support your baby's development of eye contact is by looking at him while you feed him, since a newborn can only see approximately 8 to 15 inches away, about the distance to your face when holding the baby. Whether breast-or bottle-fed, babies develop foundational social communication skills by looking at a caregiver's face during feedings. When your infant locks eyes with you, and shifts his gaze to notice what you are looking at, this shows joint attention (the social sharing of a moment between two people).

The ability to pay attention to the same thing at the same time as an adult, *coordinated joint attention*, develops between 8 and 15 months of age. The ability to direct your attention, by looking at a desired object then back to your face to indicate nonverbally, "Hey, Mom! Will you please hand me that rattle over there?" develops shortly after *coordinated joint attention*. Directing you nonverbally is also referred to as *triadic gaze* because the child connects three things by looking with his eyes—himself, something else and you. According to a study published in *Infant Behavior and Development*: "early *joint attention* skills are a predictor of a relatively larger early vocabulary." When your baby looks at you, then at an object he wants, then back to you, it shows that he understands he can influence your actions. *Joint attention* begins with baby as a passive participant, responding to the adult's communication. When the infant begins to use his eyes to show you what he wants, he has shifted from a passive participant to an initiator in the parent-child relationship.

Babies learn best from people

Personal interaction is more effective than video or audio recordings in giving very young children the opportunity to learn to use their eyes for nonverbal social communication. Babies rely on the responses and interactions from caregivers to shape their behaviors. Your baby coos. You reward him with a big smile, physical touch and talking to him. Soon he is making happy noises to gain your attention and so begins the joyous dance of bonding with your baby. Your response to his movements and sounds encourages more of the same. making the time to play and spend time with your baby is one of the best ways to help your baby learn.

<https://www.allinahealth.org/healthyssetgo/care/eye-contact-helps-babies-learn-to-talk>

Epilogue

We share with you the “smiling eyes vision” Olga Gouni found of Noboru Kobayashi, M.D., Director, *Child Research Net* at *Children Are Our Future: The Human Science of Mother and Child*, MediScience sha (2000-2006). His fuller document is in our Addendum. Through the eye-to-eye connection, the baby is able to react to following the mother with their eyes, and although under-developed, they are able to show their joy in loving and seeing the mother. The mother, then senses her child's joy in his/her eyes and builds a stronger bond with the baby. Eyesight plays a great role in tying the bond between the mother and child, and making it something rich and wonderful and full of life.

Triumphant Eyes

Annette, our wonderful physio-therapist, told us an delightful story about her 9 and a half month old grandson. He had enthusiastically crawled all the way up a whole flight of the stairs. Then turning to his mother - who had been carefully following him to the top - his gleaming eyes in triumph declared he had conquered his first Everest.

Addendum

Noboru Kobayashi, M.D., Director, Child Research Net January 1, 2002, Section: *Children are Our Future: The Human Science of Mother and Child*, MediScience sha (2000-2006).

A Baby's Focus is Set at 35 cm

When we analyze the mother's actions of cuddling the newborn baby, the longer the mother holds the baby, from the time she picks him/her up, the longer the mother will look into the baby's eyes. Of course a few months after the baby's birth, the baby's pretty eyes begin to show various reactions indicating a more complex communication. The natural reaction to this development of the baby's ability to communicate and see, is the mother's reaction of increased animation when interacting with her baby, which is apparent in every interaction that takes place. The newborn is born with a retina that is the same as any adult's, and has some sort of vision, to the extent where s/he is able to see large objects. Then, at a couple of weeks, the eyes are able to decipher much more, due to a rapid development of the nerves and they are able to identify objects approximately at a distance of 35 centimeters. Whether most mothers know this or not, they always look into the baby's eyes and when they do, it seems they are unconsciously measuring this distance so the baby is able to "communicate" with the mother. In addition, the distance kept between the mother and baby, when the baby is savoring the milk of the mother's breast, is just the right distance for the baby and mother to look into each other's eyes. It seems the mother is a natural at holding the baby in such a position that is most communicative for the child, as she is able to look into the child's eyes and read his/her reactions. When the baby tries to look through his developed eyes, s/he tries to focus the most sensitive part of the retina, which is developed between 2 and 4 months after birth. Furthermore, the ability to focus on one object develops, and the baby is now able to see objects at quite some distance. At about 6 months, the baby is able to decipher the outline of an object about 1 meter away or so. A neonatologist takes the newborn baby and determines if there is any abnormalities in the development of the baby, and detects any developmental disabilities as early as possible. In particular, the nervous system, which is at the center of allowing the baby to react, is examined very closely. However, recently, there has been much more attention paid to the child's eyes and it's glance, his/her reaction to the mother's voice calling, and the emotional cues of the baby. They are called as soft neurological signs. Thus, lately, there have been few cases where developmental disabilities and abnormalities are overlooked. The representative method is the *Brazelton's Neonatal Behavior Assessment*. Through the eye-to-eye connection, the baby is able to react to following the mother with their eyes, and although under-developed, they are able to show their joy in

loving and seeing the mother. The mother, then senses her child's joy in his/her eyes and builds a stronger bond with the baby. Eyesight plays a great role in tying the bond between the mother and child, and making it something rich and wonderful and full of life.

Kobayashi, Noboru (1981). "*Me to me de tashikameru haha to ko no ai - 2*" (written in Japanese). Tokyo: Child Research Net. Retrieved July 1, 2002, from the World Wide Web: <http://www.crn.or.jp/LIBRARY/KOBY/MIRAI/cbs0093.html>

REFERENCES

- Keller, Helen Wikipedia https://en.wikipedia.org/wiki/Helen_Keller. Werner, Diamanta (2019) Personal Communication.
- NBC TV <https://www.nbcnews.com/nightly-news/video/the-evolution-of-puppy-dog-eyes-62188613610>.
- Gouni, Olga (2008) *Soul Days* Cosmoanelixis.gr page 156 & 158.
- Turner JRG, Turner Troya (2018) *How Prenatal Psychic Trauma and Communication Works in Whole-Self Prebirth Psychology* ©2015 Revised ©2018. Excerpts from paper presented at st International Congress Mental Trauma: Prenatal, Perinatal and Postnatal Aspects: The Sources, Consequences, Diagnostics, Therapy & Prophylaxis Belgrade, 15-16 May 2015.
- Brekhman, Grigori I. (2019) Personal Communication.
- Rakovic Dejan (2019) Personal Communication
- Special Learning.com *Avoidance of Eye Contact: An Early Sign of Autism* <https://www.special-learning.com/article/avoidance-of-eye-contact-an-early-sign-of-autism>
- Logan Brent <http://www.brillbaby.com/early-learning/experts/brent-logan-1.php>.
- Science Daily (2017) *Eye contact with your baby helps synchronize your brainwaves* <https://www.cam.ac.uk/research/news/eye-contact-with-your-baby-helps-synchronise-your-brainwaves>.
- Michel Odent (2001) *The Scientification of Love* E. Vurpillot Free Association Books London
- Corinna, Most *Maternal Infant Eye-to-Eye Gaze the Center for Academic Research and Training in Anthropogony* <https://carta.anthropogeny.org/moca/topics/maternal-infant-eye-eye-gaze>.
- Journal of Advanced Nursing (1981) *Eye opening of the newborn at and up to 20 minutes after birth* Refers to The National Center for Biotechnology Information (NCBI) which is part of the United States National Library of Medicine (NLM), a branch of the National Institutes of Health (NIH). PubMed US National Library <https://www.ncbi.nlm.nih.gov/pubmed/6915048>.
- Matousek, Mark (2011) *The Meeting Eyes of Love: How Empathy Is Born In Us* on Ethical Wisdom <https://www.psychologytoday.com/us/blog/ethical-wisdom/201104/the-meeting-eyes-love-how-empathy-is-born-in-us>.
- Rhodes, Brynn D. (2016) *Eye contact helps babies learn to talk* from AllinaHealth July 17. <https://www.allinahealth.org/healthysetgo/care/eye-contact-helps-babies-learn-to-talk>.
- Kobayashi, Noboru M.D., (1981). "*Me to me de tashikameru haha to ko no ai - 2*" (written in Japanese). Tokyo: Child Research Net. Retrieved July 1, 2002, from the World Wide Web: <http://www.crn.or.jp/LIBRARY/KOBY/MIRAI/cbs0093.html> Section: Child Research Net
- Children are Our Future: The Human Science of Mother and Child*, MediScience sha (2000-2006). January 1,

Speech Personality, Individuality and Uniqueness of Human Voice

Dimitar Popov

Konstantin Preslavsky University of Shumen
116 Universitetska Street, 9700 Shumen, Bulgaria
labling@shu.bg

ABSTRACT

Voice individuality has been one of the most interesting topics in psychology and rhetoric since antiquity, and scientists have consistently tried to classify people into different groups according to the characteristics of their speech behavior. Speech Analysis as part of Experimental Phonetics and Psychoacoustics offers unique opportunities for a multifaceted research and classification of voice personality on the basis of typical speech features which characterise each individual. Everyone possesses such inherent and stable speech features, which often reflect the typical behavioral inclinations of the individual.

Speech analysis can provide an objective indication of voice personality. Repeated speech features often accurately reflect certain aspects of personality and can be described in terms of individual speech personality. Moreover, when a person activates different speech properties under specific verbal interaction conditions, these features usually reflect the mood or attitude of the speaker which are relevant to the given situation. In addition, they give an indication of the status (emotional, health, etc.) of the person. The variational richness of speech provides the opportunity to identify and classify typical speech features in different styles of speech (discourse) and use them to make conclusions about the personality of the speaker.

It is also interesting to investigate how speech can provide information about the speaker's characteristics, on the one hand, and the message, on the other. Personal uniqueness of voice is supported by the fact that it is impossible to find two people with the same voices with regards to their speech apparatus which models the sounds, or in terms of their articulation habits.

The uniqueness of individual human voice is its invisible "business card", which makes it recognizable even when talking over the phone before face-to-face introduction.

Key words: Speech Personality, Individuality and Uniqueness of Human Voice

Human voice is a result of generating articulated speech, a physical process of generating speech which can be illustrated very briefly through the psychologist Stephen Pinker's metaphor "*Speech is a river of breath, bent into hisses and hums by the soft flesh of the mouth and throat*" (Pinker, 2007: 188). Speech is, in fact, the ultimate acoustic product (filtered airflow vibrations) resulting from the arbitrary formalised movements of the respiratory and articulatory organs.

Voice personality has been one of the most interesting topics in psychology and rhetoric since antiquity, and scientists have consistently tried to classify people into different groups depending on the characteristics of their speech behavior.

Speech Analysis in Experimental Phonics and Psychoacoustics offers unique opportunities for a multifaceted research and classification of voice personality on the basis of typical speech features which characterise each individual. Everyone possesses such inherent and stable speech features often reflecting the typical behavioral inclinations of the individual.

Speech analysis also provides an objective indication of the voice personification characteristics.

For the first time the term *speech personality* was proposed by Elwood Murray in 1937 in his book of the same name, wherein he proposed a method for identifying social changes through variations in speech behavior. The term turned out to be particularly appropriate and was accepted in other sciences. Repeated

speech features often accurately reflect certain aspects of personality, and could be assigned terminology status through the concept of *individual speech personality*.

Moreover, when a person uses different speech properties in specific speech interaction conditions, these features usually reflect the speaker's mood or attitude which are relevant to the respective situation. In addition, they give an indication of the status (emotional, health, etc.) of a given person. The variational richness of speech provides the opportunity to identify and classify typical speech features in different styles of speech (discourse) and use them to draw conclusions about the personality of the speaker.

Discourse, viewed as a 'quantum' (from the Latin word for quantity, portion) of textual matter (the texture of the text), is an Ego-phenomenon of the speech utterance that directly reflects the dominants of the speaker's cognitive style. As an end-product of use, each text illustrates a certain artifact that is used for signifying and "wrapping" of information in utterances, for establishing or maintaining a certain type of social contact, for expressing attitude (e.g., politeness, neglect, or superiority, establishing the status of the interlocutor), etc. Therefore, such a description, as already noted, presupposes the consideration of discourse as a procedural, active phenomenon, as a synchronously feasible process of generating and perceiving text in on-line (real time) regime of speaking or narrating. This means that in oral communication the notion of discourse is related to the analysis of a particular speech chunk, viewed as a process (cf. Popov, 2004: 66-67).

As will be shown below, the combination of style of speech pronunciation and the manner of expression will in particular give a sufficient visual representation of a person's unique personality at a particular point in time, indicating his or her inclinations and characterizing their temper, way of thinking and attitude in a particular situation in the communication process.

Since messages in human communication are transmitted through words and sounds, speech signals carry information about the speaker's personal anatomy, physiology, linguistic experience, and mental health. The characteristics of the speaker are found in his or her speech at all levels of description – from the spectral information of the sound chain, to the choice of words and utterances in a particular type of discourse. It is also interesting to investigate how speech can become a carrier of information about the speaker's characteristics, on the one hand, and about the transmitted message, on the other. It is also important to show how the speaker's individuality can be expressed in speech, and what its characteristics are.

The personal uniqueness of voice is supported by the fact that it is impossible to find two people with the same voices, neither as a form of the speech apparatus that modeled sounds nor as articulation habits (Pinker, 2007: 211).

The uniqueness of individual human voice is its invisible "business card", which makes it recognizable even when talking over the phone before face-to-face introduction.

If two speakers utter the same statement, it will obviously sound differently, because in the speech-production process several systems are involved - nervous, physiological, anatomical and physical, and in each of them there are individual specific peculiarities of the speakers. Since it is not possible for two persons to be identical, the distinctive differences in their pronunciation systems lead to characteristic differences in their speech, despite of the fact that they produce utterances with the same meaning.

In a physiological sense, the notion of voice is expressed by the tones that are produced arbitrarily or unintentionally by living organisms as a result of the passage of a stronger or weaker stream of air through the vocal strings in the throat. The voice is in fact a modulation of the airflow (multiple touching and moving apart of the vocal cords under the pressure of the air). "The human vocal tract is a specific source of acoustic signal. It generates a signal that has only speech-specific, and is called a voice. Through the voice, one can communicate in several ways: by whispering, talking normally or singing "(Jovičić, 1999: 29). As the most important psychological characteristic of a person, the voice is directly related to the person's anatomy and physiology, as it depends both on the human body and on the capacity and capabilities of the individual speech apparatus of a particular person.

Specific speech-transmitted features, which are inherent for any person, carry information to the recipient and enable him to describe them and thus classify the speakers according to their age; pronunciation style; the language they use, and also reveal their emotions, and even their health status. It is

on the basis of such features that the speaker can be recognized by the listener. In other words, certain personality characteristics of a person may prove to be sufficiently characteristic so as to determine and verify his or her identity. These facts are used in the field of security, forensic linguistics, investigative journalism, etc. What they have in common is the attempt to describe the speech characteristics of a speaker which are expressed through his or her voice.

The communicative significance of an utterance is studied by linguistics, and the researcher draws on the knowledge of articulation, phonology, grammar, meaning and use of language.

Studying the characteristics of the speaker goes hand in hand with this process, but the focus is on the specific aspects of the utterance within the language system that provide information about the speaker. At first glance, it is very easy to distinguish the speaker's characteristics from the message itself. There is also a view that the characteristics of the speaker are to be found predominantly at a low level that correlates with their expression in a particular physical system as a set of phonetic means, while the characteristics of the message itself function at another, more abstract level, which refers to the choice of a phonetic means, for example, with the syllables, with the words or phrases used to express the meaning of the message.

The speech repertoires of people differ significantly at all linguistic levels, since speakers differ in the way they use phonetic means; their variation is noticed even in the choice of the means used, as well as in the way these means are modified by the context. Last but not least, this variation is also seen in the frequency of use of the phonetic means, the words and the structures of the message.

Human speech is individual, because it is characterized only by traits that are inherent in a particular person, with social (both identity-related as a social concept) and psychological (related to personality as a psychological concept) factors influenced by it.

The crucial factors contributing to the individualisation of the process of speech production are, for example, the socially-determined speech habits of a particular speaker, his or her individual experience, psychological attitude (temperament in particular), temper, and even intellect. The speech features that have been formed since young age, the specific intonations and the manner of speech have turned into speech habits which do not change significantly throughout life. The speech production process cannot be managed without these essential components.

As a result of speech production, the voice is inevitably linked to the human language instinct to react to the phenomena in the surrounding world by expressing attitude. The articulation of speech, which serves for the production and exchange of ideas, and the organ of voice, which was originally used by instinct alone, has accomplished much more important tasks: it has become an instrument for intercomprehension among humans (cf. Nušić, 2015: 15).

At a certain stage of human evolution, the voice gradually strengthened and matured, and the voice mutation at the age of puberty is perceived as evidence for the transition to physiological maturity and a sign of growth in the individual's personal development. "Among the countless multitudes of living organisms inhabiting our world, only humans were able to develop the rudimentary apparatus for coding and transmitting information" (Flanagan, 1968: 11).

From the point of view of speech physiology, the individuality of the voice is determined by the anatomy of the speech tract, by the characteristics of the voice source (the vocal strings) and by the articulation management system. The individuality of the human voice is determined by the shape and size of the oral and nasal passages, the throat, the respiratory organs, which are characterised by strictly individual concentration of the voice energy in a certain frequency range. and the acoustic character of the voice is relatively stable in time and remains individual even in morphological (in biological sense) and pathological changes of speech organs.

The shape of the speech tract best stands out in a neutral position of the speech organs. The articulation management system takes into account the features of the speech tract anatomy, adapting the articulation so that the acoustic parameters of the speech signal fall within a range typical of a language. Therefore, the more the shape of the speech tract is deformed, the less the contribution of the anatomy of the tract to the visualization of the acoustic characteristics (Sorokin et al., 2012).

In the analysis of speech and its characteristics, the individuality of the acoustic characteristics of the voice is determined by three factors: the mechanics of the vocal cords' movement, the anatomy of the speech tract and the articulation management system.

The size of the vocal cords, their mass, firmness and flexibility, and also the pressure in the lungs, define the vibration of vocal cords, stretched like strings in the throat. The frequency of their vibration and the pulsations of the volume velocity of the airflow passing through the throat influence the speech signal spectrum and its time parameters.

The articulation management system forms the prosodic characteristics, such as the dynamics of the main tone frequency, the duration of the phonetic segments, the speed of movement of the articulating organs, and the coarticulatory effects whose manifestation differs among speakers.

The individuality of the speech style is noticeable in chunks of speech of sufficient duration. The acoustic style is realized in the form of a contour of the fundamental frequency, along with the duration of the words and their segments, the rhythm of the stressed segments, the pauses duration, and the volume of the phrase (Kuwabara, Sagisaka 1995).

It is believed that the most important factor for the individuality of the voice is the frequency of the fundamental tone F0 followed by the other formant frequencies, the magnitude of the fluctuation of F0 and the slope of the spectrum (Sorokin et al., 2012: 13).

The initial fundamental stage in the organization of the process of speech production is the managed by the central nervous system program of the articulation movements that corresponds to the message, which is planned at a given time (Ramishvili 1981, Bloom et al., 1988). It is important to note that an articulation program is a program that could contain the rules for pronouncing certain structures. These rules refer to the management of speech intonation, its rhythm, emphasis, loudness, i.e, the management of the prosodic characteristics of speech. Thus, the articulation program affects each individual sense unit of speech (e.g., the syntagm, a rhythmic-melodic speech unit that is grammatically shaped and expresses a relatively complete thought. In Russian linguistics, for example, it is considered equal to an intonation unit (a term in Anglo-Saxon linguistics), which is equal to one breathing group). Within an intonation unit there are suprasegment characteristics, which define the individuality of the speech flow, whose basic parameters are the melodic movement of the basic tone, the intensity, the system of tone accents, the temporal characteristics (segment duration, pauses and the tempo of speech), as well as the rhythmic picture of the speech phrase (Popov, 2004).

The individuality of voice is based on the character and variety of its *timbre*. This is why voices can be similar, but never the same. If we listen carefully to voice imitation, we will notice that the disguised voices produced by actors imitate not the voice itself, but only the manner of speaking, by using similar intonations and gestures as the imitated person. This means that in addition to being individual, the voice is also unique. Similar to the fingerprints which are unique, timbre also helps to characterize the personality of the voice.

The timbre difference of one voice from another depends directly on the specificity of the vocal cords, which are strongly individualized in each person. By the typical timbre of the speaker one can judge about his or her the emotional state.

The individuality of timbre is determined by the fact that the size of the speech organs and the functioning of the nervous system that controls them are unique to every person. The timbre of voice or, as it is also called, the "colour" of voice (*Klangfarbe* in German), or the overtone order, makes the voice of every man unique. It is the presence of the overtones, presented in a certain quantity and ratio, that characterize the timbre, i.e., the source of the voice. The term *timbre* is actually a psychoacoustic characteristic of the voice, equivalent to the term *aural type* in phonetics.

From the point of view of perception, the voice is characterized by the following processes: attack, modulation, absence of modulation or fading. They take place over time. These acoustic processes have a direct impact on timbre.

The brief 'explosive' attack, for example, makes the voice tense, compelling; while the smooth, as if 'bloated' (increased in time) initial sound creates the feeling of softness, intimacy, even for calmness; but if, after the attack phase, a short phase of fading occurs, the voice is perceived as a shout; an extended

fading phase creates a sense of crying or sobbing. Loud modulation signals the vibrato in the voice at a time of particularly emotional state of affect, which creates a sense of liveliness in speech.

Due to the fact that the description of timbre is difficult, a variety of impressionist names are used, such as: velvety, rich, warm, cold, strenuous, hard, soft, stiff, sharp, dense, light, dark, weak, hoarse, choked, strong, hot, warm, dark, metallic, merciful, heavy, wide, cool, clear, icy, hoarse, squeaking, lulled, barking, colorful, deaf, trembling, ringing, wimpy, nasal, willful, jokingly-ironic, sarcastic, sad, gentle, calm, surly, gloomy, etc.

However, the objective recognition of timbre and its individuality is facilitated by the acoustic spectrum of voice, and the secrets of the individual voice timbre are expressed through the formants (the zones of the enhanced frequency of the voice channel - the first two or three formants).

The German semiotician Roland Posner, in his article "Man as a Sign", writes that everyday human behavior at various levels of truth hierarchy serves identification purposes. Every human being has a sum of "personal characteristics at each level of the hierarchy which builds their specific personal code. But in most identification situations, a very small range of this personal code is used. Usually, a brief look at the person's sweater is enough, or it is enough to hear his or her voice. We usually listen or watch more carefully if we detect inconsistencies (unusual clothing, *hoarse voice*, unusual gait). In such cases, we pay attention to the *stable characteristics, such as physical traits*, for example" (Posner, 1995: 87).

This observation makes researchers look for and analyse the characteristic, typical, and unique traits in the speech behavior of people and, more specifically, in their voice.

The communicative and, in particular, the voice behavior of the person is not only a spoken narrative of the speaker about him- or herself, about their true nature, present state, feelings and intentions, but also a request, or an order to the addressee, a speech act through which the speaker informs the addressee how he would like to be perceived by others. In addition, the human natural analyzer (the ear) is able to perceive the difference of hundreds of thousands of sounds of voice, of which only a few thousand belong to the natural spoken language.

The human voice can also produce a multitude of sounds that do not fit in the language system (in canonical phonetics), but mean something in the process of communication and form the paralinguistic stock. These sounds are mainly caused by the way or the manner of speaking, by the quality of the voice and tone, by prosody, i.e., by *the way something is said* and the reason *why it is said*.

REFERENCES

- Bloom, F., Lazerson, A., Hofstadter, L. (1988). *Mozg, razum i povedenie*. Moskva: Mir. (In Russian)
- Jovičić, S. T. (1999). *Govorna komunikacija – fiziologija, psihoakustika i percepcija*. Beograd: Nauka.
- Kuwabara, H., Sagisaka Y. (1995). Acoustic characteristics of speaker individuality: Control and Conversion. *Speech Communication*, v. 16, 165–173.
- Murray, E. (1937). *The Speech Personality*. Philadelphia: J. B. Lippincott Company.
- Nušiċ, B. (2015). *Петорика: наука о беседништву*. 2. изд. Сремски Карловци: Каирос.
- Posner, R. (1995). Chovekăt kato znak. *Sbornik lekcii, statii, dokladi, eseta. Tom I*, EFSS, '95 / Săstavitel: prof. M. N. Popova. Sofia: Peychinski, 78–91. (In Bulgarian)
- Popov, D. (2004). *Fonostilistika na diskursa*. Shumen, Universitetsko izdatelstvo „Episkop Konstantin Preslavski“. (In Bulgarian)
- Popov, D. (2016). *Lingvistichna personologiya po govora. Prevăplăshiteniyata na glasa*. Universitetsko izdatelstvo „Episkop Konstantin Preslavski“. (In Bulgarian)
- Pinker, S. (2007). *Ezikoviyat instinkt. Kak umăt săzdava ezika*. Sofia: Iztok-Zapad. (In Bulgarian)
- Ramishvili, G. S. (1981). *Avtomaticheskoe opoznavanie govoryashtego po golosu*. Moskva: „Radio i svyazi“. (In Russian)
- Sorokin, V. N., Vyjugin, V. V., Tananykin, A. A (2012). Raspoznavanie lichnosti po golosu: analiticheskiy obzor. *Informacionnye processy, Tom 12, №1*, 1–30. (In Russian)
- Flanagan, J. (1968). *Analiz, sintez i vospriyatie rechi*. Moskva: Svyaz'. (In Russian)

Electrophysiological Correlates of Reading in Adults With Dual Literacy

Mirjana Sovilj ¹, Ljiljana Jelić ², Miodrag Stokić ²

¹Institute for Experimental Phonetics and Speech Pathology “Đorđe Kostić”

Gospodar Jovanova 35, Belgrade, Serbia

²Life Activities Advancement Center

Gospodar Jovanova 35, Belgrade, Serbia

m.stokic@iefpg.org.rs

ABSTRACT

Background: In Serbia, children from the earliest stage of education learn to read and write both Cyrillic (as first) and Latin (as second) scripts. From the second grade of the elementary school children read and write both scripts effortlessly. To the best of our knowledge, there are no studies aimed at exploring electrophysiological basis of this phenomenon.

Aim: we wanted to explore possible differences in EEG during reading Cyrillic and Latin scripts in adult fluent readers with no history of dyslexia nor dysgraphia.

Method: we recorded EEG (10/20 system with 19 electrodes) in 30 right-handed adults, aged 27-42, with normal or corrected to normal vision. Participants read silently short neutral paragraph (weather forecast) written in Cyrillic and Latin capital and handwritten letters. The order of scripts and modalities were counterbalanced. The spectral power and Higuchi's fractal dimension were calculated.

Results: The obtained results showed different activity of left frontal regions in Theta rhythm during reading capital vs. handwritten letters in both Cyrillic and Latin scripts. Alpha rhythm showed decrease in spectral power during reading in posterior regions when compared to resting state. However, we found no differences in EEG theta and Alpha spectral power between Cyrillic and Latin scripts.

Discussion: the obtained results suggest that brain in people who have dual literacy from the early stage of education do not differentiate two scripts. However, increased Theta spectral power in F7 region might reflect more difficult grapheme-phoneme conversion during reading handwritten script compared to capital letters.

1 INTRODUCTION

In Serbia, children from the earliest stage of education learn to read and write both Cyrillic (as first) and Latin (as second) scripts. From the second grade of the elementary school children read and write both scripts effortlessly. To the best of our knowledge, there are no studies aimed at exploring electrophysiological basis of this phenomenon. However, there are studies that explored brain activity during early biliteracy in children and adults (Dworin, 2003; Fortune et al., 2008; Garcia, 2009; Grosjean, 1989; Hornberger, 2004; Hopewell & Escamilla, 2014). Those studies were oriented towards two distinct languages but not the same language with dual script.

Good biliteracy is important in the same ways that good literacy is, but biliteracy is special. On an economic level, biliteracy can translate into employment benefits and differential pay in the right settings. On a global level, being biliterate can increase multi-cultural understanding. On a personal level, it can increase children's ability to communicate with family members, both in spoken and written language. On a neurological level, bilinguals may actually have better brains. Because they have to constantly attend to which language is being used, neurological studies show constant strengthening of bilingual's executive functions such as planning, attending, and blocking out irrelevant information (Marian & Shook, 2012). As one result, bilinguals may have greater protection against cognitive decline as they age.

The aim of this preliminary study was to explore possible differences in EEG spectral power within Theta and Alpha rhythm during reading Cyrillic and Latin scripts in adult fluent readers with no history of dyslexia nor dysgraphia.

2 METHODOLOGY

Participants

Participants were 30 healthy adults aged 27-42, with normal or corrected to normal vision. All participants were right-handed. None of them had history of neurological disorders, language disorders nor reading difficulties.

Stimuli

Stimuli were short paragraphs with neutral text (a weather forecast) written in Cyrillic and Latin scripts each in two modalities – printed and handwritten.

EEG recording and preprocessing

The EEG was recorded while participants read silently the text. The order of scripts and modalities were counterbalanced.

EEG was recorded using the Nihon Kohden Corporation, EEG 1200K Neurofax apparatus with Electrocap (model number 16755) International, Inc., Ag/AgCl ring electrodes filled with electro-conductive gel, providing 19 EEG channels. Electrodes were positioned according to the International 10/20 system for electrode placement. The reference was set offline to A1 and A2 (ear lobes). Impedance was kept below 5 k Ω , with not more than 1 k Ω between electrodes. The lower filter was set on 0.53 Hz and the upper filter on 35 Hz. The notch filter was on. The sampling rate was 200 Hz.

EEGs were recorded in a fully lighted room with each participant sitting upright in a comfortable chair. These data were transposed into EEGLAB Software (Delorme & Makeig, 2004), plotted and inspected for manual and Independent Component Analysis (ICA) -dependent artifact-rejection. All artifacts including body movement, eye blinks, eye movements, teeth clenching, were removed from the EEG trace.

EEG analysis

For each accepted segment the spectral power within Theta (4-8 Hz) and Alpha (8-12 Hz) range was computed using Fast Fourier Transform (FFT). Before computing FFT, each EEG segment was multiplied by an appropriate windowing function (using Hanning window) in order to avoid border problems (leakage). We used a cosine window in order to control for artifacts due to data splicing.

3 RESULTS

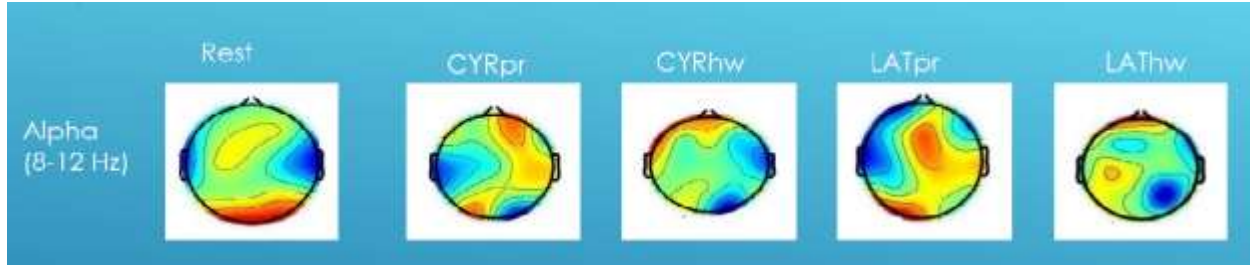


Figure 1: EEG Alpha Spectral power distribution

One-way ANOVA with post hoc Bonferroni correction for multiple comparisons found:

1. Decrease in alpha spectral power in occipital regions during tasks compared to rest
2. Increase in alpha spectral power in prefrontal and dorsolateral frontal regions during tasks compared to rest
3. No differences between Cyrillic and Latin scripts

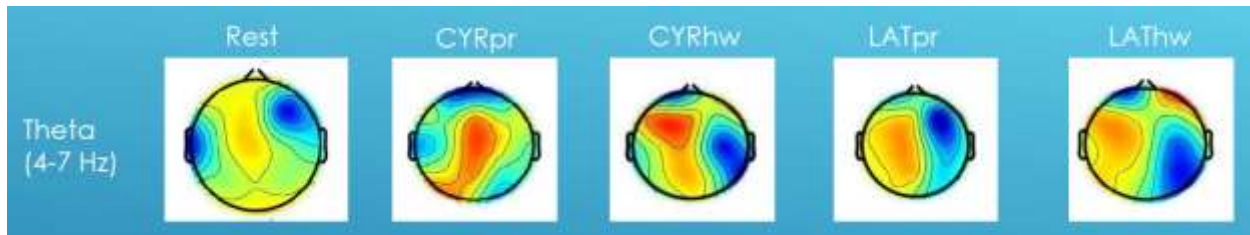


Figure 2: EEG Theta Spectral power distribution

One-way ANOVA with post hoc Bonferroni correction for multiple comparisons found:

1. Decrease in theta spectral power in prefrontal regions during tasks compared to rest
2. Increase in theta spectral power in central and parietal left regions during tasks compared to rest
3. No differences between Cyrillic and Latin scripts
4. Increase in theta spectral power in right prefrontal regions Fp2, F8 during handwritten script reading compared to printed for both Cyrillic and Latin scripts

4 CONCLUSION

The obtained results suggest that brain in people who have dual literacy from the early stage of education do not differentiate two scripts. However, increased Theta spectral power in F7 region might reflect more difficult grapheme-phoneme conversion during reading handwritten script compared to capital letters.

ACKNOWLEDGMENT

The study was supported by the Serbian Ministry of Education, Science and Technological Development within projects OI178027 and TR32032.

REFERENCES

- Dworin, J.E. (2003). Insights Into biliteracy development: Toward a bidirectional theory of bilingual pedagogy. *Journal of Hispanic Higher Education*, 2(2),171-186 DOI: 10.1177/1538192702250621.
- Fortune, T., Tedick, D., & Walker, C. (2008). Integrated language and content teaching: Insights from the language immersion classroom. In T. Fortune, D. Tedick (Eds.), *Pathways to Multilingualism: Evolving perspectives on immersion education* (pp. 71-96). Clevedon, England: Multilingual Matters, Ltd.
- García, O. (2009). *Bilingual Education in the 21st Century: A global Perspective*. West Sussex, UK: Wiley-Blackwell.
- Grosjean, F. (1989). Neurolinguists beware! The bilingual is not two monolingual in one person. *Brain and Language*, 36, 3-15. DOI: 10.1016/0093-934X(89)90048-5.
- Hopewell, S. & Escamilla, K. (2014). Biliteracy Development in Immersion Context. *Journal of Immersion and content-based language education*, 2(2), 181-195.
- Hornberger, N. (2004). Continua of Biliteracy and the Bilingual Educator: Educational Research in Practice. *International Journal of Bilingual Education and Bilingualism*, 7 (2&3), 155-171.
- Marian, V., & Shook, A. (2012). The cognitive benefits of being bilingual. In *Cerebrum: the Dana forum on brain science* (Vol. 2012). Dana Foundation.

Challenges in the Application of Telepractice

Ružica Bilibajkić, Miško Subotić

Life Activities Advancement Center

Gospodar Jovanova 35, Belgrade, Serbia

r.bilibajkic@add-for-life.com, m.subotic@add-for-life.com

ABSTRACT

The increase in speech-language pathology conditioned the need for finding new solutions for the treatment of speech and language therapy patients. The telepractice is an approach that can reconcile the various requirements of modern times, and as such is the focus of large number of scientific and professional considerations and analyses. This paper is an attempt to analyze the advantages and disadvantages of this approach through the various aspects in order to consider the current state of telepractice and its applicability.

Key words: telepractice, speech and language disorders, speech pathology

INTRODUCTION

The increase in the prevalence of speech-language pathology is a growing problem that affects most vulnerable population (children) and can potentially leave a consequence that are very far-reaching. According to the research, 10% to 15% of children (Punišić et al. 2008) have some of the more severe forms of verbal communication disorders (VCD). If not treated properly, the VCDs tend to develop into more serious disorders at an older age (attention disorders, behavioural disorders, reading and writing disorders). Timely intervention tailored to the individual patient's needs is indispensable for the treatment of VCD. In more severe cases, it is necessary to provide individual continuous 60-minute therapy treatments which, depending on the pathology, that may last from two up to four years. (Subotic et al. 2008). There are objective difficulties in the implementation of successful treatment, which are reflected in the shortage of professionals and challenges in time management within the family especially when the frequent speech therapy sessions over a long period of time are needed.

The one of the main challenges of modern life and among the biggest to overcome is the shortage of time. The systems that provide optimal time management and time saving are considered to be potentially profitable. This could be a reason why there are so many applications of telepractice in SLP.

ASHA defines telepractice as: the application of telecommunications technology to deliver clinical services at a distance by linking clinician to client, caregiver, or any person(s) responsible for delivering care to the client, for the purposes of assessment, intervention, consultation and/or supervision.

Some of the main benefits of telepractice which are frequently pointed out are the reduced cost and easy access to SLP services. Nevertheless, there is a constantly increasing demand for speech-language pathologists (Mashima et al., 1999). Some of the reasons could be found in the extension of life expectancy due to medical advancements despite the serious injury or old age, and high survival rate of premature infants and trauma victims. These categories of patients are susceptible to variety of communication disorders and they potentially need continuous SLP services.

The use of the telepractice in SLP dates back as far as 1970s when service delivery was provided using telephone and mailed printed materials (Theodoros 2013). As the quality of ICT (Information and Communications Technologies) services continue to grow it expended the possibilities for development of vast varieties of telepractice applications. Some of the models of telepractice delivery include: mobile

telepractice (where the content is delivered using the smart phones, tablets etc.), desktop model (based on personal computers, web-cameras, microphones and appropriate software), dedicated model (which include use of the high end dedicated systems), immersive virtual model (uses virtual environment) and New/Upcoming Technologies (which uses simulation, games, socially interactive robots etc.).

The quality evaluation of telepractice systems is considered to be a challenging task (Bashshur, 1995). The agreement is still to be reached regarding the evaluation criteria of telepractice system parameters such as system implementation, design, utilization etc.

In the remainder of the paper, we will briefly examine the benefits of telepractice and try to indicate the main challenges we are still facing in implementing this approach.

THE BENEFITS OF TELEPRACTICE APPROACH

It is suggested that telepractice can be useful in solving the problems emerging from traditional speech and language approach like: the distance of the patient to facility that offers speech and language therapy treatment, family time management difficulties, difficulties in patients transportation, availability of trained experts in the area of residence, accessibility of adequate treatment to the individuals with impaired mobility.

Telepractice can help overcome such challenges by offering the possibility of more frequent and efficient service delivery, increase in service accessibility, increase work efficiency and productivity; providing opportunities for more efficient professional development, offering the consultation with experts, providing the team connectivity, inclusion of caregivers and providers in therapy, possibility to provide services in client's native language.

It is not surprising that the above advantages have caught the attention of the professional and scientific public with a desire to explore the benefits offered by telepractice approach. However, in order for telepractice to function optimally, it must be able to reconcile demands that come from different areas and sometimes the opposite requirements should be satisfied.

CHALLENGES IN TELEPRACTICE

The telepractice is only one of the approaches in treating patients with speech and language impairments and it must find its place within the health, legal and economic system in which it is implemented (Popovici & Buică-Belciu, 2012). The need to harmonize real requirement imposes a number of challenges that must be overcome in order to exploit the full range of benefits that telepractice offers. It is reasonable to expect that the telepractice will inherit the requirements from all the areas that is affected by like: technology, methodology, roles and responsibilities, ethical considerations, licensure and teacher certification, client selection, data protection and confidentiality, the e-commerce, distance contracting, electronic signatures, legislation, reimbursement etc.

Each of these areas has its own requirements and optimization criteria and their assembly into one functional entity represents a serious challenge. Without going into the detailed analysis of the individual elements of each area, we will list only some of the challenges in order to demonstrate the complexity of the problem.

Considering the problem of the methodological approach to telepractice, perhaps one of the most serious problems is the difficulty to sustain eye-contact between the patient and the therapist during the conversation via videoconferencing. The patients and therapist have to look directly into the camera in order to maintain eye-contact which could be contra intuitive since the face of the corresponding person is shown on the tv or computer monitor. One other serious challenge with telepractice is the SLP's inability to make direct physical contact with the patient in order to provide traditional tactile cues and reinforcement or even to assess muscle tone and strength.

In order to evaluate the effectiveness and efficiency of telepractice, we face the problems of clear standards that would be applied and would allow a unified and objective assessment (Taylor et al. 2014; Wales et al. 2017).

The telepractice may not be the appropriate option for all patients and its application may be limited under certain circumstances. There are certain requirements that patients must fulfil in order to successfully receive therapy via telepractice. The patient's age, cultural background, level of education and other may condition its suitability for services provided through telepractice.

Some of the factors that could potentially influence patient's ability to make most of the telepractice therapy sessions are listed below:

- Hearing and visual ability; the patient must be able to see material on a monitor/display;
- Dexterity and physical endurance; the patient must be able to operate a keyboard if needed and to have certain sitting tolerance
- Level of cognitive functions and attention span; the patient must be able to be relatively still when in front of a camera and to suppress unnecessary movements
- Family member/caregiver involvement; when needed the family member/caregiver to receive instructions through telepractice.
- Speech intelligibility and auditory comprehension
- Adequate environment and technology resources; the patient must be equipped with computer, appropriate network bandwidth, it must be situated in relatively quiet room without distractions

A serious problem within the legislation is the harmonization of legal bases when the telepractice services are provided under different legal frameworks. We can ask ourselves how the legal framework of telepractice is regulated when the patient resides in one and the therapist in another country.

CONCLUSION

The opportunities offered by telepractice clearly indicate that in the future this will be an increasingly prevalent form of service delivery and will become a serious rival of the classical approach to speech language therapy. However, the telepractice is a complex approach that pervades different areas. Each of these areas has its own requirements and the optimization criteria. The problem is that sometimes they are contradictory, so optimization is the search for solutions in a multidimensional space. In order to solve this problem in an optimal way, it is necessary to establish clear standards and criteria which currently do not exist.

ACKNOWLEDGMENT

The research was financed in part by the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the projects No. OI178027 and TR32032.

REFERENCES

- Bashshur, R.L., (1995). On the Definition and Evaluation of Telemedicine," *Telemedicine Journal*, Vol.2, No.1, 19-30.
- Mashima, P., Birkmire-Peters, D., Holtel, M., & Syms, M. (1999). Telehealth applications in speech-language pathology. *Journal of Healthcare Information Management*, 13 (4), 71-78.
- Popovici, D. V. & Buică-Belciu, C. (2012). Professional challenges in computer-assisted speech therapy. *Procedia-Social and Behavioral Sciences*, 33, 518-522.
- Punišić, S., Subotić, M. & Pantelić, S. (2008). A longitudinal Study of Verbal Communication Disorders in Children Included in the KSAFA System. *Early Prevention in Children with Verbal Communication Disorders*, Eds. Sovilj M., Bojanova B., Skanavis M., Pantelić S., ISBN 978-86-81879-22-1, Belgrade, pp. 106-112.

- Subotić, M., Punišić, S. & Čabarkapa, N. (2008). Efficiency and Duration of Dyslalia Treatment Based on Application of the KSAFA system. *Early Prevention in Children with Verbal Communication Disorders*, Eds. Sovilj M., Bojanova B., Skanavis M., Pantelić S., ISBN 978-86-81879-22-1, Belgrade, pp. 117-123.
- Taylor, O. D., Armfield, N. R., Dodrill, P., & Smith, A. C. (2014). A review of the efficacy and effectiveness of using telehealth for paediatric speech and language assessment. *Journal of telemedicine and telecare*, 20(7), 405-412.
- Theodoros, D. (2013). "Speech-language pathology and telerehabilitation", in *Telerehabilitation*. Springer, pp. 311-323.
- Wales, D., Skinner, L., & Hayman, M. (2017). The efficacy of telehealth-delivered speech and language intervention for primary school-age children: A systematic review. *International journal of telerehabilitation*, 9(1), 55.

Innovations in Bulgarian Child Syntax

Velka Popova

Konstantin Preslavsky University of Shumen
116 Universitetska Street, 9700 Shumen, Bulgaria
labling@shu.bg

ABSTRACT

The article analyses problems related to the mastery of the Bulgarian language at early and preschool age. An attempt has been made to show the significance of the "syntactic beginning" for the linguistic achievements in ontogenesis on the basis of some observations on the speech production of five Bulgarian children. The focus of this research is on syntactic innovations, which, in the context of the system's potential, compensate for the child's linguistic and cognitive deficits and create conditions for expanding and enhancing his/her linguistic competence. Speech data is analyzed and interpreted both "vertically" and "horizontally". This double-oriented research paradigm creates favorable conditions for the optimal realization of the main goal we have set, namely the syntactic innovation phenomenon to be presented not so much and not only "vertically" as a deviation from the norm, but also "horizontally" as a supporting language mechanism that provides the relevant development phase with child-friendly constructions.

Key words: Child language, Bulgarian, Syntactic innovations

INTRODUCTION

The article discusses problems related to mastering Bulgarian language at an early and pre-school age. Based on observations on the speech production of five monolingual children (Alexandra, Stefka, Velislava, Bogomila, Ivelin)¹ an attempt is made to show the importance of the "syntactic beginning" for mastering a language in the context of ontogeny.

In Bulgarian linguistic literature, the syntax of children's speech has already been the subject of a comprehensive study from the perspective of linguistic pragmatics (see Stoyanova 1987; 1990; 1992) and psycholinguistics (see Popova, 2000; 2007; 2012). Researchers agree that Bulgarian children acquire basic syntactic structures relatively early and quickly (up to the age of three), which can be explained by the fact that Bulgarian "belongs to languages with a relatively" transparent "surface structure" (Stoyanova, 1987: 596). In addition to the presence, of special morphological markers for expressing different syntactic relationships in mastering native language syntax, Bulgarian children are also relieved and assisted by the presence of so-called "pronoun doubling" (Maslov, 1982: 304). This phenomenon, known in Bulgarian linguistics as duplication of syntactic categories (see more in Penchev, 1984; Savova, 1994; 1996), provides a return to a syntactic position, while duplicating (specifying) its "syntactic meaning" without adding a new semantic component. In this sense, the fact that duplication occurs too early in a child's speech is fully explainable, and soon afterwards it is realized in a variety of constructions typical of the speech of adult native speakers. The ability of the child to "replace" and "repeat" a syntactic position with a pronoun is a clear indicator of an already developed sense of the categorical status of syntactic units.

The proposed study fits in with the tradition of studies of child syntax, but the purpose is no longer to record various facts related to early language acquisition, but rather to draw attention to its "failures". They are manifested in specific occasional constructions, which, insofar as they result from the norms of

¹ Instead of the names of the children studied, three-letter codes were used in the text as follows: Alexandra – ALE, Stefka – STE, Velislava – VIL, Bogomila – BOG, Ivelin – IVE. Their age is indicated by the following standard: the first digit indicates the years, the second - the months, with the two sections separated by semicolons.

the language system, contain the potential of an internal language mechanism which, with varying degrees, aids ontogeny and turns the language-acquiring child into an active participant in the process.

CHILD LANGUAGE INNOVATIONS AS VARIATIONS OF "NEGATIVE LANGUAGE MATERIAL"

The focus of the proposed work is children's speech innovations, which are understood as a specific kind of so-called 'negative language material'. In the linguistic tradition, the term was introduced by the Russian linguist Shcherba, who notes that "the role of this material" is enormous yet still greatly undervalued in linguistics "(Shcherba, 1974: 33). At the same time, he singles out as the most important part of this "negative language material" the mistakes children make in the course of mastering their mother tongue in early childhood. Children's mistakes are the best source for obtaining information about their language acquisition, the hierarchical organization of the language rules which a person uses in the perception and production of speech, and the complex arrangement of grammatical categories among others. This is confirmed in the words of one of the iconic researchers in Russian ontolinguistics, Gvozdev, who claims that: "the distribution of certain groups of homogeneous phenomena in the language in the order in which they occur sequentially in children, as well as the characteristic deviations in children's language from the language of adults can provide considerable data to reveal the natural grouping of various elements in the language system" (Gvozdev, 1981: 9).

Calling child deviations from the norm "formations by analogy", he notes that "a child discovers language without any distortion" (Gvozdev, 1981:16), which makes this material more valuable in linguistic terms, compared to the mistakes of people who acquire a language as a second language, as well as the deviations from the norm in conversational speech, occasionalism in artistic speech, etc.

Over the last few decades, with the emergence of child language linguistics as a separate research area, the deviations from the norm, recorded in the course of linguistic ontogeny, are already considered in a new perspective, not so much and not only as external evidence in solving various linguistic problems, but rather with a view of child language as a "self-worth object" (Frumkina's term). Thus, the research focus is on the process of mastering the language itself, and in this context deviations from the norm in child speech are viewed as stages of the process of acquiring the language, which allows to highlight the language acquisition strategy used by the child. Deviations from the norm in child speech have already been referred to as innovations. This term is widely used by both Russian and Western researchers of child speech (cf. Clark, 1993), but is interpreted differently. Some authors see innovation as having the potential to be accepted in language (which corresponds to the definition of innovations in Ahmanova's Dictionary of Linguistic Terms (Ahmanova, 1969: 178). Other authors limit the scope of their use in speech due to their short-term existence. According to Coseriu, "... innovation is not change. Language change ('change in language') is in itself a spread or generalization of an innovation" (Coseriu, 1963: 192).

For the purposes of this study, innovations are interpreted more in the meaning proposed by E. Coseriu, ie. they are understood as a speech fact which differs from common use. The fact that the same innovation can occur not in one, but in a number of different speech situations, supports the fact that the degree of its intrinsic linguistic conditions is high enough to cause the formation of this structure in the presence of such conditions. A fundamental feature of innovations is their productivity, not their reproducibility in the speech process. The term "occasionalism" could also be used, but in its broad understanding.

Different types of innovations are observed in child speech: derivational, morphological, lexico-semantic, and syntactic. It should be noted that when presenting these phenomena in child speech, it is necessary to take into account the double nature of speech, which implies both comprehension and production. This would allow the analysis to distinguish between two groups of children's innovations, namely innovation as a consequence of deviation from the standards of analysis of language units in the language of adults on the one hand, and innovation as a consequence which contradicts the norm of synthesis of language units, on the other. Although the focus of the present work is on innovations related

to speech production, innovations related to a non-standard comprehension of syntactic units could not be ignored. In some of the latter innovations the problems of children's perception are rooted in the asymmetry between the surface and the deep structure of the utterance (cf. Example 1), while in others they originate in the lexico-semantic deficit of the corresponding temporary linguistic system (cf. Example 2).

Example 1:

MAM: *Ti si prosto dete.*

‘You're just a kid.’

% com²: The mother (MOM) calms the child in a situation where he or she apparently does not handle things, pointing out that the reason for this is that he or she is too young – only a child. She uses *prosto* ‘just’ as an adverbial.

STE (4;0): *Ne sâm prosto dete.*

‘I'm not just a kid. (In the sense of ‘I'm not a stupid child.’)

STE: *Umna sâm.*

‘I'm smart.’

%com: The child recognizes the attributive construction of a mere child and is very angry and angry.

In Bulgarian the confusion stems from the fact that in isolation the combination "prosto dete" can be interpreted as either "silly, stupid child" or "only a child", meaning too young and inexperienced. While the mother meant the latter, the child was upset as she perceived it in the former sense, as stupid.

Example 2:

MAM: *Kato izlezesh na prostor, ti se ticha, igrae, luduva.*

‘When you go out in the open, you run about and play.’

STE (4;6): *A-a, tova e prostor da prostirash. Nali mamó?!*

‘Ah, that's the **washing line** to hang the washing on. Is that it, Mom?!’

In Bulgarian the word "prostor" can mean both "open space" and "washing line".

The focus of this work is primarily on syntactic innovations, which are registered with the emergence of the two-word phrase in child speech, while accepting the idea of the "syntactic" nature of speaking in early childhood. This idea is not new; it was proposed by the Russian psychologist Vygotsky, who said that in the development of the semantic aspect of speech, the child begins with the whole, with the sentences, and only later goes on to master single semantic units, the meanings of the individual words, by splitting a one-word utterance, into a number of distinct, interrelated meanings (Vygotsky, 1996). In support of this, a number of examples from the psycholinguistic research tradition can be cited, which emphasize that the earliest speech products of the child are holophrases which are complete statements, the referent of which is not a separate object or feature, but a whole situation. However, unlike the two- and many-word statements that appear later, in holophrases the situation is reflected in the monosyllabic statement indiscriminately, by choosing the word that indicates the cognitively most important for the child component of the situation.

The present paper will demonstrate the importance of the "syntactic beginning" for language achievement in the consequent language development phases. For this purpose, syntactic innovations will be monitored and analyzed, which, in the context of the system's potential, compensate for child language and cognitive deficits and creates conditions for expanding and enhancing his or her linguistic competence.

² The illustrative examples are extracted from the Bulgarian Child Speech Corps, developed by a team of the Applied Linguistics Laboratory of the Konstantin Preslavski University of Shumen under the ClaDa-BG project (Agreement No. D 01-164 / 28.08.2018). The data is transcribed in the CHAT format of the CHILDES system (<https://childes.talkbank.org/>), which includes, in addition to the main lines with replicas of the participants in the interaction, service lines (% com – comment and % sit – situation), which provides additional information necessary for a clear interpretation of children's statements.

In other words, the phenomenon of syntactic innovation will be analyzed not so much and not only "vertically", as a deviation from the norm, but rather "horizontally" as an auxiliary language mechanism, which provides the corresponding developmental phase with structures close to child understanding.

SYNTACTIC INNOVATIONS IN THE PROCESS OF SPEECH PRODUCTION

If a new unit enters an already evolving system of relationships, then different types of innovations, such as syntactic innovations may appear as a result of the system pressure on it. That happens when rules that are not applicable to the new unit are used in accordance with the language norms and the restrictions imposed by tradition. Such cases show that the language rules are not fully understood; the child is not familiar with the ways of their normative, traditional implementation.

Syntactic innovations are also recorded in the spoken language of older native speakers, and the cause of their occurrence is understood to a different extent by the speaker. For example, it could lie either in the desire to overcome the usual stereotypes (e.g. I am not fat, I am short), to increase expressiveness of speech, or, in some cases, there are simply uncontrollable "failures" in the mechanism of speech generation due to its spontaneous nature and conditions of communication (cf. Example 3).

Example 3:

DAD: *Kakvo ima za vechrya?*
'What's for dinner?'

DAD: *Kak sa decata?*
'How are the kids?'

% sit: The father (DAD) comes home from work and asks the mother (MOM) both questions in one sequence. Without waiting for the answer to the first, he asks the second.

MOM: *Musaka s angina.*
'**Moussaka with sore throat**'. (Contamination of two sentences: *Za vecherya ima musaka.* 'We have moussaka for dinner.' + *Decata sa s angina* 'The children have sore throat.')

As a rule, with adults this type of blocks of words are more likely to be comprehended as nonsense and as isolated facts, whereas in child speech their manifestations are regular, ie. used with a much higher frequency than expected. The explanation may lie in the fact that child cognition is extremely rich in nonlinear processes, within which, when combining, merging, forming, forming thoughts through the combination of these complete blocks (extrapolated in syntagms rather than in individual lexical units), some of the words are inevitably lost, or omitted, and the remaining components create some very strange fragmented combinations. (Examples 4-10).

Example 4:

ALE (3;8-3;9) *Az sām mnogo silna ot nego.*
'I am very strong than him.' (Contamination of two sentences: *Az sām mnogo silna* 'I am very strong' + *Az sām po-silna ot nego* 'I am stronger than him')

Example 5:

STE (2;6)

MOM: *Kak se kazvash?*
'What's your name?'

STE: *Stefka.*

MOM: *Drugoto ti imence kak e?*
'What is your other name?'

STE: *Dimitrova.*

MOM: *A drugoto?*
'And the other one?'

STE: *Popova.*
 MOM: *Znachi se kazvash Stefka Dimitrova Popova.*
 'So your name is Stefka Dimitrova Popova.'
 STE: *Znachi **sām** kazvam Stefka Popova.*
 'So I'm name is Stefka Popova.'
 %com: *I am* is merged with *My name is*.

Example 6: STE (3;0): *Nito pāk ne iskam da spya.*
 'Nor do I don't want to sleep.'

Example 7: STE (5;0): *Nito sega shte doyda.*
 'Neither will I come now.'

Example 8: STE (5;6): *Nito pāk ne doyde.*
 'Neither he didn't come.'

Example 9: PAV (4;0): *Ako ne me rodeshe, shteshe nikoy da ne ti raztrivashe glavata.*
 'If you wouldn't give birth to me, no one would have massaged your head.'

During the process of mastering the language, typical child innovations, which are not characteristic of the spontaneous speech of adult native speakers, are also observed. Some of them may be regarded as expected, insofar as their presence is to some extent typical of the relevant phase of linguistic ongesis. For example, at the time of the emergence and dominance of the two-word utterances, there is a clear orientation to a fixed word order, which is manifested in the fact that in most cases the subject precedes the predicate, which is also observed with respect to the direct object and the predicate. Particularly indicative in this respect are the early constructions of this phase, with the meaning of *belonging to* and *attribution of an object to a particular person*, in which the component designating the person is always in the first place (Examples 10–11). This regularity is also preserved in the later emerging prepositional phrases with 'of' to indicate belonging or attribution (cf. Examples 12–13).

Example 10: ALE (1;3): *Mama tiytata [:kutykata].*
 'Mom ... [: box].'

Example 11: VIL (1;6): *Lili kole [:kolelo].*
 'Lilly whe... [: wheel].'

Example 12: BOG (2;1): *Naa mamunaata [: maymunata] sāceeto [:sārceto].*
 'Mom's ... [: monkey] the ... [: heart].'

Example 13: IVE (2;7): *Na Ici [:Ivelin] shinata [:mashinata].*
 'Ichi's [: Evelyn] ... [: machine].'

The examples show that the word order of the early child utterances is not always determined by the respective rules ordering the components in the adult utterances. For example, in the usual for the normative Bulgarian construction, the *defining adjective* precedes the *defined noun*, yet in child speech, as a rule, it comes after it (see utterances like: ALE: *Mama moyta* 'Mom mine.' or IVE: *Zhabka maka [:malka].* 'Frog ... [: small].'. And this "childish" way of word placement corresponds to the natural logic to a much greater extent. The object as we see it in our mind actually precedes its attribute, but nevertheless, when we construct a phrase, we manage to change the position of words in order to create a construction that corresponds to the norm. The child does not yet have full command of the utterance generation technique, which psychologically could be defined as prediction. In this sense, it can be assumed that these are original own child formations (ie constructed independently by the child), while parallel existing ones which are

more usual for modern Bulgarian could rather be conceived as borrowed from adult speech and resulting from imitation.

At the same time, however, in these cases there is a danger of overinterpretation, since the non-grammaticality of the utterances of this ontogenetic phase does not make it possible to interpret unambiguously the adjective – noun relation as attributive, as it could also be understood as predicative. Unfortunately, during this period, the use of adjectives by children is too scarce to base observations on a sufficiently large corpus of uses, but this could be compensated by studies that offer in-depth analysis of the situations when adjectives are used as well as their prosodic characteristics. The truth value of the claim that such word-order innovations exist could rather be tested on the basis of observation and analysis of child-produced structures from the following ontogenetic phase, in which the components of the utterance are more than two and the relations are clearly recognisable.

This preference for a particular word order as a way of distinguishing the syntactic functions of the components from the period, when the child does not yet have the ability to differentiate these functions through formative affixes, is a universal phenomenon observed in all languages (see Slobin, 1984: 176), regardless of a language word-order being fixed or free. Consequently, it could be assumed that it is a realisation of a deep-surface syntactic rule, which in many languages has not developed at the level of the norm, but is nevertheless felt by children. The widespread presence of such constructions in Bulgarian child speech is a clear testimony to word-order innovation, whose dominance in the phase of two-word utterances compensates for the syntactic faults of those early constructions, which usually lack a verb predicate, prepositions, and conjunctions.

In the following phases of linguistic ontogeny, individual cases are recorded among the children studied, in which the dominance of a particular verbal innovation is characteristic only for a certain period of time for the speech production of the respective child, after which it is gradually forgotten and abandoned. This is confirmed by the observation of two of the children studied (STE and ALE), whose speech is characterized by the absolutisation of the Subject – Verb word-order in some cases. Before interpreting the children's utterances in question, it is appropriate to check how this particular word-order pattern is regulated in the grammar of modern Bulgarian. In *The Grammar of the Contemporary Bulgarian Language* (GSBKE, 1983: 274) it is stated that "the main grammatical word-order pattern in the Bulgarian language is Subject (...) – Verb (...). This pattern, which is almost universal for analytical languages like Bulgarian, is basic and common in the Bulgarian language". The absolutisation of this pattern in the speech of the two children studied is observed in complex compound sentences with the conjunction ZA DA (IN ORDER TO): (1) MAIN CLAUSE + ZA DA + SUBORDINATE CLAUSE (SUBJECT – VERB) and (2) ZA DA + SUBORDINATE CLAUSE (SUBJECT – VERB) + MAIN CLAUSE, such as:

Example 14: STE (4;3): *Tiho kazhi na tatko, ZA DA Sasheto ne chue.*
'Quietly tell Daddy ZA DA (so that) Sasha doesn't hear.'

Example 15: STE (4;5): *ZA DA vsichko e nared, se staraya., a sashto taka i ZA DA tya pomisli, che ne e doshla.*
'ZA DA (so that) everything is okay, I am trying hard, and ZA DA (so that) she thinks that she has not come.'

This over-generalization is probably due to the fact that the observed children accept the given word order as fully grammaticalised (not susceptible to change) in constructions with ZA DA, while in all other cases the word order SUBJECT – VERB is flexible and non-permanent. At the same time, these syntactic innovations are overly correct constructs whose occurrence in the speech of both observed children is considerably high at the age of about four. They could be seen, on the one hand, as errors, by native speakers of the Bulgarian language. On the other hand, their high frequency of use may be a signal for a new level of language proficiency in children. Moreover, "traces" of these syntactic innovations were registered with these two children and in the first few years of the following (school) period.

The emergence and rapid unfolding of multi-word linguistic utterances in linguistic ontogeny are accompanied by a lexical explosion and intense morphological development. These accomplishments help child language to be freed from the constraints of the *here and now*, and allow for much more complex constructs involving double negation to evolve as syntactic innovation. The following examples are indicative of the difficult process of their acquisition, both at the level of production and at the level of perception (see Examples 16–18).

Example 16: ALE (1;11): *Maykata nishto ne ima.* [:*Maykata nyama nishto.*]
 ‘Mother nothing doesn't have.’ [:‘Mother has nothing.’]

Example 17: ALE (2;4): *Az vinagi ne hodya.* [: *Az nikoga ne hodya.*’]
 ‘I always don't go.’ [: ‘I never go.’]

Example 18: ALE (3;8)
 ALE: *Toy ne tryabva da ne ya obicha!*
 ‘He must not dislike her!’
 MOM: *Kakvo?*
 ‘What?’
 ALE: *Toy nyama da ne ya obicha!*
 ‘He won't not love her!’
 ALE: *Abe, tryabva da ya obicha!*
 ‘Well, he must love her!’

CONCLUSION

The observed and analysed examples in the present work do not present the whole scope of the formal and functional diversity of syntactic innovations in child speech. The shared results are only a small part of a larger study, the ambition of which is to capture and systematise the typical innovations that emerge in the course of syntactic ontogeny of the Bulgarian language. It is quite understandable that due to limitations of size, a number of important issues in mastering diversity in the lexical representation of predicates, conjunctions, and so on, remained beyond the scope of the present paper. The main aim of the paper was limited to a panoramic presentation of issues and main ideas, with the focus not on finding the answers but rather on posing questions and indicating ways for their solution. The observations and analyses of occasional child language constructions in the proposed pilot study clearly show that they are not just a curious exotic language phenomenon, but phenomena which deserve an expanded and in-depth study insofar as they carry the charge of internal auxiliary language mechanisms that support and optimize the process of ontogeny.

REFERENCES

- Ahmanova, O. S. (1969). *Slovar' lingvisticheskikh terminov*. Moskva, Sovetskaya ensiklopediya. (in Russian)
 Vygotskiy, L. S. (1999). *Myshlenie i rech*. Moskva, Labirint. (in Russian)
 Gvozdev, A. N. (1981). *Ot pervykh slov dopervogo klasa: Dnevnik nauchnykh nablyuduniy*. Saratov, Izdatel'stvo Saratovskogo universiteta. (in Russian)
 GSBKE (1983). *Gramatika na sávremenniya bălgarski knizhoven ezik. T. 3. Sintaksis*. Sofia, Izdatelstvo na BAN. (in Bulgarian)
 Coseriu, E. (1963). *Sinhroniya, diahroniya i istoriya. Novoe v zarubezhnoy lingvistike. Vyp. III*. Moskva, Izdatel'stvo innostrannoy literatury. (in Russian)
 Maslov J. S. (1982). *Gramatika na bălgarskiya ezik*. Sofia, Nauka i izkustvo. (in Bulgarian)
 Penchev, J. (1984). *Stroezh na bălgarskoto izrechenie*. Sofia, Nauka i izkustvo. (in Bulgarian)
 Popova, V. (2000). *Psiholingvistika na razvitiето. Kognitivni aspekti na sintaktichnata kompetenciya*. Shumen, UI “Episkop Konstantin Preslavski”. (in Bulgarian)

- Popova, V. (2007). Eksperimentalno izsledvane na detskata gramatika. *Psiholingvistichni izsledvaniya. Sbornik v chest na prof. dr Slama Cazaku*. Sofia, Riva, s. 251–271. (in Bulgarian)
- Popova, V. (2012). Specificheskie osobenosti bolgarskogo sintaksicheskogo ontogeneza. *Problemy ontolingvistiki – 2012. Materialy mezhdunarodnoy nauchnoy konferenciiq posveshtennoj 139-letiyu so dnya rozhdeniya K.I. Chukovskogo I 120-letiyu so dnya rozhdeniya A. N. Gvozdeva*. Sankt-Peterburg, Zlatoust, s. 168–175. (in Russian)
- Savova, Iv. (1994). Substantivno-pronrminalni podlozhni konstrukcii v razgovornata rech. *Problemi na bălgarskata razgovorna rech*. Veliko Tărnovo, s. 83–95. (in Bulgarian)
- Savova, Iv. (1994). Belezhki vărhu podlozhnite pronominalno-substantivni konstrukcii v spontannata ustna rech. *Episkop-Konstantinovi cheteniya. T. 2*, Shumen, UI “Episkop Konstantin Preslavski”, s. 16–24. (in Bulgarian)
- Slobin, D. (1984). *Kognitivnye predposylki razvitya grammatiki*. Moskva, Progress. (in Russian)
- Stoyanova, J. (1987). Ontogeneza na bălgarskoto izrechenie. *Vtori mezhdunaroden kongres po balgaristika. T. 3. Săvremenen bălgarski ezik*. Sofia, s. 595–603. (in Bulgarian)
- Stoyanova, J. (1990). Văprositelni izkazvaniya v ranna detska vazrast. *God. SU, T. 3, №1. Ezikoznanie*. Sofia, s. 5–40. (in Bulgarian)
- Stoyanova, J. (1992). *Vasheto dete govori. Rechevi aktove v rannata detska vazrast*. Sofia, UI “Sv. Kliment Ohridski”, s. 595–603. (in Bulgarian)
- Shherba, L. V. (1974). *Yazykovaya sistema i rechevaya deyatel'nost'*. (in Russian)
- Clark, E. (1993). *The Lexicon in Acquisition*. Cambridge, Cambridge University Press.

The Applicability of Phonetic Perceptive Tests for Speech Therapy and Practice

Hotimir Tivadar

Faculty of Arts, Ljubljana Slovenija
h.tivadar@ff.uni-lj.si

ABSTRACT

Phonetics (together with phonology) and speech-language pathology are scientific disciplines that are closely related research-wise. Both disciplines are methodologically rooted in natural science because they try to describe human speech as accurately as possible. Both measure speech phenomena and illustrate patterns with empirical data.

The disciplines differ in their focus and aim. A speech-language pathologist tries to mend a speech disorder and focuses on “ideal” articulation/perception, whereas a phonetician (a linguist) wishes to describe and accurately represent speech so that a language learner (a child/adult) can engage in spontaneous communication. Since both disciplines deal with speech, which is intrinsically a human activity, they come together in education, where they must complement each other. Perception tests (Tivadar 2004) can bridge the gap between the two disciplines. Namely, speech therapists focus on ideal speech production, so they are faced with the question about when their patient’s therapy should end or when their patient’s speech becomes good enough

In order to establish the acceptability of ideal and less ideal speech production (e.g., a news anchor’s rapid speech, the speech of children with cochlear implants, sigmatism), it is possible to use objective phonetic perceptive tests. Speech therapists, by relying on experience as well as data from medical devices, do not know when their patient becomes content with his/her articulation. In addition, speech therapists do not receive feedback on whether a particular device (e.g., a cochlear implant) leads to better articulation by a hearing-impaired individual. Consequently, in 2017–2019 in the context of speech-language pathology and surdopedagogy studies at the Faculty of Education in Ljubljana, we designed and tested phonetic perceptive tests with which we measured how non-ideal speech production influences speakers’ perception. In this article we focused on non-prosodic (differences between ideal and unideal phoneme realisations) features of speech.

Keywords: phonetics, phonology, perceptive speech analysis, speech perception, Slovenian speech, speech therapy

1 INTRODUCTION - -The Meaning of Speech and Perception for Human Being

Speech is an activity, which ontologically defines a human being. Every social group has its own rules of behaviour that also occur in speech. Phonetics (together with phonology) and speech-language pathology (Speech Therapy and logopaedia) are methodologically rooted in natural science because they try to describe human speech (articulation and perception) as accurately as possible. Both measure speech phenomena and illustrate patterns with empirical data. Perception tests (Tivadar 2004) can bridge the gap between the two disciplines. Since both disciplines deal with speech, which is intrinsically a human activity, they come together when it comes to education, where they must complement each other. In order to establish the acceptability of ideal and less ideal speech production, it is possible to use objective phonetic perceptive tests. The aim of this article is to create an applicative connection between speech therapy and phonetics (with phonology).

1.1 A Change in Communication Situations in Modern Society – the Use of Modern Technologies and Social Networks

This is an interdisciplinary research, where the main topic is the relationship between Phonetics and Speech Therapy. Today, the meaning of phonetics and speech therapy is good communication, social inclusion and human development. The challenge of the 20th century was creating a tolerant society; something that was more or less always only mere wishful thinking and a theoretical possibility in the past; in reality it was never truly achieved. Liberalisation was very important in the 20th century, the result was a more inclusive society sensitive to diversity and political correctness. But political correctness can also create non-spontaneous, non-fluent speech and possibly result in no speech at all.

The key factors of high-quality modern communication in the 21st century are: good education, a lot of communication, spontaneous speech and speech as the most common type of communication. However, close relationships, who are also important for good communication, are today mainly virtual. Also, Standard Speech is very often reserved only for professionals and prestigious communication, and that can be a problem, or a source of problems, with speech. Another important question is also the role of Standard Language and orthoepy (and phonology) in our languages. It is very important that our languages are alive. Therefore, the standardisation of languages should help languages develop in all their diversity. The most important thing in communication is acceptance.

How does real life communication look like in the 21st century? The most frequent is i-contact – even addition to digital devices – instead of eye-contact. This is a challenge for society and speech in a global digital world. But our primary and secondary schools lack the teaching of speech. In Slovenia today, and possibly also in other countries, the National (external) Assessment of Knowledge of Pupils is still based on written tests. Looking at the pedagogical process, speech consists only 3-5 % of the curriculum, also Slovene lessons, from primary school and up to the university (Tivadar 2015). The most influential media today is twitter, where you can read and write only short messages. However, modern technology is now a part of our world. You can tell this also by looking at politicians, they are well prepared and often read from a teleprompter (see Picture 1 and Barack Obama's speech). They are also well prepared when it comes to content and speech. If they are skilled and important politicians, their speech is of high quality and very prestigious.



Picture 1: Speech made by the president of the USA on a political rally where the two teleprompters can also be seen to aid the speaker. (source: Petr Josek, Reuters)

What is the role of phoneticians? For one, they should raise awareness regarding the importance of speech in public and in schools. The present situation in the media is such that only the fluency of speech is important. Orthoepy is mainly important only for prestigious speakers.

But with greater accessibility to digital devices and also videos of various speakers (streaming on YouTube, Facebook etc.), modern society also became more inclusive. From the linguistically ideal, society is moving towards the ideal in perception (Tivadar 2010) and is therefore receptive to non-ideal realisation of phonemes. Hence, it is the duty of psychophonetics and sociophonetics to search for what is pleasing and acceptable (minimal standards). We should also not forget the emotional component (likeability) of the spoken phrase, which is quite important when it comes to speech impediments. Speech impediments have distinctive non-typical voice colouring.

For the purpose of discovering suitable speech we can adapt the already developed phonological perceptive tests (Tivadar 2004, Huber 2006), which we adjust to the needs of speech-language pathology.

1.2. The Role of Phonetics and Phonology for Speech Therapy – Theoretical View

Every study of speech therapy usually also includes the knowledge of phonetics and phonology. For example: the speech therapy study (logopaedia) in Zagreb used to be in a very close relationship to phonetics and phoneticians on the Faculty of Arts. Today, the situation in Croatia is much more complicated – logopaedists (speech therapists) and phoneticians are competitors; in clinics, only speech therapists are officially recognized as independent and competent associates who can write professional opinions (medical reports). This means the medical report can be written by a doctor or a speech therapist, but not a phonetician; because they haven't passed the appropriate professional exam in the Croatian employment system (they are now introducing changes to the Register of occupations). When the research and study of phonetics and speech therapeutics was in its infancy, there was a lot of cooperation between speech therapists and phonetics in Croatia. **SUVAG** is a verbotonal method used in the rehabilitation of listening and speech (employed at the SUVAG Polyclinic, which is a health institution dealing with specialistic consultative health protection of individuals with speech communication problems) and also an acronym of the name: Guberina's Universal Verbotonal Auditory System (**S**ysteme **U**niversel **V**erbotonal d'**A**udition **G**uberina). The verbotonal method was defined in Petar Guberina's *Linguistics of Speech*. Petar Guberina is also the founder of Phonetics in Zagreb (1954). Cooperation between phoneticians as humanists and linguists and speech therapists is very normal and necessary. Something the academician Peter Guberina managed to do. Speech is the structure emerging from sound and the body using the brain as a processor of speech content and its forms, as is written on the SUVAG clinic website (<http://www.suvag.hr/en/>). Every study (and also practice) of speech therapy usually includes also the knowledge of phonetics and phonology. Therefore, cooperation between phoneticians and speech therapists is absolutely necessary.

1.3 The Role of Phonetics and Phonology for Speech Therapy – Meaning of Speech Perceptive Tests

Perceptive tests make it possible to objectively inspect certain phonetic traits, which is the content value of what is heard, where it is necessary to exclude outside influences as much as possible (various noises, bad audibility of what is spoken), and also internal (description of what is heard based on personal experience) factors. The objectivity of perceptive tests is largely ensured by a large number of respondents – the grade does not depend on just one or more researchers. The phonological perceptive tests presented in this article were developed for the needs of orthoepy and phonological research of Slovenian vowels (Tivadar 2004; Huber 2006). Comparable perceptive tests were developed for the Czech language at the Phonetic Institute on the Faculty of Arts of the Charles University in Prague (prof. dr. Z. Palková).

1.3.1. An Example of Speech Perceptive Tests in Slovene Phonology

The basic problem we set for our phonological test (Tivadar 2004) was the differentiation between long and short vowels (for example, *sit* 'satiated' : *sít* 'Gpl. Sieve') and the differentiation between various vowel phonemes (*góst* [gost] 'thick' : *gòst* [gɔst] 'guest'). It is very important to prepare appropriate phonological material (analysed words). During the first test (P I, 4. 3. 2002) we analysed 21 different phonological examples (20 minimal pairs and inspecting the audibility of the non-accented word *vas* 'Genitive form of you'), mostly phonological pairs spoken by four different speakers – two males and two females. Phonological pairs were mixed up enough so that the interviewees could not establish “artificial differences”, but had enough time and the possibility to discover the meaning of the word they heard. These phonological examples were heard four times from different speakers, all together 84 examples (e.g. Tivadar 2004). We interviewed 52 freshmen students of Slovenian Studies from all across Slovenia, who were phonetically and phonologically competent and motivated. (The same method was used for the test given to secondary school students from Pomurje (Huber 2006).).

Phonological material: The following phonological pairs:1 *góst* : *gòst*, *grób* : *gròb*, *klóp* : *klòp*, *kós* : *kôs*, *pót* : *pòd*; *léd* : *lèt*, *méd* : *mèt*, *pét* ('peti') : *pêt* ('peta') (vowel quality); *k njìm* : *z njím*, *sít* : *sít*, *bíl* : *bíl*; *kúp* : *kúp* (and *nakúp*); *naglàs* : *na glás*, *bràt* : *brát*, *vàs* : *vás*, *kákšen* : *kákšen*, *kàj* : *káj* (also difference based on vowel duration (unaccented vowels): prepositions *med*, *pod*, *vas*).

Preparing phonological material: The materials were specifically prepared for the analysis of accented vowels in a neutral sentence position:

Vzel je led iz novega čarobnega napoja. — To je bil let iz novega podzemnega letališča.

The examples of the researched vowels were in a neutral sentence position on the basis of a stress based (non-tonemic) literary (standard) speech.

Selecting speakers: The readied sentences with analysed words were **read** by professional Radio Slovenia speakers, who are highly trained in speech. Professional speakers – announcers of the national radio feature often on radio and are very popular, therefore they have great influence when it comes to shaping contemporary spoken norms.

Recording: Recording quality is very important. There were several sentences and words read and recorded that were then used during testing. We recorded over 100 sentences and several texts by 9 professional speakers (tonemic and non-tonemic). The materials were recorded from November 2001 till January 2002 on Radio Slovenia in wave format 40100 Hz stereo; one speaker was recorded on Radio Antena with the same studio quality.

Preparing phonological perceptive test P1: Words that interested us from segmental (vowel quality) and suprasegmental (accent and duration) phonological view were cut out from sentences from selected speakers. Before the word was recorded, a number would be pronounced, synthesized on a Slovenian speech synthesizer (Gros 2000). Each tested example was played three times so that the respondents had enough material and time to decide on the meaning of what he or she heard. After the words were played there would be a longer pause.

The played clip would sound like this:

synthesized »dva« (1.2 second pause) + led (1 second pause) + led (1 second pause) + led and 2 second pause.

Results: Through these perceptive tests we proved the differentiation between individual vowel phonemes (/e/ and /ɛ/ and /o/ and /ɔ/) all across Slovenian territory, even though this is not spoken in the east Styria region of Slovenia (Toporišič 1991: 44). Also the respondents, regardless of their geographical origin, differentiated between accented and unaccented vowels (example of the unaccented personal pronoun in the genitive *vas* 'you'). However, the respondents did not differentiate between short and long vowels /a/, /i/, /u/ in /ɔ/. More on the result in the article Tivadar (2004).

Through objective testing we audibly tested and proved the differentiation between central phonemes (/e/ in /ɛ/ ter /o/ in /ɔ/) across the territory of Slovenia and refuted certain linguistic presupposition based on personal feel (differentiating between long and short accented vowels, what is written in the Slovene grammar and current codification (in the orthography and dictionary).

2 PERCEPTIVE TESTS IN SPEECH EVALUATION OF PEOPLE WITH A COCHLEAR IMPLANT /

When it comes to perceptive analysis of persons with a cochlear implant (two pilot researches during speech-language pathology studies of students Petra Obrul, Jana Bojovič, Maja Cigüt and Nika Pregarc, mentor Hotimir Tivadar) we researched likeability, acceptability and especially intelligibility of non-ideal speech. Objective data will help us develop therapeutic practices. As we know, individuals with full or partial hearing loss often have very specific speech, which is quite nasalised. Such speech often makes inclusion in communication (likeability) more difficult and the acceptability of the speaker when communicating. Differences from the viewpoint of colourfulness of speech can, by educating to be tolerant to different speakers, be made acceptable. However, it is practically impossible to replace unsuitable phonetic realisation. Therefore, in this article the focus will first be on the minimal pairs (phonological testing the semantic value of what is spoken). Methodologically, these speech-language pathology (logopaedic) tests are comparable to previously presented orthoepical phonological perceptive tests.

2.1. Case Study: Phonological distinctiveness of the speech of a person with a cochlear implant

The same methodology as in phonological tests was used in the phonological perceptive test in speech therapy (Bojovič-Cigüt-Pregarc 2019), the material was also carefully prepared. Minimal phonological pairs (for example mama ‘mother’ – baba ‘woman’) were recorded in high quality by a native speaker with a cochlear implant. Respondents were students (18 female students) of speech therapy and surdopedagogy from all over Slovenia, also highly motivated and phonetically educated.

2.1.2 Results of a Speech Therapy Phonological Perceptive Test

From the results (Picture 2) we can see that the main problems are clusters bl-pl, tr-dr-kr, kr-gr, and š-č, which were not correctly recognized by the respondents. Also, instrumental analysis confirmed that pronunciation was not clear, but instrumental analysis confirmed unclear pronunciation also for other examples, which were more or less correctly understood by the respondents. Some of these answers were also marked with “?*”, which denotes an understandable word, but one very different from standard speech.

In conclusion we can say that the more complex phonemes (/tʃ/) and clusters of phonemes must be clearly articulated in order to be well understood.

For future research we would like to include several different tests by various speakers with a cochlear implant, to expand the respondents' base to less qualified speakers and to evaluate the likeability and acceptability of the speaker and the degree of nasality. We believe that more data will help create a more inclusive society.

No.	Minimal pairs	Correct	Incorrect
1	mama – baba	18 (baba)	0
2	nimam – imam	18 (nimam)	0
3	mapa – napa	18 (mapa)	0
4	mica – ptica	18 (ptica), 2x ?*	0
5	mama – baba	18 (baba)	0
6	mamica – babica	18 (mamica) 1x ?*	0
7	nimam – imam	13 (nimam)	5 1x ?*
8	mapa – napa	18 (napa)	0
9	mica – ptica	18 (mica) 2x ?*	0
10	mamica – babica	18 (babica)	0
11	<u>blatno – platno</u>	<u>7 (blatno) 1x ?*</u>	11 4x ?*
12	hiša – niša	16 (niša) 4x ?*	2 1x ?*
13	gos – kos	13 (kos) 7x ?*	5
14	kaj – kdaj	18 (kaj)	0
15	<u>trava – Drava – krava</u>	<u>13 (Drava) 4x ?*</u>	5 (2 – trava, 1x ? in 3 – krava, 2x ?*)
16	šop – čop	18 (šop) 2x ?*	0
17	<u>krivo – grivo</u>	2 (grivo) 1x ?*	16 1x ?*
18	džip – čip	16 (džip) 2x ?*	2 1x ?*
19	trava – Drava – krava	16 (krava) 5x ?*	2 (trava) 1x ?*
20	<u>šop – čop</u>	<u>8 (čop)</u>	10 4x ? *
21	džip – čip	15 (čip) 2x ?*	3 1x ?*

Picture 2: Intelligibility of minimal pairs of different consonant phonemes

3 CONCLUSION

Digital devices, especially smartphones, have a huge impact on brain development, particularly the development of children. The decline and unnatural retrograde development of the brain have been increasingly raised by psychologists and physicians alike (e.g. Spitzer 2012). As linguists, we point out the change in communication. The early use of smartphones and social networks by young people will definitely change the manner of articulation and perception. That is a new and big challenge for phoneticians and speech therapist. First, we should encourage as much speech as possible. Second, we will closely monitor the ability to perceive and phonological distinctiveness through the objective perceptive tests presented in this article. These objective phonological tests will have to be developed for both linguistic and speech-therapy purposes.

REFERENCES

- Bojovič, J., Cigüt, M., Pregarc, N. (2019). *Ugotavljanje prisotnosti nosne komponente in prisotnosti distorzije sičnikov, šumnikov in glasu r pri gluhi osebi s polževim vsadkom / Determination of presence of nasal component and presence of distortions of /s/, /z/, /c/, /š/, /ž/, /č/, /dž/ and voice r in a deaf person with a snail implant*. Seminar paper in Year 4 of surdopedagogy (Mentor: H. Tivadar).
- Gros, J. (2000). *Samodejno tvorjenje govora iz besedil. Postopek za izdelavo sintetizatorja slovenskega govora*. Ljubljana: Založba ZRC SAZU.
- Huber, D. (2006). Percepcija samoglasniških opozicij pri dijakih pomurskih srednjih šol. *Jezik in slovstvo* 51/1. Ljubljana: Slavistično društvo Slovenije. 69–83.
- Spitzer, M. (2012). *Digitale Demenz: Wie wir uns und unsere Kinder um den Verstand bringen*. Hamburg: Droemer Verlag.
- Srebot Rejec, T. (1998). O slovenskih samoglasniških sestavih zadnjih 45 let. *Slavistična revija* 46/4. 339–346.
- The SUVAG Polyclinic (website). Zagreb. (<http://www.suvag.hr/en/>)
- Tivadar, H. (2004). Priprava, izvedba in pomen perceptivnih testov za fonetično-fonološke raziskave (na primeru analize fonoloških parov). *Jezik in slovstvo* 49/2. 17–36.
- Tivadar, H. (2010). Normativni vidik slovenščine v 3. tisočletju – knjižna slovenščina med realnostjo in idealnostjo. *Slavistična revija* 58/1. 105–116.
- Tivadar, H. (2015). Vloga pravorečja in njegovo poučevanje v slovenskem osnovno- in srednješolskem izobraževanju. *Jezik in slovstvo* 60, št. 3/4. 161–172, 252.
- Toporišič, J. (2000). *Slovenska slovnica*. Maribor: Založba Obzorja.

Современное Развитие Лингво - Педагогических Технологий

М.С. Гончаренко

профессор, доктор биологических наук; Глава Всеукраинской общественной организации
«Украинская ассоциация валеологов»

Харьковский национальный университет имени В. Н. Каразина

E-mail: m.goncharenko@karazin.ua

АННОТАЦИЯ

На основе анализа современного развития лингво-педагогических технологий сделан вывод о том, что для реализации принципов синергетики в образовании необходима новая образовательная технология, которая решила бы триединую задачу: воспитание творческой личности, ее адаптацию к условиям жизни, которые изменяются, предоставление возможностей для дальнейшего саморазвития и самореализации.

Ключевые слова: педагогика, образование, лингвистика, синергетика, здоровьесбережение.

Лингвистика - Языкознание - наука об общих законах строения и функционирования человеческого языка.

Современная Лингвистика составляет внутренне дифференцированную систему отдельных широких отраслей и узких ответвлений (разделы, дисциплины). Одним из разделений Лингвистики является ее деление - на конкретное (специальное) и общее.

На почве исследований сравнительно-исторического языкознания в 70-х гг. 19 в. сформировалось психологическое направление в языкознании, которое отрицало связи языка с логикой, сосредоточившись на анализе психологии индивидуального акта речи. Многообразие языков и языковых форм - это направление объяснялось особенностями психологии различных народов, считая, что язык является психическим явлением. Психологическое направление начал В. Гумбольдт, дальнейшее развитие он получил в основном в трудах Г. Штейнталя и В. Вундта (Германия). В Украине его ярким представителем был А. Потебня (учение о внутренней форме). Психология речи, уже на интерметодологических принципах, является предметом научных исследований и теперь.

Учредителями социологического направления лингвистике в начале 20 в. были Ф. де Соссюр и А. Мейе. Это направление исходило из тезиса, что речь является не психическим, а социальным явлением и ее основной функцией является общение. В процессе изучения проблем, связанных с социальной природой языка, его общественными функциями, возникла социолингвистика. Однако ведущей идеей языковедения в 20 в. стал не социологизм, а концепция языка как знаковой системы, концепция языковой структуры, в которой значимы не только единицы, но и связи между ними. Основателем структурной лингвистики стал Ф. де Соссюр.

В российском языкознании так или иначе выходили на структурную лингвистику труда Л. Щербы, С. Поливанова, представителей московских и ленинградских фонологических школ.

В Украине эту отрасль представляют В. Русановский, С. Семчинский, М. Муравицкий, А. Тараненко и другие.

В Украине проблемы языковедения разрабатывают Институт языкознания им. А. А. Потебни НАН Украины, Институт украинского языка НАН Украины, языковедческие кафедры университетов и педагогических институтов. Издается журнал «Языкознание».

Настоящая работа рассматривает педагогические аспекты лингвистики (языкознание, «мовознавство» А. А. Потебня), через интеграцию и компоризацию идей, объединение всего человечества, новые цели, новые задачи, новое понимание сохранения жизни на Земле.

Цель – не обогащение, а самореализация, рост качеств человека, новое мировоззрение, его платформа – «Духовность – Здоровье – Валеология», через педагогические технологии создание нового общества, новых целей общества, их проявление через новые диагностики и методологии.

Несение новых идей осуществляется через лингво-педагогические технологии.

Лингвистика – должна стать носителем новых целей существования человечества; новых знаний о его гармоничном взаимодействии с Окружающей Средой и Миром.

Валеология – новая молодая наука, указывающая цели и ценности здоровья, сохранение жизни на Земле и пути дальнейшего развития; создание здоровьесберегающего пространства, здоровьесберегающего социума, развитие духовности – как ведущего человеческого качества, ведущей жизненной цели: Валеология – как наука XXI столетия дает новое мировоззренческое понимание энергоинформационной структурной организации мира и человека с указанием иерархически ведущей роли духовности.

В качестве примера представляем использование лингвистических технологий преобразования педагогики современного этапа развития науки на основе синергетического подхода. [7, 8, 12]

Современное состояние образования характеризуется вхождением синергетической парадигмы как междисциплинарной парадигмы познания мира и педагогической реальности.

Темпы развития нашего динамического мира приводят к тому, что специализированные знания теряют свою прикладную ценность через 10-15 лет. Все это требует построения новой педагогической системы, которая бы осуществляла формирование новых знаний на основе междисциплинарных связей. Кардинальная трансформация образования Украины требует внедрения в учебный процесс синергетических принципов ее самоорганизации как открытой социальной системы.

Еще в конце прошлого века эти вопросы нашли развитие в трудах академиков Б.А. Астафьева и Н.В. Масловой, которые стали инициаторами развития ноосферного образования. [2]

В своей монографии «Ноосферное образование» Н.В. Маслова пишет: «Какими умениями должен обладать педагог-новатор? Главное - уметь любить, то есть безусловно принимать мир и человека. Уметь целостно мыслить, то есть одинаково хорошо владеть методами работы левого и правого полушария и их совокупной работы. Педагог нового поколения должен уметь трансформировать негативные проблемы, настроения, направлять их в позитивное». [12]

Учитель сегодня должен быть духовным. Духовность человека определяется степенью развития его духа. С категорией «духовность» соотносится потребность познания мира, себя, смысла и назначения жизни своей. А самое главное, что из-за достижения равновесия обоих полушарий возвращается к человеку духовное зрение. В правом полушарии живут наши духовный и эмоциональный центры. Эти составляющие знают, что все взаимосвязано, все едино. Левое полушарие не чувствует единства, когда оно осматривает реальность. Все, что оно видит, это разделение, разъединение. Но при совместной работе левого и правого полушарий мозолистое тело открывается, обеспечивая соединение обеих половинок, связь между левым и правым полушарием укрепляется, информация передается туда и обратно, противоположные стороны мозга начинают объединяться и действовать синхронно. При этом особым образом включается в работу шишковидная железа, а мозг начинает использовать сверхспособности, что приводит к появлению более высоких уровней сознания [2-7].

Сегодня мир пришел к единому мнению о том, что уровень развития цивилизации определяется только одним фактором - существующей системой образования [6, 12]. Учитель сегодня несет ответственность за выбор пути современной цивилизации.

«Учитесь от природы» - говорил мудрый болгарский учитель А.Н. Айванхов. Он писал в своей работе «Природа сделала так, что в каждом своем семени она записывает свойства, цвета, размеры,

вкусы, запахи будущих плодов, то почему возможно думать, что она не сделала тоже самое и с людьми?

Концепция синергизма в обучении и воспитании приобретает интенсивное развитие. Благодаря научным исследованиям д.п.н., проф. А.В. Вознюка, педагогические системы начали анализироваться в терминах синергетической теории самоорганизации. [2-6] Методология синергетики раскрывается в работах В.И. Андреева, Л.Я. Зориной, Г. Шефера, М. С. Гончаренко, А. П. Бугаева и других. [2, 7, 8] Этот подход освобождает педагогическое пространство от однолинейности, штампов, открывает полифункциональность и многомерность гипотез и теорий.

Творческое направление развития синергетического подхода в современном образовании развил талантливый украинский ученый, д.п.н. А.В. Вознюк. Свое видение развития феномена творческой многомерности он изложил в монографии «Синергетическая парадигма креативной педагогики», в которой показал, что талант учителя состоит из его способности сочетать различные когнитивные стратегии, стили деятельности и черты характера. Обосновывается, что творчество, одаренность и интеллект имеют определенную генетическую связь. По моему мнению, эта связь имеет волновую природу.

Именно в «точках бифуркации», что представляют собой развилки процессуальных возможностей, возникают благоприятные условия для изучения и моделирования различных ситуаций с раскрытием у студентов (учащихся) творческих новых путей развития. Как показывает Н.А. Федорова, в учебной деятельности благодаря синергетическим подходам осуществляется сочетание сознательной и бессознательной психической деятельности, которая реализует направление в удовлетворении познавательных потребностей. Такой процесс способствует повышению качества его усвоения и эффективности обучения. [14]

Синергетика постулирует, что хаос является конструктивным механизмом самоорганизации сложных систем и является необходимым условием выхода системы на собственную траекторию развития. [7, 14]

В соответствии с этим, Ю.В. Шаронин выделяет характерные «синергетические» черты творческого мышления педагога: многовариантность, разнообразие ходов, случайность, хаотичность. Краеугольными параметрами личности он считает: активность, диалогичность мышления, открытость, творческое воображение, морально-ценностные ориентации, ответственность, волю, самовыражение, реализацию, удовлетворенность деятельностью. [15]

Анализ научных источников позволяет выделить следующие особенности процесса педагогического творчества, которые анализируются с позиции синергетического подхода:

1) наличие такого феномена, как энергетика, которая предстает активным деятельным началом всех участников учебно-воспитательного процесса;

2) вхождение личности как активного элемента в педагогическую систему, приводит к творческому обогащению всех участников педагогического процесса;

3) открытость педагогической системы - ее постоянный обмен энергией, информацией с окружающей средой, предусматривающий как тесную связь процесса педагогической деятельности с жизненным опытом и знанием жизни, так и связь внутренних потребностей самой личности с возможностью их реализации во внешней среде;

4) диалогичность педагогической системы - способность к общению, умение обратиться к внутреннему миру воспитанника, увидеть мир глазами другого, сделать общение в системе «педагог-воспитанник» творческим, плодотворным, таким, что взаимно их обогащает;

5) свобода выбора всех участников педагогического процесса предполагает нелинейность развития, что лежит в основе синергетики, когда, в первую очередь, здесь имеются многовариантность, альтернативность, возможность выбора из данных альтернатив, что предусматривает возможность отбора школьниками и студентами учебных заведений, предметов, преподавателей, форм и методов обучения, индивидуальных средств и методик, творческих задач, личностных подходов в обучении и воспитании;

6) удовлетворенность деятельностью, ситуация успеха, что должны распространяться на деятельность всех участников образовательно-воспитательного процесса. [11]

Реализуя синергетические механизмы творческого мышления, педагог должен проявить: многовариантность, разнообразие ходов, случайность, хаотичность. Краеугольными параметрами личности он считает: активность, диалогичность мышления, открытость, творческое воображение, морально-ценностные ориентации, ответственность, волю, самовыражение, реализацию, удовлетворенность деятельностью.

Существует тесная феноменологическая связь между такими характеристиками человека, как творчество, одаренность, интеллект. Исследование этих вопросов легли в основу Концепции функциональной асимметрии мозга человека. [6]

Как показывает анализ научных источников, полушария головного мозга человека можно рассматривать психофизиологическим фокусом человеческого организма. [6, 8] Правополушарная сфера психической активности кадия среды включается автоматически, а левополушарной среды - произвольно. [6, 8, 9]

Правое полушарие как субстрат подсознательного, ориентируется на высокочастотные информационные сигналы (эмпирика, циклотимность, высокоэмоциональные реакции), левая как субстрат сознательного – ориентируется на низкочастотные (рефлексия, шизотимность, холодноэмоциональные реакции). [12, 13]

Следует отметить, что в целом правополушарная стратегия восприятия мышления и освоения мира является эмоционально-образной, конкретно-экспрессивной, целостно-синкретическим мировоззрением, что формирует многозначный лингвистический и мотивационно-смысловой контексты отражение действительности, «пробуждает» такие формы общественного сознания, как искусство и религия. Левополушарная стратегия, наоборот, является абстрактно-логическим, понятийно-концептуальным, дискретно-множественным мировосприятием, формирует однозначный лингвистический и мотивационно-смысловой контексты отражения окружающего мира и актуализирует науку и философию. [6, 12, 14]

Можно сказать, что развитие человека проходит от правополушарного аспекта психики (у младенца оба полушария функционируют как единое целое в основном по принципу правого полушария) до левого полушария, а от него - к функциональному состоянию полушарного синтеза. Если принимать во внимание, что правое полушарие функционирует в настоящем с направленностью в прошлое, а левое - в настоящем времени с направленностью в будущее, то можно утверждать, что развитие человека естественным образом идет от прошлого к будущему, а от него - к синтезу прошлого и будущего, когда пространственно-временная дихотомия бытия нивелируется.

Рассмотренная эволюционная парадигма является универсальной, поскольку она отражает общее правило движения как формы бытия материи, которая реализуется, как процесс изменения состояний дискретности и континуальности в развитии тех или иных предметов и явлений.

Таким образом, развитие человека происходит от чувственно-эмоциональной к рационально-интеллектуальной, а от нее - к медитативной форме постижения и освоения мира.

Представленные результаты научных исследований, дают возможность утверждать, что целью развития человека является достижение синтеза право- и левополушарных аспектов типов мышления (психики), то есть, когда такие полярные категории функциональной природы полушарий, как образ и идея, предмет и знак, ощущение и мысль, единое и множественное «сливаются».

В результате такого процесса формируется основа для интуитивно-медитативного эвристического отражения действительности. В этом процессе конкретное и абстрактное, экспрессивное и логическое, сливаются воедино, создавая феномен истинного, и в то же время парадоксального бытия, а человек предстает как гармоничное, духовное, творческое существо.

Проведенный анализ позволяет сделать вывод, что творчество, одаренность и интеллект имеют определенную генетическую связь, которая реализуется в процессе развития ребенка. [3-5, 10]

Одаренность (правое полушарие мозга) измеряется исследованием:

- 1) аффективно - перцептивной сенситивности;
- 2) эмпатийности;
- 3) уровня альтруистичности;
- 4) способности к художественному освоению действительности;
- 5) образного мышления

Интеллект (левое полушарие мозга):

- 1) исследование интеллектуальных ресурсов мышления, абстрактно-логическое мышление;
- 2) гипотезирование;
- 3) исследование индекса полушарной асимметрии;
- 4) способность к непрагматической ценностно-мировоззренческой ориентации.

Как утверждает д.п.н. проф. А.В. Вознюк, процесс развития человека, осуществляемый от правого до левого полушария, а от него к бифуркационному состоянию полушарного синтеза, предстает определенной пояснительной моделью образовательных и социоприродных явлений, иллюстрируя целостный процесс развертывания образовательной реальности, как на глобальном, так и локальном уровнях. [3, 5, 6]

С помощью синергетической парадигмы, что предстает мощным эвристическим средством изучения мира, осуществляется объяснение логики развития системы образования в виде чередования субъект - субъектной и субъект - объектной образовательных парадигм.

Мы видим, что принципиально новое создается только в практической сфере бифуркационной педагогики в контексте механизмов творчества. (Рис. 1) Указанное выше позволяет сделать вывод, что для реализации принципов синергетики в образовании необходима новая образовательная технология, которая решила триединую задачу: воспитание творческой личности, ее адаптацию к условиям жизни, которые изменяются, предоставление возможностей для дальнейшего саморазвития и самореализации.

Для решения этих проблем необходима разработка современного аппаратно-программного (АП) оборудования для измерения волновых процессов человека, которые дают возможность следить (измерять) за динамикой действия различных факторов на состояние здоровья. Эти наработки осуществлены в Харьковском национальном университете имени В.Н. Каразина на кафедре валеологии. [2]

Наше с Вами задание сделать так, чтобы современное образовательное пространство соответствовало уровню научного познания мира.

Исходя из синергетической парадигмы организации мира, энергоинформационная (духовная), а не социальная сущность человека может позволить ей эволюционировать в направлении выживания.

Поэтому надежда возлагается на «Педагогику» или «Философию образования», которая сможет подготовить армию носителей новой идеологии – учителей будущего. Позитивное и негативное влияние человеческой психики на здоровье, способ жизни и социальный статус определяется потоком мышления (т.е. волнового излучения), который выносит человека или к творческой самоорганизации, здоровью, счастью, успеху в случае позитивности или (вносит) создает дисгармонию, болезни, раннее старение и смерть в случае негативных мыслей.

Актуальность поднятых вопросов реализуется на основе возможностей учебно-воспитательного процесса. Высокая культура речевого общения на основе постнеклассического парадигмального мышления особенно важна для учителей, которые пользуются словом, как инструментом своей профессии и являются образцом для наследования участников.

Преодоление педагогических рисков является приоритетным направлением педагогических исследований и путей модернизации современного школьного образования в целях его гуманизации и здоровьесбережения.



Рис. 1. Развитие трех типов педагогического воздействия (трех педагогик) как модель развития образовательной сферы [6]

ЛІТЕРАТУРА

- Брагина Н.Н. Функциональные асимметрии человека / Н.Н. Брагина, Т.А. Доброхотова. - М.: Медицина, 1988. - 288 с.
- Бугаев А.Ф., Белявский Г.А., Нагорнюк О.Н., Гончаренко М.С. Самоконтроль духа и тела – главное условие нашего существования в Новой эпохе // Наука и Космос: прошлое, настоящее, будущее. – Санкт-Петербург: Изд. Астерион, 2019. – С. 432-445.
- Вознюк О.В. Системно-інформаційний підхід до організації навчальної діяльності обдарованих дітей // Виявлення та підтримка обдарованості учнів загальноосвітньої школи. Матеріали всеукраїнської науково-практичної конференції. Тернопіль, 2009. - С. 36-42.
- Вознюк О.В. Спроба обґрунтування універсального підходу до діагностики обдарованості // Методичні основи діагностики академічної обдарованості учнів (з урахуванням специфіки освітніх галузей): Матеріали науково-практичного семінару 15 вересня 2001 р., м. Київ. – К.: ІОД НАПН України, 2011. - С. 34-40.
- Вознюк О.В. Сутність феномену обдарованості // «Інтелект і особистість», семінар. Матеріали семінару «Інтелект і особистість» та круглого столу «Структура особистості дитини у віковому вимірі», 27 квітня 2010 р. / НАПН, Ін-т обдар. Дитини. – К., 2010. – С. 31-32.
- Вознюк О.В. Синергетична парадигма креативної педагогіки // Педагогічна творчість, майстерність, професіоналізм у системі підготовки освітянських кадрів: здобутки, пошуки, перспективи: монографія / за ред. Н.В. Гузій; МОН України. Нац. пед. ун-т ім. В.П. Драгоманова – К.: Вид-во НПУ ім. М.П. Драгоманова, 2015. – С. 3-22.
- Гончаренко М. С. Синергетичний світогляд сучасного розвитку світу і людини: монографія / М. С. Гончаренко. – Харків: ФОП Панов А.М., 2017. – 104 с.
- Гончаренко М. С. Технологія здоров'язбережувальної освіти на основі цілісного мислення: навчально-методичний посібник / М.С. Гончаренко, Д.В. Стрілова, Т. О. Богомаз. – Х.: ХНУ імені В. Н. Каразіна, 2018. – 144 с.
- Губенко О. В. Феномен інтуїції та інтелектуальної творчості / О.В. Губенко // Практична психологія та соціальна робота. - 1999. - № 7. - С. 10- 14.
- Дорфман Л. Я. Основные направления исследований креативности в науке и искусстве / Л. Я. Дорфман, Г.В. Ковалева // Вопросы психологии. - 1999. - № 2. - С. 101-106.
- Кудрявцев В. Т. Выбор и надситуативность в творческом процессе: опыт логико-психологического анализа проблемы / В.Т. Кудрявцев // Психологический журнал. - Т. 18. - 1997. - № 1. - С. 16-30.
- Ноосферное образование – ключ к здоровью: монография / М. С. Гончаренко, Н. В. Маслова, Н. Г. Куликова. – Харьков: ХНУ имени В. Н. Каразина, 2017. – 200 с.
- Педагогическая антропология. Учебное пособие / Авт. - сост. Б.М. Бим-Бад. - М.: Урао. - 1998. - 576 с.
- Федорова М.А. Педагогическая синергетика как основа моделирования и реализации деятельности преподавателя высшей школы: диссер... пед. наук. - 13.00.08. - Теория и методика профессионального образования / Федорова Марина Александровна. - Ставрополь, 2004, - 169 с.
- Шаронин Ю. В. Синергетика в управлении учреждениями образования / Ю. В Шаронин // Высшее образование. - 1999. - № 4. - С. 14-18.

The Mathematical Alphabetical Systems Originating the New Paradigm

Gennady Dlyasin

Independent researcher, Tolyatti, Russia
gensin777@yandex.ru

Dedicated to the 150th anniversary of the Chemical Elements System

ABSTRACT

This paper presents the concept of organizing the fundamental principles of mathematics - elementary functions and convex bodies of Plato and Aristotle. Exploring the systemic of natural and socio-psychological phenomena and continuing to search and find in this objective world the invariant of the universal system of 24-elements (after the first system – protein amino acids and nitrogenous bases of nucleic acids), the author remains convinced of the possibility of the existence of new systems. And he transfers his conviction to abstract subject areas — and discovers his systems in these areas twice. Functions and convex polyhedrons confirm the principles of the adopted research program - the consistent unfolding and complication of constituents of the systems in fives (rows) and tens (periods) of elements, mirror symmetry of two periods with each other, the presence of the "genetic" kernel from four elements- "generals" and another.

Keyword: Arithmetic (operators): addition, subtraction, multiplication and division. System of four arithmetic actions. Elementary functions and their curves. System of twenty functions. Symmetry of system of functions. 3D-system of the functions. Platon's bodies. Aristotle's bodies. A prism and an antiprism. System of twenty convex bodies. Symmetry of bodies system. System of four special elements for twenty convex bodies. 3D-system of convex polyhedrons. Transfer of the notion about the genetic code of living on mathematical abstractions.

The submitted work was planned by the author only in the sense of searching for new systems. The fact that it will be the mathematical system - elementary functions and convex polyhedrons - was a complete surprise. One way or another, but from the point of view of the method - from the point of view of Metachemistry itself as the author's research program - the preparation for work was more than significant and took about twenty years. Immediately before switching attention to mathematics, work was completed on a system in another subject area, a report on which will be published in the near future¹. All this, coupled with the relatively recent completion of the expanded exposition of the phonetic alphabet system (Dlyasin, 2013, 2015), created the author's methodological readiness to such a level that the very first thought that the functions along with their reverse "sisters" was about a twenty, in a short time it turned out to be the last - the system (Figure 1) was ready.

The discovery of the system of bodies was not much different, but there was a special inspiration here, since it was a question of the system that wrap up Plato and Aristotle thoughts into the united and final picture...

The first candidate for the element of the new system - and it did not matter the least - I just talk about how it all happened - was a function of square root. Probably, of all the symbols, the icon of this function is the most distinctive, vivid, expressive, and unlike anything else. I drew a symbol of square root, then a signs of a factorial, the logarithm, exponential and power functions. They were five, it was not

¹ Announcing here this one more paper, we are not only want to inform about the fact of its release simultaneously with the present work, but also to pay attention to the fact that there for the first time will be presented some new alphabetical systems.

enough, and below I immediately wrote the symbols of sine, cosine, tangent and cotangent. There were nine functions - still not enough, and, having signed the symbols of secant and cosecant even lower, I counted eleven. A sense of the insight joy was already present - and, for some unclear reason, adding signs of limit, differential, integral and the circumference formula, I left my occupation. After some time, it became clear that the four elementary operations of arithmetic – addition, subtraction, multiplication and division – will serve as the central "generals" of a square of system. And also - the fact that the second half of the system (ten constituents, "reflected in water") - these will be functions, the opposite of the first ten. In addition, and this was the result of some effort - I guessed that the system is formed by all known functions, that they are all the same, the same (elements) - and the habitual algebraic ones - exponentiation or root extraction, - and trigonometric functions, traditionally studied in another mathematics section.

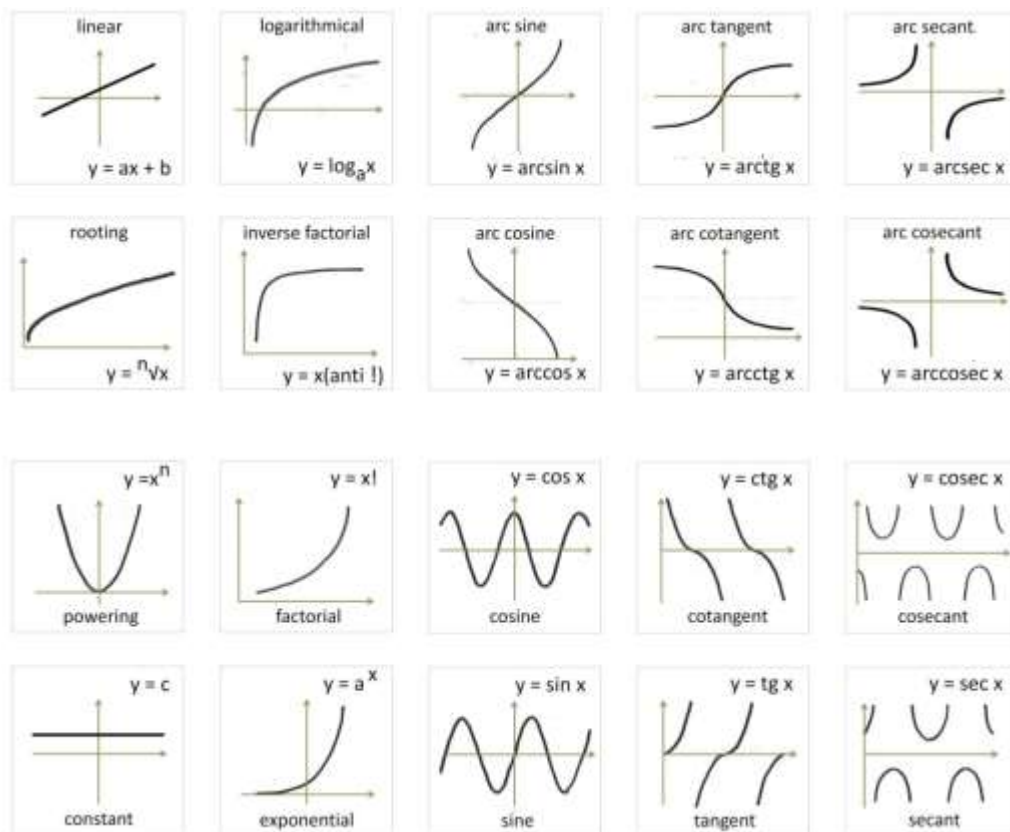


Figure 1. The alphabet of functions – system of elementary mathematical functions²

Before the discovery of the final picture, there was very little left to fill the empty cage with a certain special element - which is inverse function to factorial. I have never met a special mention of similar function - and, nevertheless, it followed from the very logic of the system. This function must exist, and its meaning was quite clear. As in the system of protein amino acids (Figure 2), discovered by the author of the first in a row, here in each set of five there was a complication of constituents - from functions elementary - to the most complex. The same thing happened in each set of ten - for example, the bottom "snake" began with the simplest function, when nothing changes at all, but ends with a complex trigonometrical, namely the cosecant. Upper ten-elements "snake" began with the other of the second

² Metachemistry systems in the matrix form of twenty elements. However when it comes to exit in volume, four more elements - "Generals" are added. In the text below, we indicate that these four elements are the square of operators «addition - subtraction - multiplication - division». This is not shown on Figure 1, but implied. The functions curves are demonstrated, firstly, not accurate, but stylized, and, secondly, for the simplest or one of the possible occurrences. For example - the curve for the power function taken only for the variant, when degree is even.

simplest dependences - with the equation of line and consisted strictly of the inverse functions, mirror-symmetric with those of the bottom "snake" and ended with arc cosecant.

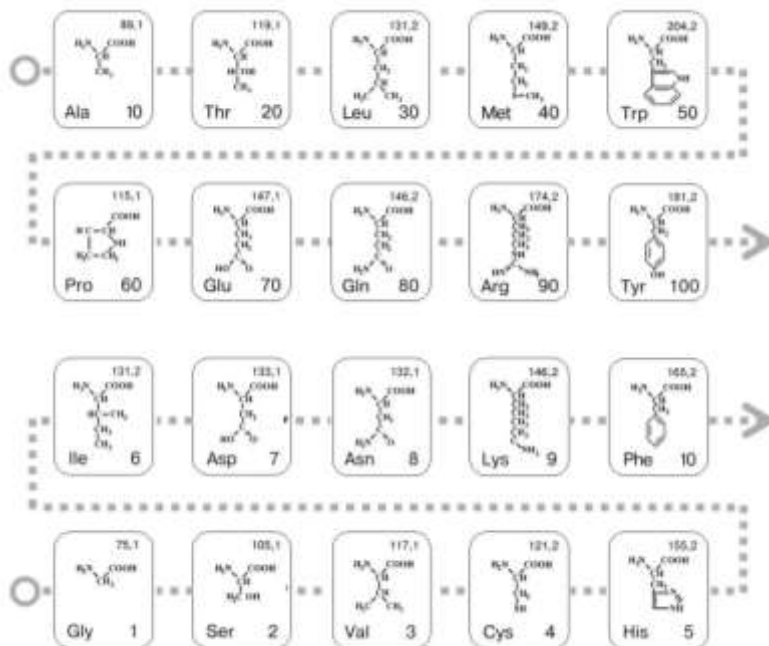


Figure 2. The system of protein amino acids (Dlyasin, 1998)³

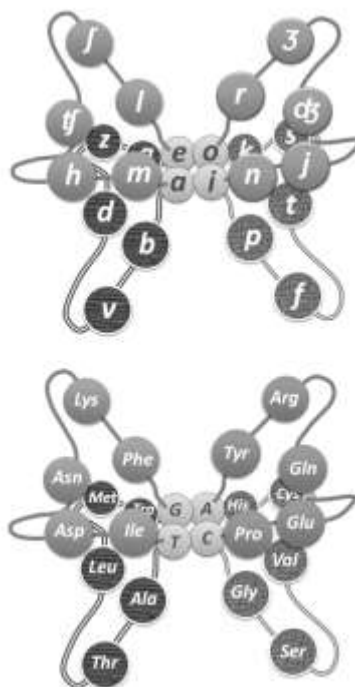


Figure 3. Gen- and Phon-butterfly - the alphabet of amino acids and nitrogenous bases, and also the alphabet of human sounds in the form of 3D-systems of one structure (Dlyasin, 2013)

³ The system is resulted in the matrix form. Four nitrogenous bases of nucleic acids are not shown. Each amino acid has the molecular weight on the upper right and the serial number on the lower right.

The time has come to present the system found in the 3D-form, when twenty "ordinary" elements in a special way (in pentamerous rows) "wrap around" four elements-"generals". Unlike detailed studies (Dlyasin, 2013), which were carried out to determine the exact relative position of the "generals" and which rags of the these pentamerous-rows and how (relative to one

another) they will come to the central square⁴ - for the gen- and phon-butterfly (Figure 3), here I just outlined the appearance of the system (Figure 4).

Let us leave these important clarifications for the future and move on.

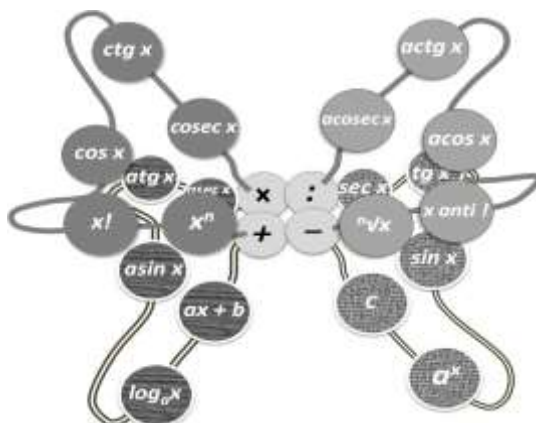


Figure 4. The system of elementary functions (3D-butterfly) in the structure, homologous and invariant to systems of amino acids and speech sounds⁵

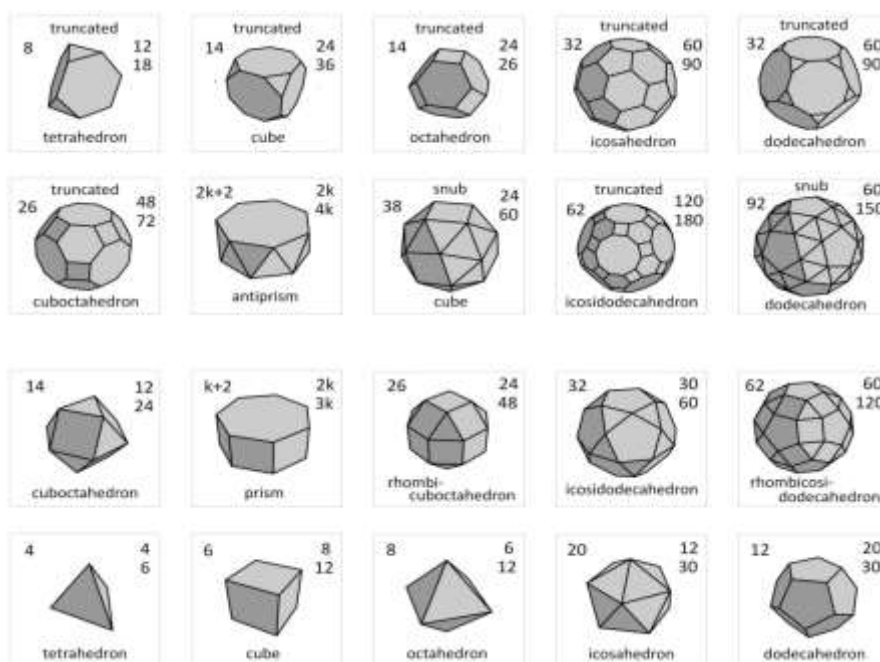


Figure 5. The alphabet of convex bodies - system of the convex polyhedrons in the matrix form⁶

⁴ Several other issues should also be addressed, including the selection of cistrans and optical isomerism and other tasks.

⁵ For obvious reasons, instead of the first part of the name of inverse functions «arc», on the image of the system we signed just "a", for example, instead of "arcsin x", on the system it is written "asin x".

⁶ At the upper right - the number of vertexes, at the little lower right - the number of edges. Images of each of the polyhedrons are taken from Charles Volhart's work (Wohlhart, 2001). The System presence implies the possibility of assigning serial numbers to each of the bodies, for example, as in amino acids system (Figure 2). For example, the

After the discovery of the functions system, I once again, with new enthusiasm – immersed myself into thinking about the picture of all floors of objective reality - with the desire and plan to disclose some more new 24-element systems... An important new creative state appeared - I realized that I could search for systems not only in the knowledge of the nature, but also in the abstract knowledge, for example, in the mathematics or logic. And very soon the "polyhedrons" word appeared in the first drafts, with the addition - "there must be the geometry own butterfly !". There were exactly enough elements - Plato and Aristotle's bodies formed the set of eighteen. Moreover, the set of superbly internally symmetric. Along with a prism and an antiprism - two more convex bodies - exactly from twenty constituents (Figure 5). The basis of the system was made up of ready-made pentamorous row - Plato's bodies in their sequences of complication, and the truncated bodies symmetric to them. The second rows of each period were made up of prisms and Aristotle's bodies, whose ensemble also turned out to be internally symmetrical, and there was only one thing for me - to place them (with prisms) on two sets of five.

So I eliminated another "scientific list" - after amino acids, phonemes and functions - one more strict system appeared - convex polyhedrons.

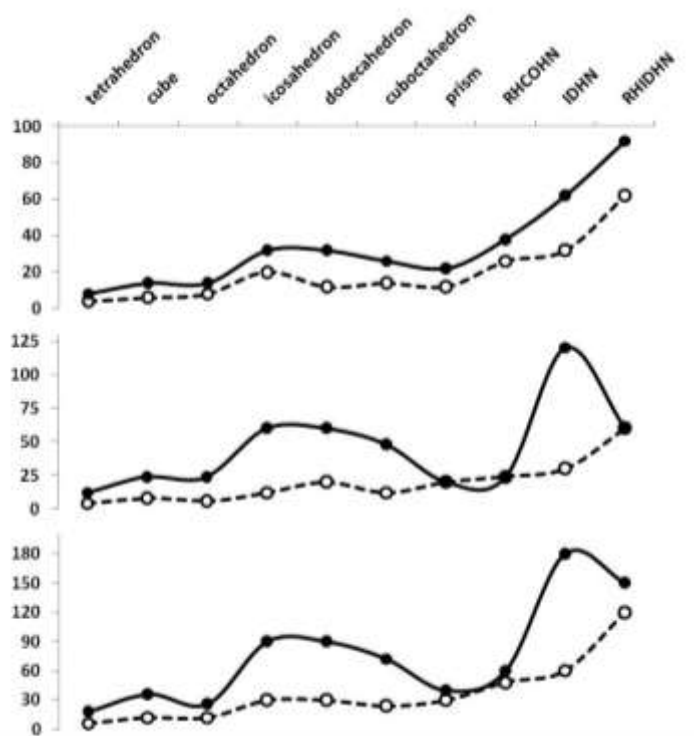


Figure 6. Curves of systemic change of the key parameters of convex polyhedrons, top-down: numbers of facets, vertexes and edges⁷

However, there were some doubts on the arrangement of elements - I changed the places of the icosahedron and the cuboctahedron (and the bodies paired by them in another "ten"), but eventually accepted the order shown here on the image of the system. The view of the system gave me no less mathematical and aesthetic pleasure than the functions system. Similarly, again and again I wanted to

tetrahedron has the a serial number - one, the dodecahedron - five. Such numbers are implied, but not shown here. Note that the same applies to the function system (Figure 1).

⁷ Values are given for all twenty elements, although for simplicity only one set of ten elements (period or "snake") are indicated, the second set of ten is implied according to the system. For visualization, the parameters for prisms are taken conditionally at $k = 10$. The rhombocuboctahedron is designated as RHCOHN, the icosododecahedron - as IDHN and rombo-icododahedron - as RHIDHN.

admire the symmetry of “sets of five” - here⁸ from tetrahedron to dodecahedron and their truncated “brothers” from above... No less inspiring was the symmetry the second pair of “sets of five” – from cuboctahedron to rhombicosidodecahedron and truncated and snub-nosed “brothers”. There were, of course, other systemic ties - for example, in the right part - in the vertical group - all the elements were dodecahedrons - simple, truncated, snub-nosed and others. Complicated polyhedrons at the end of the first and second pairs of rows (“sets of five”) stood just at those positions where the amino acids had radicals with benzene and heterocyclic rings (Figure 2). In each row (“set of five”) and periods (“set of ten”), the numbers of facets, vertexes and edges smoothly and regularly changed with a gradual increase. One can see how outwardly perceived and visible harmony and symmetry of system is complemented by a picture of the co-phase of curves course (Figure 6).

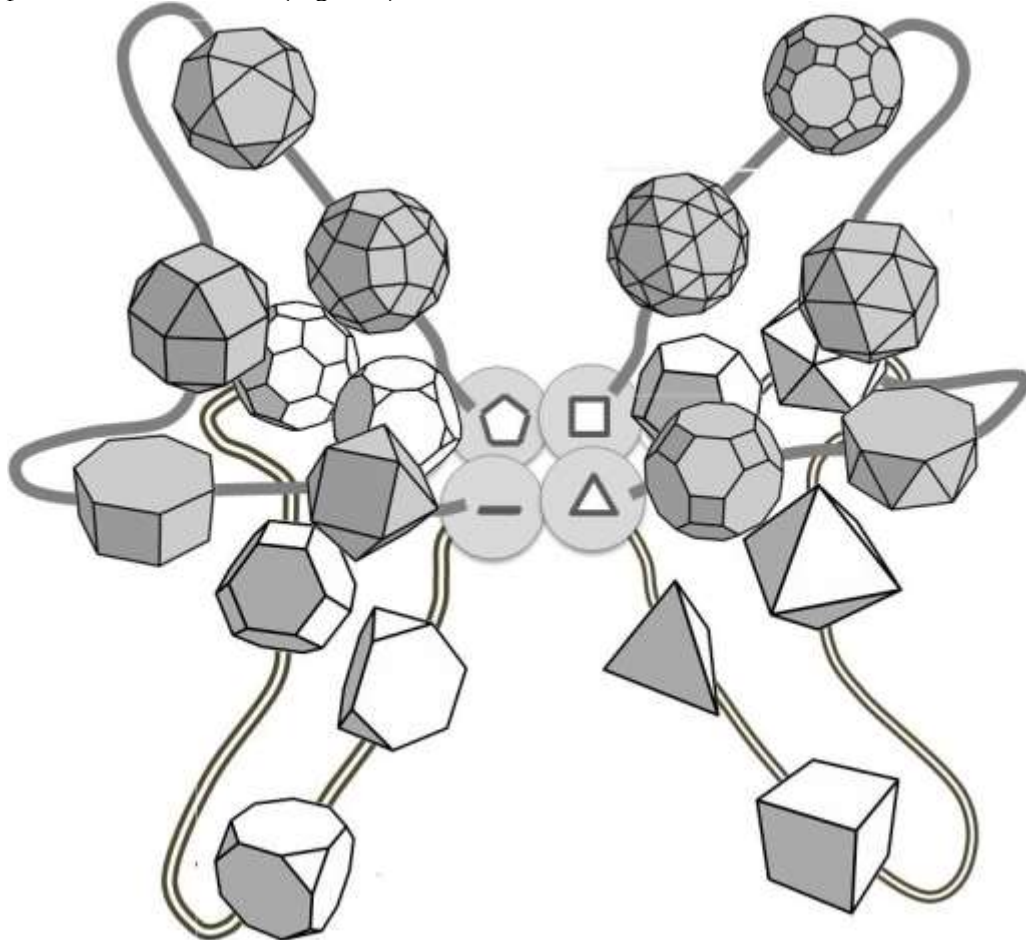


Figure 7. System of convex polyhedrons⁹ (3D-butterfly) in structure, homologous and invariant to the systems of amino acids, sounds of speech and elementary functions

Unlike the system of functions, where the "generals", it seems to me, are the main arithmetic operators, here from the very beginning to this moment - I was not sure what the main four elements define convex bodies. In the first image of the system in my draft I indicated a point (1), a segment (2), an angle (3) and a circle (4). There was also a variant consisting of a point (1), a segment (2), an angle (3) and a

⁸ Of course, I also thought about the cultural-historical meaning of this fact (recalling Egyptian pyramids or recalling Albrecht Durer's picture "Melancholy") and philosophical significance, recalling the interpretation of Plato bodies by Johannes Kepler - as a display of Five Primary Elements of the nature. Gokhan Kiper from Ankara, in particular, reminded me of these meanings in his historical review of polyhedrons (Kiper, 2007).

⁹ Polyhedrons are not consciously signed - when so then the system is better perceived as a whole.

plane (4). Today I would point to the third option, following from an analysis of Plato bodies, consisting of a segment (1), a triangle (2), a square (3) and a pentagon (4).

Now the reader can go back and repeat everything that I wrote above about the degree of completeness of the 3D-alphabet of functions (Figure 4). Let me remind you once again that four central elements have not yet been established - and here one of the options is taken, just mentioned just now - a segment, a triangle, a square and a pentagon. However, and without a detailed elaboration - the 3D-system of polyhedrons (Figure 7) was built and very impressed me not only as an author, but also as its first spectator.

Here is - and the depth of the fact (perhaps I would call it an event) that all the convex bodies are collected, and the symmetry, and the integrity-completeness of system as such, and the design, and didactic value ... However, this is enough.

Turning to a discussion of the results, it is immediately worth pointing to a certain "chromosome" in which the "structure of the idea" (functional relationship and forms) of space and time is hidden. The logic of analysis and comparison involuntarily leads to such an idea, when you see that the system of functions or system of bodies exactly repeats system of protein amino acids and the nitrogenous bases of nucleic acids. Does this mean that the genetic code acts everywhere - in all dimensions of the objective reality - in the nature, as well as in the thoughts, in the speech of the human, and also in the abstract science constructions. In fact, the author's system of the alphabet permeates and organizes all the worlds presented to a person in his consciousness and practice of life - both objective natural (the amino acids of protein and the nitrogenous bases - elements of the genetic code), and ideal - abstract - speculative (two mathematical systems presented here), and socially-psychological intellectual and communication (system of the actual phonetic alphabet) and others.

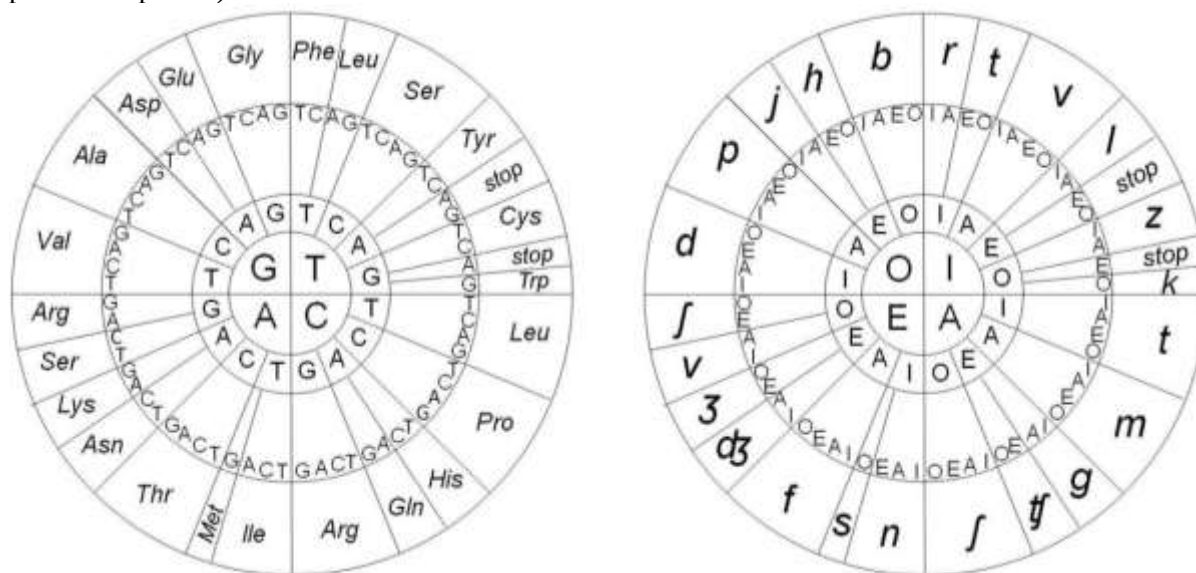


Figure 8. Two triplet code – of life and communications (Dlyasin, 2013)

Now, after the discovery of the system of the bodies, we need to recognize that any naturally determined morphogenesis (which obey natural known or unknown laws of the symmetry of growth transformation) - growth of living organism, maturation of a ridges, growth of crystals or mushrooms - is in fact even more complex because these patterns of relationship are "pressed" into their own "topological" genetic code - even more important than the living genetic code - the future forms in which (where?) by points, junctions, edges, and flat-bed polygons are recorded. The same applies to the interrelation of everything with everything else - myriads of laws that formulated in the form of functions - gravitation, electricity, wind, sea currents, planetary and molecular both particle motion - only an outward expression of an even deeper and one for all (hidden somewhere in a fabric "primary point of pro-generation") genetic

code with triplets from four elementary arithmetic operations - addition, multiplication, subtraction and division.

In order for the thought of “genetic code of other systems” to find support in the image, I’ll give my attempt to transfer the well-known map of the genetic code on the system of sounds of human speech (Figure 8). Now, acting on exactly the same algorithm and having two new systems, you can continue this “travel to a world chromosome”... I’ll note that the “travel” is not fantastic, but real, - the key to this is precise systems (sounds of speech, elementary functions, convex polyhedrons and others) that exactly repeat the system of four nitrogenous bases and twenty amino acids.

The eyes of the reader are probably already accustomed to expressions like “genetic code of innovations”, “genetic code of a society”, “genetic code of humanity”, up to “genetic code of poetry”. Any such phrase so far has been just a phrase - speculative, demagogic and populist - completely unfounded. I believe that another time is coming now - the time of actual research of a genetic code of each level of the Universe, each human philosophical or mathematical abstraction...

So, I managed to add two more 24-element systems to the Metachemistry collection. But I realized and realize that my task is to find such a system from such a discipline, for which and for the representatives of which, it would be expected and valuable. Then, in retrospect, it may be that the value of all the Metachemistry systems that have been discovered so far will be realized. Even today, amino acids still do not have a serial number and are listed by the first letter of the name. It is the same as if in the chemistry textbook - imagine the elements would still be listed in alphabetical order: actinium, aluminium, americium, antimony, argon, arsenic, barium, berkelium and so on. I will repeat after Andrei Bely: “Sparkle my star, out of the distance! The years, like milestones, mark our road: Along it, like some unknown pilgrim, I trudge before my very self...” (Bely, 1979)

Well, the paper is ready - now let's look at the reaction of readers. Until now, the opinion of chemists, molecular biologists and linguists was important to me. Now - the attitude of mathematicians and philosophers. Paradoxically, the fact is that the attitude and opinion particularly from mathematicians and specialists in adjacent disciplines - have been present for many years. I’ve paid attention to it just now, they seemed to have presaged and awaited - otherwise how could the mathematicians be interested in the work of a chemist?

Indeed, “A thought once uttered is untrue” (according to Fyodor Tyutchev¹⁰). And I don’t only “trudge before my very self” but I meet the reflection of the scientific world, including mathematics. And here I want to especially note and thank these researchers - the mathematical systems represented here, to some extent appeared thanks to them. More than ten years, my works have invariably been paid attention by the mathematician Dainis Zeps (Zeps, 2009, 2011). After the publication of the Metachemistry monograph, these conceptions carefully analyzed, formulated comments, suggestions and wishes - mathematician Lev Gelimson, author of the theory of infinity (Gelimson, 2014). And one more impulse for searching and further creativity, really invaluable, I was lucky to have time, I got from Vyach. Vs. Ivanov¹¹. He mentioned Metachemistry in one of his last lectures¹² on the theory of symmetry and its applications: “I

¹⁰ Line of Fyodor Tyutchev «SILENTIUM» poem, Nabokov translation (Three Russian poet, 1944).

¹¹ I repeat once again the wisdom just written in the text - “A thought once uttered is untrue”. Not only unforgettable Vyach. Vs. Ivanov was a universal scientist. As soon as I began to talk here about mathematicians who paid attention to my work, first of all I remembered that the chemist who paid much attention to Metachemistry – Miloje Rakocevic from Belgrade (Rakocevic, 2004) is the researcher of the Universal Code of Nature and indeed... the universal code of harmony in the poetic texts of Dante, Shakespeare and Nogosh - therefore Rakocevic also is biologist and mathematician. Secondly, I drew attention to the fact that the mathematician Dainis Zeps explores the principles of biocentrism, being also a philosopher and a theologian. And thirdly, another mathematician - Lev Gelimson, is also a universal scientist (here both physics and strength theory), and, besides, a multilingual poet. In general, as the reader can see, it’s impossible for me to write an article only about mathematics. And my research program — universal and everyone, whoever I recall here in connection with this program — turn out to be universalists.

¹² In the text I give a link to this lecture Vyach. Vs. Ivanov and mention about it in the References. Here I will also pay attention to full name of this lecture, location, time and project, in which it took place, namely: «“The theory of symmetry as a separate science and its connection with other sciences (humanities, natural, mathematics)” at the seminar of World Culture Institute of Moscow State University in cooperation with the Mineralogical Museum of the Russian Academy of Sciences on the project “Living Stone: From Mineralogy to Mythopoetics” September 10, 2015». The Speaker begins to speak about Metachemistry from the moment of 58 minutes 55 seconds.

would pay attention to recent work on metachemistry. There are several large consolidated works now in Russian, where the results of applying the theory of symmetry to chemical phenomena are described” (Ivanov, 2017).

I am sure that there comes a time when sets and lists of notions of various sciences will take their place in the strict systems as their elements and these systems will be homologous to the systems given here for the two sections of mathematics.

Moreover, combinations of actual units-constituents behind these notions (or denoted by these notions) will turn out to be genetic structures that encode nature - and our life, our thinking and speech, and even more - encoding abstract worlds brought into the inner reality of our intellect. - encoding the worlds of mathematics, logic and symbolism.

Also it is those genetic structures which allow not only to the future live organism to be written down in a kernel of one cage, but to all World to be written down in one Point. Which allow all World to be rolled-up in one Point and again to be unwrapped from this supergenetic Point in the World as a result of the Big Bang.

REFERENCES

- Bely, A. (1979) *The First Encounter*. (Translated by Gerald Janecek, with Nina Berberova) Princeton University Press, 168 p.
- Dlyasin, G. G. (1998) *Azbuka Germesa Trismegista ili molekularnaja tajnopis' myshlenija [Hermes Trismegistus's alphabet, or the molecular cryptography of thinking]*. Moscow: Belye al'vy Publ., 144 p.
- Dlyasin, G. G. (2013) *Metahimija. Ot himii k Antropnoj Vselennoj [Metachemistry. From Chemistry to Anthropic Universe]*. Moscow: BUKI VEDI Publ., 680 p.
- Dlyasin, G. G. (2015). Metahimija: smysl azbuki i azbuka smysla [Metachemistry: the meaning of the alphabet and the alphabet of meaning] In.: PROC. *Speech and Language 2015, 5th Int. Conf. Fundamental and Applied Aspects of Speech and Language* (M. Sovilj, M. Subotić, eds.) 17 – 18 October, 2015, Belgrade: LAAC / IEPSP. – 396 p. (P. 7 - 26) (In Russian and Serbian) (http://www.iefpg.org.rs/Conference/2015/SL2015/2015_PROCEEDINGS_SPEECH_AND_LANGUAGE_2015.pdf) (accessed 8 March 2019).
- Gelimson, L. (2014) On Gennady G. Dlyasin's Monograph "Metachemistry.From Chemistry to Anthropic Universe" *Physical Journal of the "Collegium" All World Academy of Sciences*. Munich, Germany. 14 (2014), 1 (<http://scie.awardspace.co.uk/PopMChem.htm>) (accessed 9 March 2019).
- Ivanov, Vyach. Vs. (2015) Teorija simmetrii kak otdel'naja nauka [The theory of symmetry as the separate science]. *Zhivoe TV*. Published in Sep 16. 2015. (https://www.youtube.com/watch?v=jb_ze8vK_r0&t=1152s) (accessed 5 March 2019). (video lecture, in Russian)
- Kiper, G. (2007) Polyhedra. A Historical Review. (by Gokhan Kiper) Ankara – February 2007 [http://web.iyte.edu.tr/~gokhankiper/POLYHEDRA%20 - %20A%20Historical%20Review.pdf](http://web.iyte.edu.tr/~gokhankiper/POLYHEDRA%20-%20A%20Historical%20Review.pdf) (accessed 8 March 2019).
- Rakocevic, M. M. (2004) A harmonic structure of the genetic code. *Journal of Theoretical Biology*, vol. 229, no. 2, pp. 221 – 234.
- Three Russian poet. Selection from Pushkin, Lermontov and Tyutchev in new translations by Vladimir Nabokov*. Norfolk, Conn, 1944. 39 p.
- Wohlhart, K. (2001). Regular Polyhedral Linkages. In: *Proceedings of the 2nd Workshop on Computational Kinematics*, Seoul, pp. 239 – 248.
- Zeps, D. (2009) *Par dzivibas funkcionalitati [About the Functionality of Life]*. Riga, Novembris, 2009 (<https://quantumdistinction.files.wordpress.com/2009/12/dzivibas-funkcionalitate.pdf>) (accessed 10 March 2019) (In Latvian)
- Zeps, D. (2011) *Quanta Mathematica Instrumentalis. Institute of Mathematics and Computer Science*. January – March, 2011 (<https://hal.archives-ouvertes.fr/hal-00578729/document>) (accessed 10 March 2019).

The New Alphabetical Paradigm: From the System of Society Further Everywhere

Gennady Dlyasin

Independent researcher, Tolyatti, Russia
gensin777@yandex.ru

Dedicated to the 150th anniversary of the Chemical Elements System

ABSTRACT

This work presents the author's concept of organization of each level of the Universe (Pagoda of World) in the form of a matrix (and 3D-) system-alphabet from 24 elements. This system was previously discovered for molecular foundations of the genetic code – and then – for the vowels and consonants of the phonetic alphabet. When considering the system of the society, the four bases were the Culture, Economics, Politics and Law, while the remaining twenty elements surrounded them with four tapes of five in each. They completely covered all sides of the social existence. Each of these twenty elements turned out to be a unity of paired opposition, homologous to that for the protein amino acid (amine + acid), and the model of society appeared as the globule of a protein molecule. The discussion of the results is built around the principal aspects of the Breakthrough – these are new perspectives for the historical research and futurology and the possibility of introducing the accuracy of the natural sciences into the Sociology. But we insist that there is no Reductionism and Transfer. On each floor of the Pagoda we build our own system, although we use our knowledge that all systems are homologously to each other. Then, here we present several anthropic systems, as well as systems of philosophical and synergetic categories. And also – some of the alphabetical foundations of the physical and biological worlds. These systems have transformed this work from Sociologic to Synthetic. The beginnings of genetic chemistry are presented. All discovered systems are considered as the New Alphabetical Holistic Paradigm. All of them are anthropic, genetic (Global Genetics), symmetric, periodic and semiotic – a manifestation of the Universal Alphabet Code of the World. The Instant Communication of all system with each other is considered. **Keyword:** System, Vortex (spiral system of chemical elements), Alphabet. Amino acids. System of protein amino acids and nitrogenous bases. Universe “floors” or “Pagoda of World”. Metachemistry of the Society. Socio-“butterfly”. Symmetry. Alphabetical Systems in the Philosophy, Synergetics, Physics and Biology. Anthropic principle. Global Genetics. Universal Alphabetical Code. Instant Communication. New Holistic Paradigm.

1 “FLOORS” OF THE UNIVERSE AND PREDICTION OF THE SYSTEM OF SOCIETY

1.1. Vortex and Alphabet - Early and Recent Searches

Already in the early papers, in addition to chemistry, we examined the topics of cultural studies, psychology and sociology – the deepest symbolism of the Vortex and its direct and completely enigmatical connection with the archetype of Karl G. Jung (Dlyasin, 1994a, 1994b, 1995, 1996)¹. The echoes of these thoughts were reflected in a book about two alphabets – units of the genetic code and speech sounds (Dlyasin, 1998, 2007).

We found several 20 – (in the form of matrices on the plane) and 24 – elemental (in volumetric form) alphabets. The first in our research program was system of the amino acid of protein (Dlyasin, 1998, p. 68, 69). Subsequently, we managed, in its image and likeness, to find a system of sounds of human speech that

¹ We consider it necessary to indicate that in the fully version of this paper, we also refer to the works of E. V. Babaev (1996), S. Grof (1985), K. G. Jung (1968), S. V. Meyen (1989), A. I. Subetto (1992, 1993, 2014) and others.

is homologous to the system (Dlyasin, 2013², p. 117, 118)

At the same time, another discovery took place – the unity of the system of twenty amino acids and the system of four nitrogenous bases of nucleic acids, as well as twenty consonants and four vowels of speech. And this unity was associated with transformation of the planar system into 3D (Dlyasin, 1998, 2013, 2015).

The positive experience gained predetermined a new search. We came to the conclusion about the necessity and possibility of the existence of a system of the Social.

1.2. On the crisis and prolegomens of the upcoming revolution in sociology

Once we turned to Sociology, we have discovered fluctuations and vagueness in the glossary of even the very basic concepts. The same concepts different classics (and after them our contemporaries) called either structures, or institutions, or subsystems. For example, Talcott Parsons identifies the social subsystems as economics, politics, and culture. As well as the system of "social community", which "contains mainly the structure of norms". At the same time, the central concept of modern social science is the concept of "social institution". The development of this concept is associated with the names of Auguste Comte and Herbert Spencer, and the introduction of it to science was made by Karl Heinrich Marx. As you know, Max Weber identified five institutions – family, state, production, public education and religion.

For the necessary analysis of the state of modern sociology, we drew the opinions of the sociologists themselves – Yu. M. Plotinsky, and through him Randall Collins, with his work "Sociology – pro-science or anti-science?" (Collins, 1989). Collins "notes that for 100 years of research in sociology there are practically no universally recognized laws" (Plotinsky, 1992, p. 9 – 10).

Secondly, we drew attention to an paper by Richard Jenkins (Jenkins, 2015; primary source – Jenkins, 2013), which, in itself, was the complete introduction to our study. Jackins sharply criticizes the current state of his science (Jenkins, 2015, p. 16 – 20).

The third in our analysis was Niklas Luhmann. We drew attention to his judgment in the form of a quote cited by P.V. Agapov in his paper (Agapov, 2014, p. 60). The idea of N. Luhmann directly anticipated, so to speak, the "launching pad" of our work, not only not condemning, but in every way justifying the way we adopted to get out of this crisis. Here (in this capsule version of the paper) we highlighted the main thing in this thought – Niklas Luhmann suggests abandoning the traditions of sociology and turning to resources brought in from outside, for example, systems theory, cybernetics, communication theory and others (Luhmann, 1999, p. 202 – 203).

Now, according to N. Luhmann's thought, we can only take the resources of the author's research program (from molecular biology, linguistics and systems theory), "bring them into sociology from the outside" and take a step to a new state of sociology³.

2. STRUCTURE OF THE SOCIETY IN THE METACHEMICAL PARADIGM

2.1. The structure of the society – the collection of amorphous dissonance and the first analysis

The very definition of sociology reminded us of chemistry. "Sociology is a science that studies the structures of society, their elements and conditions of existence, as well as the social processes that occur in these structures" (Frolov, 2000, p.15). Let's read this definition of Sergei Frolov again, replacing the concept of "structure" with "molecule", and by elements we mean chemical elements.

We decided to find and isolate separate entities (elements-constituents) from within the existing Sociology. We decided to install these entities in the cells of a symmetric system – the Alphabet of Society. And to rebuild Sociology already as an exact science with its exact system, and precisely⁴ established

² We called our research program Metachemistry, as well as the book published in 2013.

³ We have reduced the volume of the paper by completely deleting the paragraph "Predictions given in Metachemistry-2013".

⁴ By overly optimistic "precisely" we mean a process, not a result.

mathematically expressed laws.

So, we are looking for twenty-four social constituents ("molecules"), wherein four will be "generals" among the rest of the "ordinary", they will be special – other in their internal structure. These elements of the "floor" of the world of the society will be so to speak, enormously huge, since we will move from molecules or sounds of human speech – to a different scale, to macro-objects.

What else do we know about these "molecules" a priori? They will have to be a harmonious and symmetrical system. The "four" should be a universal square, such as the Plato square (Truth – Good – Beauty – Benefit) or the Square of Greek Primary Elements (Earth – Water – Fire – Air) and the "twenty" will consist of two periods of ten constituents (two "snakes"). And at the same time will consist of four rows of five ("wings" of the "butterfly-biplane"). Social "amino acids" – those which twenty – respectively should be paired, and "snakes" and "wings" – symmetrical.

We also know a priori that each molecule of the system – including a "social molecule" – should be a dipole, a kind of paired entity "within itself" (amino acid – amine and acid) – or unity of opposites.

Our task was – not to tie the isolation of the constituents of society to any specific concepts and glossaries so that they do not become obstacles for us.

We structured fields of social meanings – short, but infinite (in its internal content) – "family", "ideology", "state"... Same short but polysemantic meaning as in "I Ching", when one of the hexagrams, for example, "Xu", means "Waiting", and the other – "Tai" – "Happiness" (TsungHwa, p. 117, 142).

At some point, the search process leads to the first very important discovery – our preliminary square of four cards – the elements "generals" or "aces"⁵ are "Culture", "Politics", "Economics" and "Law".

Omitting the details of the search for "ordinary" constituents of the system, we note that we selected candidates as an array of data (putting them on cards) from a variety of sociological literature.

2.2. Crystallization: a system in the form of a matrix and a 3D-"butterfly"

Number of cards on our desktop gradually increased to about seventy and gradually began to decrease. It became clear that we must continue to adjust our consciousness to such an unusual action.

Of course, if we had some inherent property of each of our social "units", expressed as a number, then it would be easier to build a system. But such a number was still not found, and so far, in the first stage, it was necessary to rely only on meaning. The first "patience" did not satisfy us very much; there were four "generals" in it, but not twenty, but twenty four "ordinary" – twenty eight elements in all.

Then we got a great second "patience", which we realized as a new important step and event confirming the original hypothesis. There were already exactly twenty-four (20 + 4) elements (constituents) – but now it was important for us to more precisely establish the boundaries of each of them.

For example, we mixed concepts – science, knowledge, magic, myth, occultism, added to them a dozen more concepts of a lower rank – pseudoscience, esotericism and others – clarified the definition of each – and re-allocated – clarified internally contradictory constitutions. So we established ourselves in two "molecules" – "science and magic" and "knowledge and myth". In the same way we worked out the whole system.

We tried to show by examples the process of our work – we give these reasonings so that it is clear that system did not appear suddenly and out of nowhere. The alphabet of society was born with movement and stops, with redistribution of cards with concepts written on them, with clarifying of definitions, redistributing the boundaries of close constituents, with attempts to look inside the constituents, to understand its "atomic" composition and structure.

The system was born (Figure 1)

⁵ Our first monograph-1998, where we reported on our discovery of the amino acids system - in one of its hypostases meant a special – alphabetic and amino acid – meaning of Tarot cards. For example, the psychologist Alexander Danilin drew attention to this. And he gave the analysis of our study in the light of the relationship between the Tarot and the genetic code (Danilin, 2010, p. 7-10).



Figure 1. System of society in the matrix version

The next constituent – 2b – "knowledge and myth". The sets of "atoms" that fill it and all subsequent units of the system are given in the tables. We will publish these tables, as well as the numbers (number of references) of constituents and "atoms" (concepts below rank) in the Internet search engine in the full version of this paper.

Following step – we have constructed socio-"butterfly" – the system in 3D-form (Figure 2).

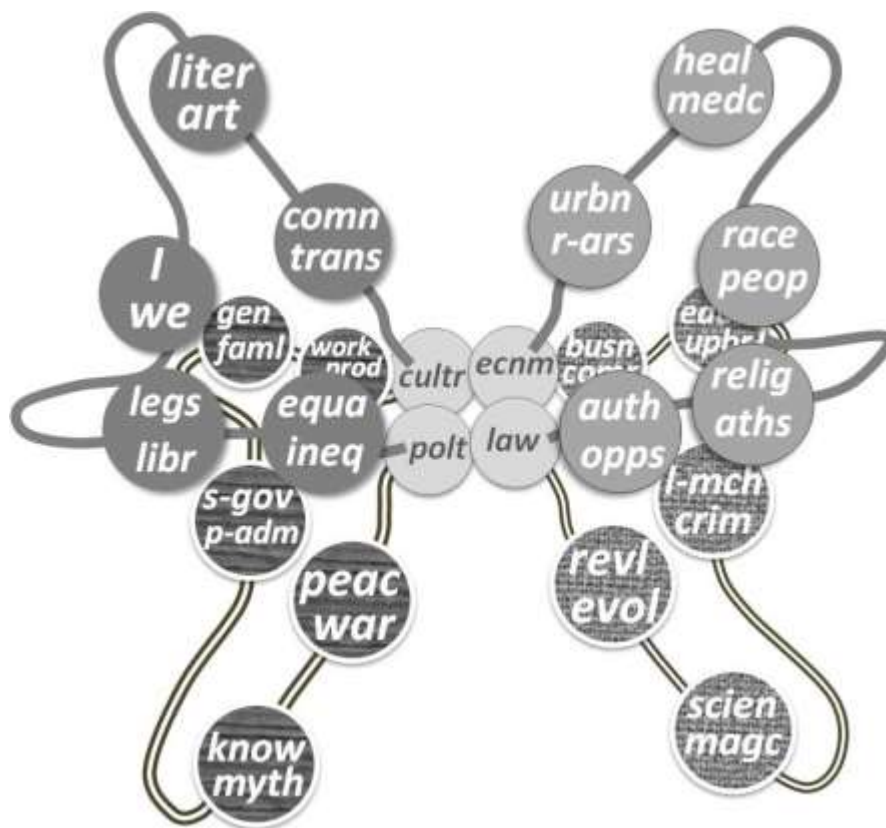


Figure 2. Another alphabet of Metachemistry – the society system in 3D: socio-“butterfly”

In our last monograph (Dlyasin, 2013), building a 3D system of amino acids and speech sounds, we examined in detail the stages of joining the “five-membered” series of constituents and the central square of constituent “generals”. We drew attention to the options for such a connection and the options for the location of the "generals" in the central square. Here we will not consciously repeat all these arguments in full - referring to this monograph.

In Figure 2 we have presented one of the options of the system⁶.

2.3. Presentation and proof of the system through quantitative properties

When working with amino acids and speech sounds, we had a lot of their characteristics and properties. Finding systems in these subject areas, already from the initial stages we have begun to build curves of changes in properties for series, periods and groups. This was a necessary help. And having received the final forms of the systems, we built curves to prove them.

Here, already at the stage of transition from the (mentioned above) patience 1 to patience 2, we began to search for the numerical characteristics of constituents to analyze the socio-system – just as we used to work on the first two systems.

There were obvious numerical candidates – “people and money” – the share of employees and the share of costs in the country's budget. Having spent a fair amount of time and effort, we could not adequately correlate these data with our system and completely abandoned this direction.

Nevertheless, we have found a way out – in fact, we used this method earlier - for amino acids, and

⁶ In order to reduce the volume of this first and capsule version of the paper, we have removed several figure explaining the abundance of structural and spatial variants of any of the open 3D-systems, presented here.

for chemical elements, and for speech sounds – we’ve decided to use the frequency of occurrence of words and key phrases ("atoms" – those that expressed the meanings embedded in our sociological "molecules") on the world wide web. We have already noted above that here – in the first capsule-version, we omit this side of our study, including Applications with arrays of numerical data. For example, we give only one of the images (Figure 3).

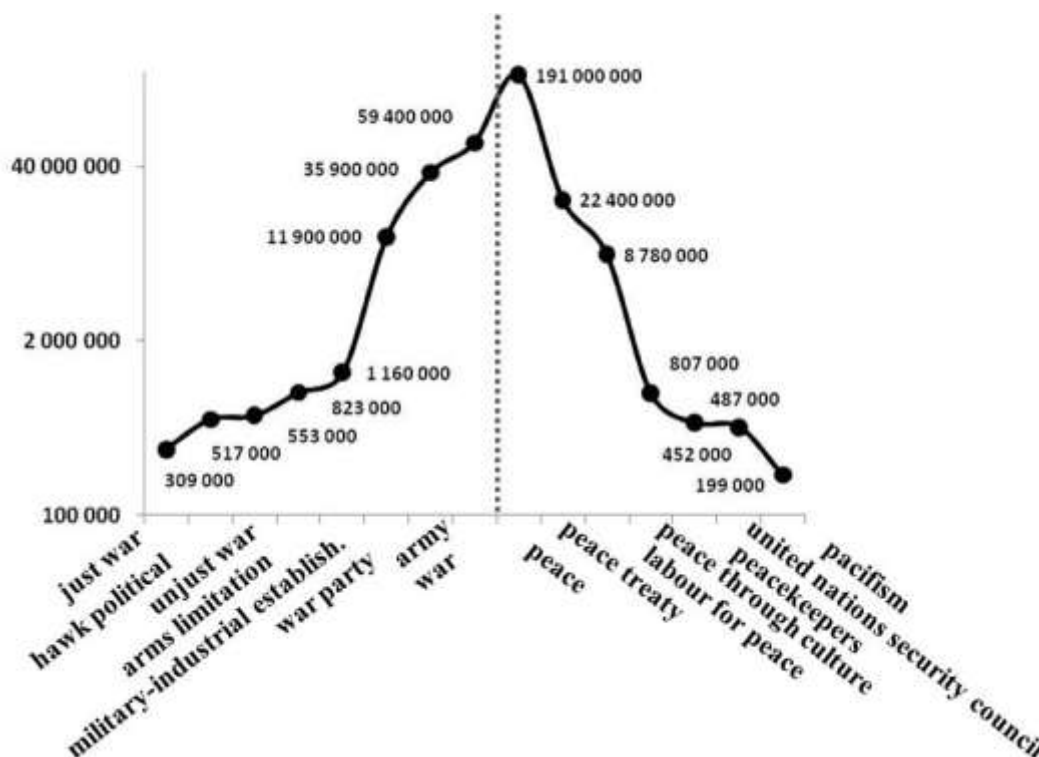


Figure 3. Distribution of “elements” (structural units – "atoms") of a social “molecule” by frequency of occurrence⁷ in the Google search engine on the Internet. For example, taken “war and peace” (serial number in the system 1b)

3. SOCIETY AS A GENETICALLY STIPULATORY “PROTEIN GLOBULE” IN THE TIME FLOW

3.1. Genetics, phonetics, society – man and the world

It seems to us that something what happened here is what philosophers spoke of for several decades. They spoke theoretically and abstractly, positively or negatively – making assumptions of varying degrees of speculativeness. In our study, there was a real transfer⁸ – we managed to find an end-to-end system through which from the border of chemistry and molecular biology through phonetics and psychology, we moved to sociology and transferred the strict selection (singling out) of elements in a precisely defined number, transferred symmetry, transferred systemic organization – and everything else, which now constitutes a different picture of sociology.

⁷ The research was carried out in Russian in October 2014. In this abridgement, we completely omitted the Appendix with an array of “atoms” of social “molecules” – sets of concepts that outline the boundaries of these “molecules”.

⁸ Moving on – from sociology to philosophy, biology and physics, we came to the conclusion that our work is not a “transfer”. Using the discovered Universal Code, we discover new systems in the next field of knowledge and we work in this field and only in it.

Having walked up this “staircase” of the world from the bottom up (along the path from α to ω), we can state that “the alphabet itself is a laconic formulation of the anthropic principle. At the beginning of the Universe there was a word, and the system of this word – the alphabet – indicates a person – on his four limbs and twenty fingers of ten and five on each of his arms and legs⁹. This is the anthropic principle, saying that the Universe and Man are inseparable from each other, that the idea of Man is in the Universe, and the idea of the Universe is in Man. As the ancient Greek Protagoras discovered with his brief thought: “man is the measure of all things” (Dlyasin, 2015, p. 13).

3.2. Triplet genetic code of society

Each socio-amino-acid is encoded by a triplet selected from four socio-bases.

We cannot prove this thesis yet. We can only assume that if the systems have the same shape and properties, primarily symmetry, then the other essential characteristics of their constituents will be the same.

We formulate the hypothesis that since the two alphabets of the genetic code of life make up a single 24-element system, and in this system while triplets of the four bases during the synthesis of a protein in a living organism cell encode twenty amino acids, then in other systems-alphabets found exactly the same structure is present and the same genetic code¹⁰ is implemented.

First, let's see what kind of picture will be for speech sounds¹¹, if we assume the possibility of coding. For the sample, we took the well-known circular image of the standard genetic code and next suggested what the genetic code of human speech might look like (Figure 4).

It seems to us that such coding allows us to read thoughts from certain “structures of our intelligence”, where the convolution of these thoughts is arranged not just supercompactly, not just taking into account modularity, encapsulation or another, but using a genetic code.

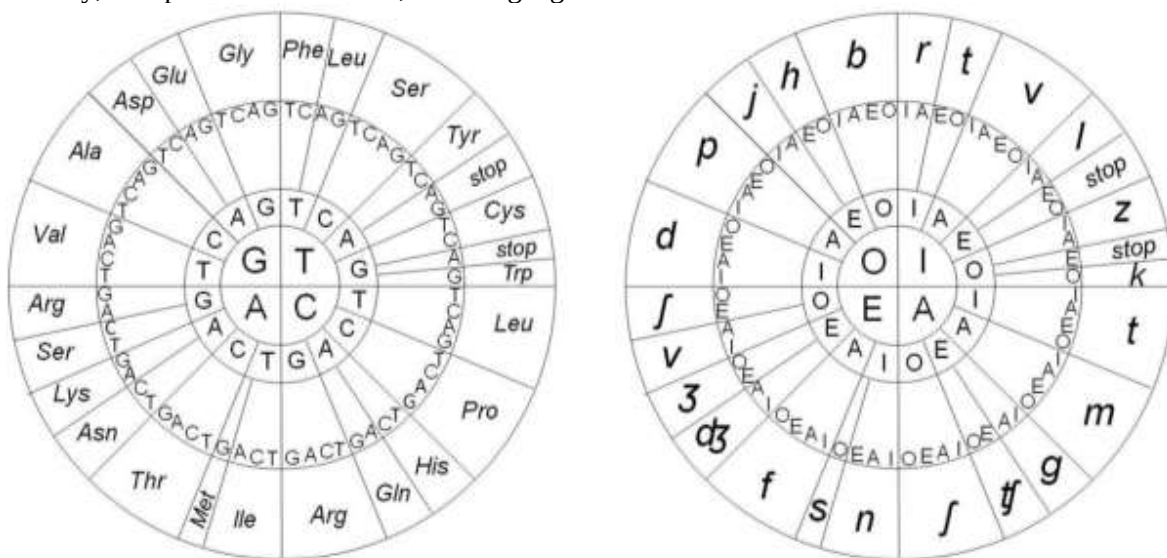


Figure 4. The two codes – of life and communications (Dlyasin, 2013, c. 190; 2015, c. 13, 23)

⁹ This is one of the Alphabets of Metachemistry discovered – the Alphabets of human as such was first described in the 2013 monograph (Dlyasin, 2013, p. 188, 189). Here we will examine this vector of our research in more detail in the Appendix.

¹⁰ Formulating this hypothesis, we will not forget that its action at different levels (in different systems) not in isolation, but in man. Accordingly, we, in continuation of the hypothesis, assume the synchronization and instant connection of code carriers – conditionally, body DNA – with the DNA of intelligence (mind) – with the DNA of society, echoes of which are also present in humans. We have already suggested above that this echo is the pattern of the collective unconscious Carl G. Jung.

¹¹ The system of human speech sounds is given in the monograph (Dlyasin, 2013, p. 118, 158) and in one of the papers (Dlyasin, 2015, p. 9, 12, 19, 22).

We can assume the same for society (Figure 5). The entire diversity of social globules is encoded in a certain “socio-intellect” (or a certain “socio-chromosome”) through triplet codons consisting of four powerful aspects of life of a society, its four essences – “culture”, “law”, “economics” and “politics”.

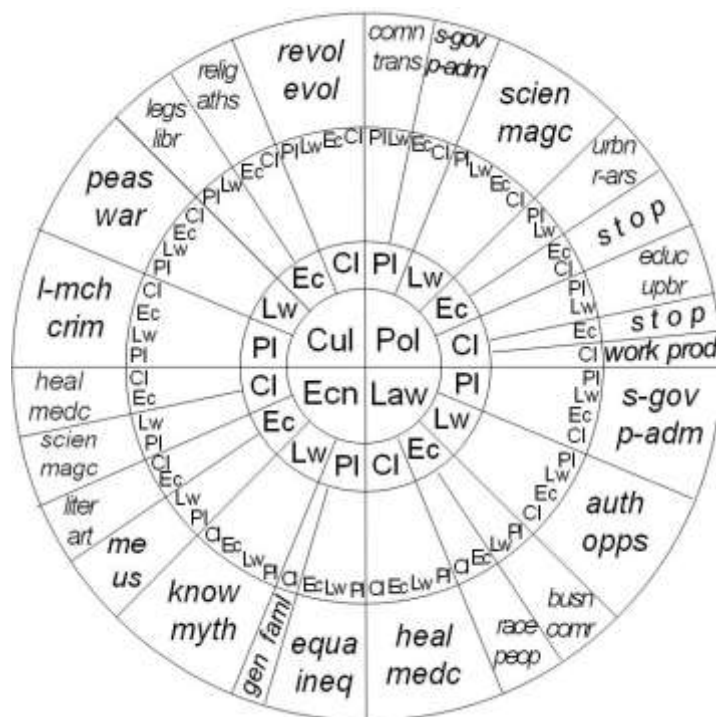


Figure 5. The third triplet code – the code of society¹²

3.3. Large “planetary protein globule”. New positivism

Let us try to reason in that particular sociology, which opens up in connection with the discovery of the "socio-butterfly." Suppose that social institutions, and in our glossary – “social amino acids”, like chemical amino acids, are capable of connecting to each other into polymer peptide chains, which, in turn, bending in space, are able to form secondary and tertiary “protein” structures. Turning out in this way – “social globules”.

Suppose also that then a large society (planetary) consists of smaller millions of globules, namely, countries, communities, parties, condominiums, groups and families. Also, now we can talk not only about proteins, but also about peptides – small "polymer molecules" of several "social amino acids." In living organisms, peptides perform a variety of functions, for example, enzymes or activators that trigger biochemical reactions.

Several decades ago peptides began to be used as medicines. By the way, how do you like the “peptide” drug from socio-amino acids prescribed to a sick society or a social group?

Here we omit in the first abridged version of this paper some explanations and examples.

3.4. From exact sociology to exact history

History is a “socio-butterfly” flying through time. This flight is slandered, distorted and forgotten. Social management through history management has reached its cynical peak. But now we have a magic

¹² The names of the socio-molecules are, for obvious reasons, abbreviated; the union “and” is also removed. Cul - Cl - culture, Ecn - Ec - economics, Pol - Pl - politics, Law - Lw.

enigma or “code of society” – a social globule. And now we can go back along the thread of this fabulous roll, which, unwinding, rolls along human history.

Very soon history will appear as this “butterfly” – with 24 separate trajectories of particular “molecular” stories. We emphasize – naturally connected with each other. A complete rethinking of history will take place – from “almost sacred lies” to a mathematically verified objective picture. Events in each “molecule” will chronologically line up in a single chain, and the twenty four chains will organize the main historical bridge from the past to the present and to “tomorrow” – always strictly symmetrical with respect to “yesterday”.

4. CONCLUSIONS ON THE SYSTEM OF SOCIETY

Now to the question of social institutions and the structure of society can be answered, consisting of several new provisions:

1. Each social institution has a dual (yin-yang, opposition in a single) structure;
2. The sides of this duality (yin-yang) cannot be described in terms of "good – bad", "kind – evil", "moral – immoral", "positive – negative" (etc.);
3. All social institutions (“molecules”) differ from each other in structure (by the structure of their “radicals”), but are equal rights and have a single nature and essentially a single internal structure. Let us explain that this device resembles amino acid molecules, which all have the same part of the molecule (amino group and carboxyl group), which ensures the formation of the peptide bond, but the cardinal third part of the molecule is different radicals;
4. The number of social institutions equals to twenty;
5. Social institutions interact with each other through a special social connection, forming agglomerates (globules); the totality of all agglomerates is a society;
6. The social connection through which institutions interact with each other is determined by that single (equally arranged) and dual (ambivalent) device that is present in each of them;
7. Social institutions are connected by the main law – the fact that they are the elements of a 3D system (Socio-Alphabet), in which everyone has a specific place. Moreover, all their characteristics are subordinate to this systemic organization, interdependent and symmetrical;
8. The location of social institutions (constituents of the Socio-Alphabet) is strictly defined, each of them is located in a certain place of the five-membered series (the “wings” of the system-“butterfly”) and has its own serial number, while all four rows are closed through the center, in which special constituents (“generals”) of the system – social foundations – are located;
9. The number of social foundations is four. These are “Culture”, “Economics”, “Politics” and “Law”;
10. These special – genetic (if you like – “genetic”) – other constituents of society are not institutions and have a different structure than institutions. At the same time, like institutions, social foundations differ from each other in structure, but are equal rights and have a single nature and essentially a single internal structure. Despite the different structure of “generals” and “ordinary”, endless closed threads of system communication of all 24 constituents are closed through the center. They can be considered in two series of cycles of 12 constituents;
11. Our hypothesis states that the triplets of these social foundations (in some, yet unknown, DNA of society) determine how institutions are woven into the agglomerates (globules) of society. This is due to the fact that, as we suppose, there is a hidden, but always working – triplet genetic code of society, through which society retains its structure and functions;
12. The history of society, we believe, is twenty histories of each of the institutions, at each moment of time remaining in systemic interaction in the Socio-Alphabet. According to our hypothesis, the symmetry and laws (including quantitative ones) of this static, but also dynamic system will allow us to restore the history of some institutions through knowledge of the history of others, to investigate and correct white spots and random or conscious distortions of the history of society made in the past and present.

In conclusion to the main text and before the presentation of several other alphabetical systems, we

would like to thank everyone who helped and inspired us. In our other papers published this year, we have already mentioned several researchers. Here we would like to add to them the philologist Sava Rocić and the historian, language researcher Radovan Damjanović¹³, as well as Milan Đorđević, the author of his own concept of language (Đorđević, 2014).

5. THE MAIN AND CENTRAL – THREE ANTHROPIC SYSTEMS-24

5.1. Human is the alphabetical system

Let us recall one of the well-known theories and practices of alternative medicine that came to us from antiquity, namely the Su-jok system. It claims, as you know, that all parts of our body – both external and internal – are interconnected and, acting, for example, on the little finger of the left hand, we send a signal to some completely specific organ or system of our body.

But today Metachemistry will say more than that – the little finger of the left hand can send a signal to the planet, elementary particle, amino acid, sound of speech (and, therefore, a unit of thinking) and a completely defined social institution. Of course, this is under the same doubt as the justice of Su-jok therapy.

That is why in the first image of the anthropic system-24 (Dlyasin, 2013, p. 188 - 189) we marked the fingers and toes with those units of other systems that also stand in these places¹⁴ (Figure APP - 1). So that it does not look too naturalistic, we have depicted feet and hands as stylized.

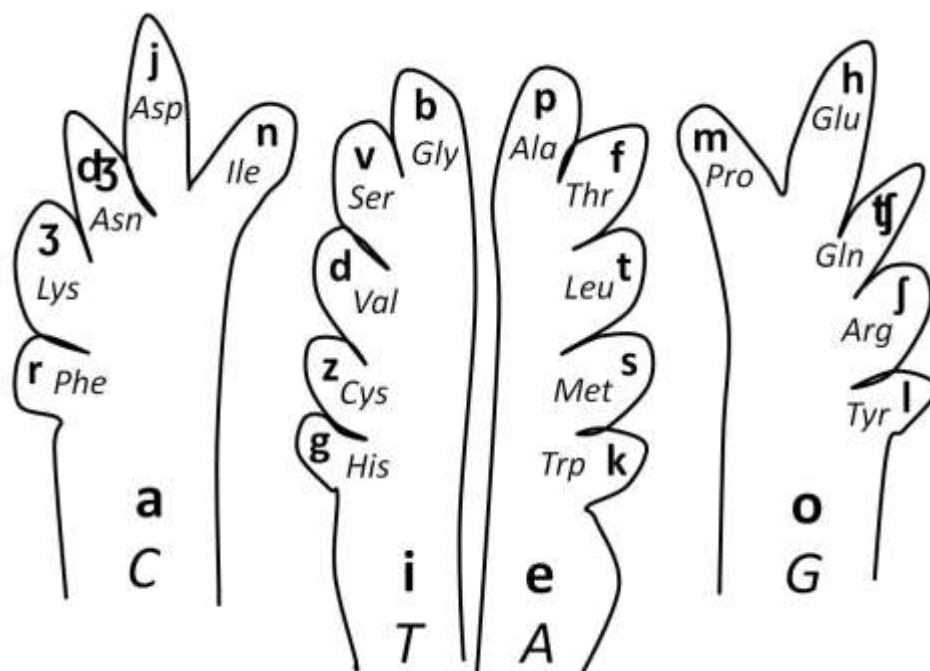


Figure APP - 1. “Feet and hands” of the main and central system-24: the human body system. The connection with the elements of the constituent systems of the genetic code and the alphabet of speech is shown

5.2. Alphabets of Human body systems and paired organs

¹³ Thanks to the efforts of Sava Rocić and Radovan Damjanović, my 1998 monograph was published in Belgrade (Dljasin, 2007). Translation from Russian into Serbian was done by Sava Rocić.

¹⁴ As well as the exact sequence of the arrangement of elements in our systems, as well as the exact geometry of the systems, the exact (element-wise) correspondences of several systems with each other are still unknown to us.

Further, it does not seem strange to us at all that not six, not seven, and not thirteen or fifteen, but precisely ten systems function in the human body. Given the symmetry of two different methods of control (regulation) – through nerve impulses and through substances (humoral regulation) – we see the divided into two symmetrical halves, that is, the familiar twenty-element matrix (Figure APP - 2).

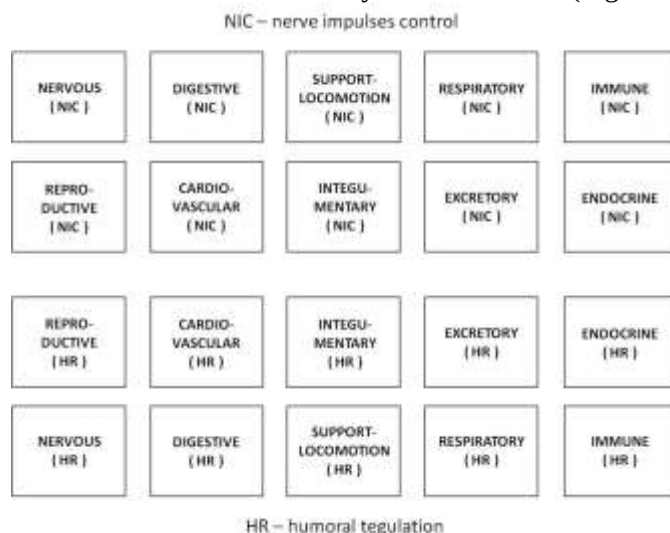


Figure APP - 2. The matrix of the human body systems. The following notation are introduced: NIC – nerve impulses control, HR – humoral regulation. In the name of each unit, the word system is implied, for example: “digestive system (HR)”

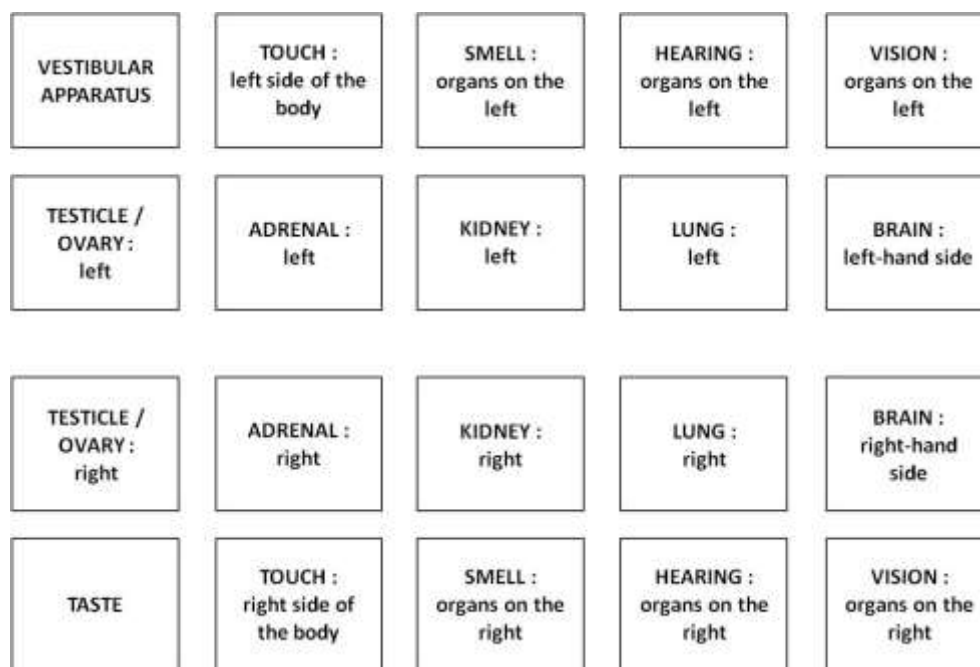


Figure APP - 3. The system of paired human organs¹⁵ that transform matter and information about the world

Each of us has five senses and four of them inside us have right-left symmetry. If we take into account that chemistry is the science of information (and we are convinced of this), then the transformation of

¹⁵ We were not able to solve the problems of the location of two units falling out of the general logic. This is “taste” and “vestibular apparatus”.

information and the transformation of matter are equal rights processes. Then another pair of five is added to the pair of five (almost) just reviewed. In fact, each of us has five paired organs involved in the conversion of matter. And each of them also has a right-left symmetry. We get another twenty-element system of paired organs that transform information (if you like – substance and information) (Figure APP - 3).

6. THE SAME SYSTEMS IN ABSTRACT THOUGHTS ABOUT NATURE – PHILOSOPHY AND SYNERGETICS

6.1. The alphabet of Philosophical categories

The alphabetical system in philosophy consists of twenty sets of well-known paired philosophical categories (Figure APP - 4), which we tried to arrange symmetrically by the proximity or opposition to the fields of their meanings. As the four elements – “generals”, we took the main “square of choice” of any philosopher and any concept – “materialism” and “idealism”, as well as “dialectics” and “metaphysics”.

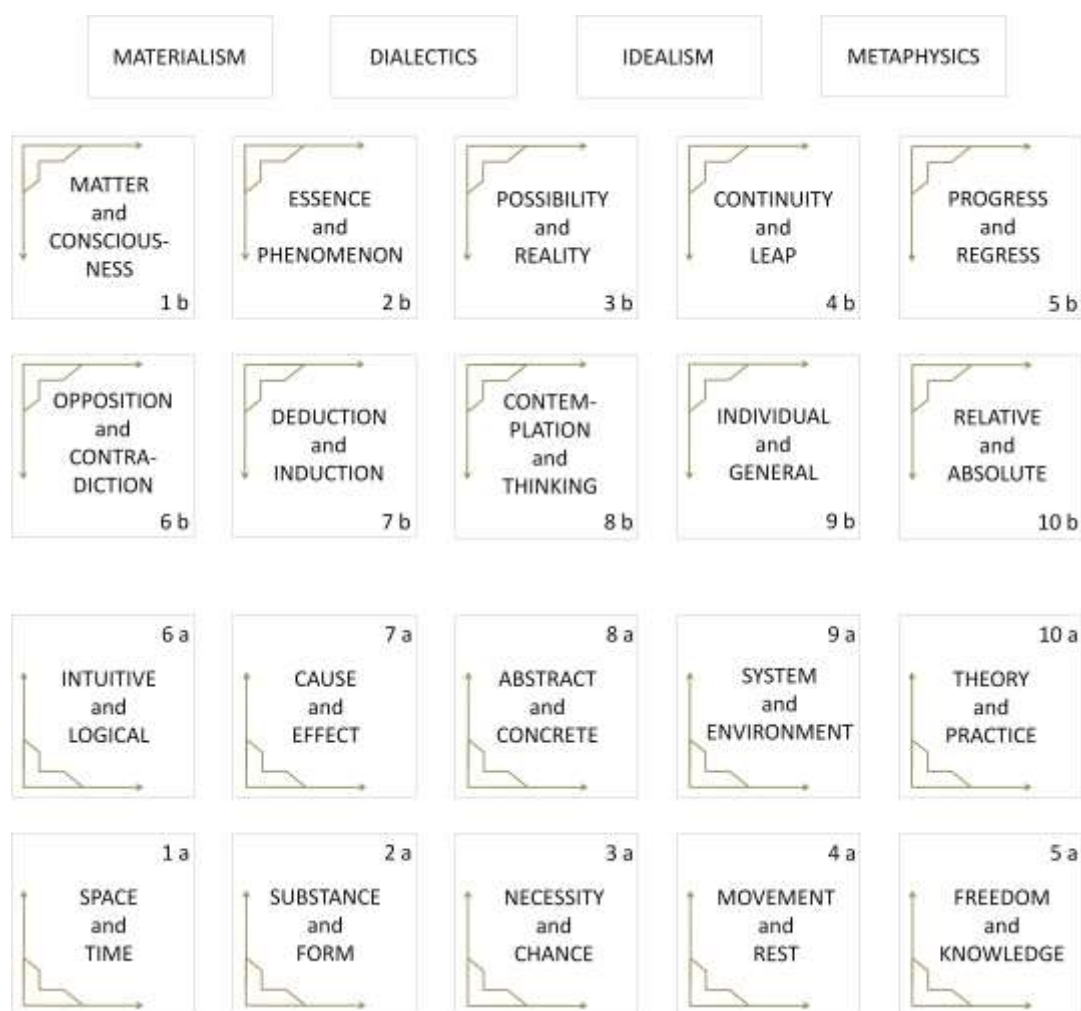


Figure APP - 4. The system of philosophical categories

Developing our research program in breadth, we stopped working on it and refining the detected systems with the same thoroughness with which we once did this for speech sounds, or – already here – for the system of society. So in the system appeared a pair of “freedom and knowledge”, which is not a

generally accepted philosophical category¹⁶.

6.2. Metachemistry of Synergetics

Having received the finished system of philosophy, we turned to the constituents of synergetics – the characteristics of complex systems (Vasilkova, 1999, p. 155). This work did not present any difficulty at the stage of formation – there were exactly twenty characteristics – ten straight lines and ten symmetrical inverse ones. There were also exactly four characteristics – “generals” – “simplicity”, “complexity”, “order” and “chaos”. At the second stage – choosing the sequence of categories in dozens and fives, we laid out “hermeneutic solitaire” (Figure APP - 5). It turned out our vision of the alphabet of synergetics. A strict and beautiful system – another one – was born...

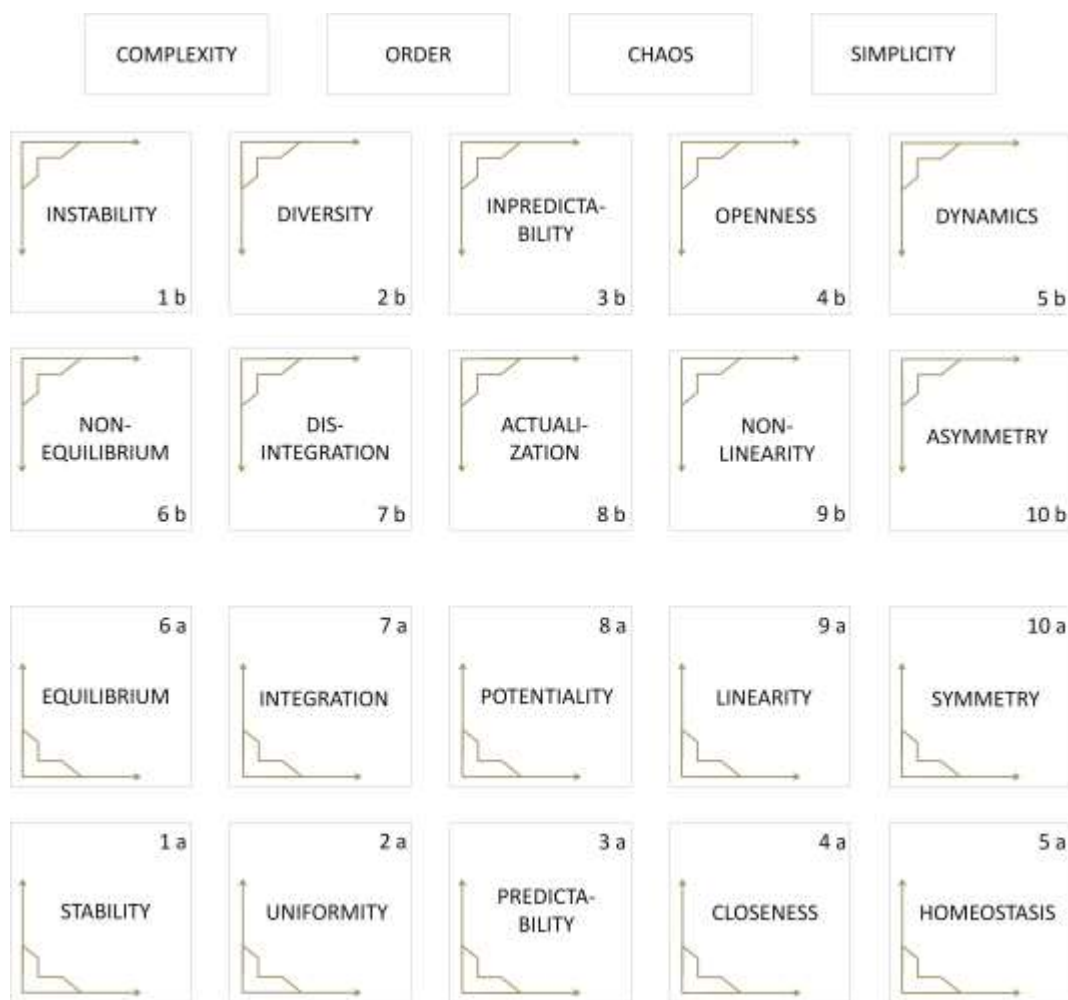


Figure APP - 5. Alphabet of characteristics of complex systems in synergetics

Someone from the readers in this place will remember about the “logical square”. The task of detecting a Logic Alphabet is left to the future.

¹⁶ “Freedom and knowledge”, we included in the “personal list” of categories long before the birth of this system – after becoming acquainted with the work of the same name (Nevvazhay, 1995).

7. ALPHABET SYSTEMS IN THE WORLDS OF PHYSICS, CHEMISTRY AND BIOLOGY

7.1. The first alphabet in Physics

In our “breakthrough”, when several elementary systems were discovered at once at different levels of the “staircase” of the Universe, alas, there remain “degenerate” levels where our research program did not work. And paradoxically for Metachemistry, this is chemistry and psychology. Also, we were not able to open a 24-element system among elementary and sub-elementary particles. We are optimistic that this does not mean that they are not there.

As for physics in general, we found that the essential paired characteristics of natural processes (as elements) form a twenty-element system, and the “generals” here are the four fundamental interactions in nature (Figure APP - 6).



Figure APP - 6. The example of a 24-element system in physics. Twenty characteristics of natural processes and four fundamental interactions in nature

7.2. Symmetry of the worlds of Plants and Animals

The time has come to turn to biology, where we discovered several patterns at once. Firstly, the system

was formed by plants and animals – symmetrically passing two ten-element “snakes” with the ending, respectively, in the most advanced – “flowering plants” and “chordate animals” (Figure APP – 7).

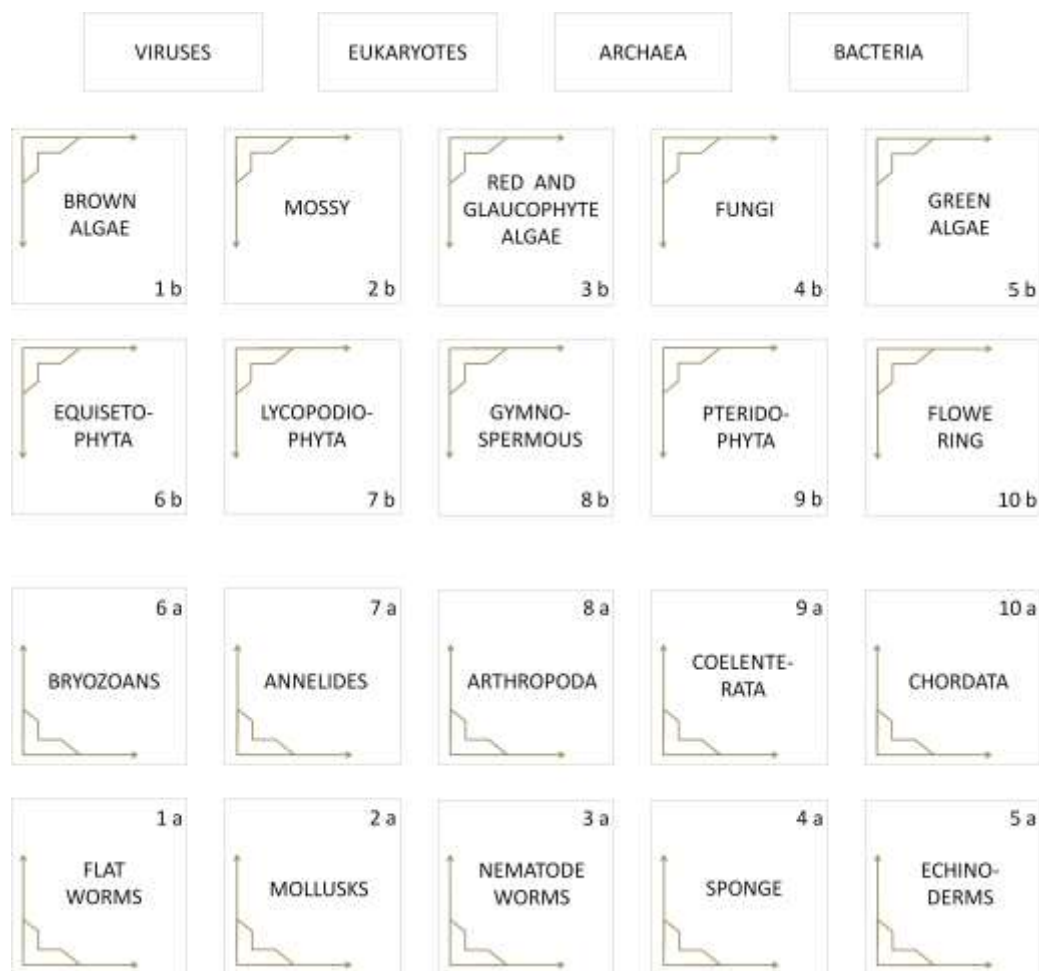


Figure APP - 7. The system of the living in the symmetry of the plant and animal worlds

It should be added to this that the system, of course, requires clarification by specialists in theoretical biology, not only in twenty¹⁷, but also in four “general” elements. In addition to the “four” indicated here – “Bacteria”, “Archaea”, “Eukaryotes” and “Viruses”, there were other options.

7.3. The alphabet of Mammals

But looking at mammals, we found that they, apparently, also make up the alphabet system. In this case, our ten-element “snakes” finish with “Tupai”, which have the maximum value of the ratio of brain mass to body mass, at the end of the first period, and “Primates”, at the end of the second period (Figure APP - 8). This system was discovered last and we have not yet considered the question of the four elements-“generals”.

¹⁷ Note that the “Horsetail” (Equisetophyta) department, taken as an element of the system – in different sources, is interpreted in two ways – either as an independent one or as a subdivision (Equisetidae) of the “Fern” (Polypodiophyta).

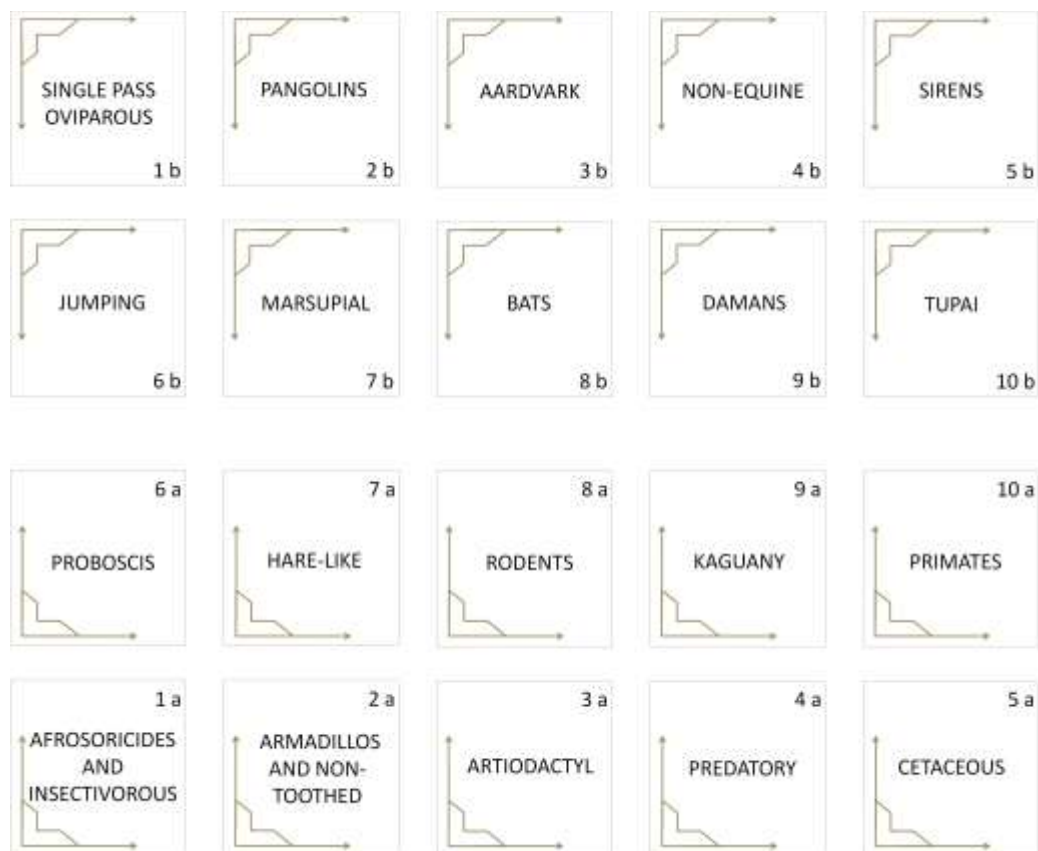


Figure APP - 8. The system of mammals in the symmetry of two ten-element “snakes”. Orders taken as elements

7.4. Prolegomena to Alphabetical Genetic Chemistry

This paper did not accidentally begin with a story about the two main subjects of our research program – the Vortex and the Alphabet. At the same time, considering and combining them several times in our work, today we come to yet another, apparently, programmatic and most important combination. Of course, alphabetical systems should be present in chemistry, because by this moment, counting the systems in a parallel paper on mathematics, we had already found thirteen units of them. Actually, this paper has the Vortex dedication, or rather, its 150th anniversary, and at the same time, devoted to the story of the discovery of the multitude of Alphabetical genetic systems.

For a long time, we looked closely at the most noble of the noble gases – the element Helium. Its atom is the real alphabet embodied in matter – in any case, with respect to the nucleus – there are four “generals” constituents here, namely a proton with a spin of $+1/2$, a proton with a spin of $-1/2$, a neutron with a spin $+1/2$ and a neutron with a spin of $-1/2$. We have four very close, similar, but various constituents. Moreover, with diverse pairwise mirror symmetry.

But in the alphabet there are twenty “ordinary” constituents, while helium has only two electrons. In a stable state, they have opposite spins – so that the symmetry of the alphabet is obvious – if each of the electrons was also divided into ten...

Our reasoning has stopped here for several years now – it seems strange to talk about one tenth of an electron, but today we decided to go ahead. In the end, there are increasing reports of the detection of different hypostases of particles. You can start with the fact that each particle of the microworld has two “faces” – it is both a particle and a wave. So can we not think of the “absurd one-tenth” of an electron, but of its ten “hypostases - faces”? Let's do that.

An electron is a carrier of a (minimum) charge, and when we deal with static electricity, this is it.

The second face of an electron is an electric current. Third is the photoelectric effect. Fourth – electron tubes and cathode ray tubes. Fifth – radioactivity: β -rays, Sixth – an electron, like an orbital, like a chemical "body" of an atom. Seven this a degenerate electron gas in the evolution of stars. And so on.

So, we have two electrons symmetric to each other (opposite spins), each of which has ten "faces" – twenty in total. Twenty constituents of the system, each of which is another hypostasis (face) of the electron. The helium atom, therefore, appears as one more alphabetical system. Which can be represented¹⁸ both in the form of the matrix and in the 3D-form.

"The helium atom is an alphabet" – this statement may cause a bewilderment amongst chemists, and I am being primarily a chemist, can truly realize that. But at the same time, there is a feeling of novelty and fruitfulness.

This is due, firstly, to the theory of the origin of Everything. Above, we just wrote about the Super Genetic Point and the Big Bang.

And if at the Point there is a certain "chromosome" of the Universe, then how is it arranged? What are the constituents of its genetic system? Approaching it from the side of the "after-explosion world" and considering helium as a genetic system, we find ourselves quite close to the Point – literally in a few minutes.

And secondly, this is connected with chemistry as such, with the Vortex, with such an important function for chemistry as the relationship of structure and properties. For example, we, chemists, have found carbon in living molecules and explained this. Before that, we, chemists, found it as the basis of a separate huge special world of Organic chemistry and explained everything. For example, we explained all this by the ability of hybridization of external atomic orbitals.

But why exactly carbon, only one of the cells of a large system of chemical elements is capable and provides a breakthrough to the next Floors of the Universe? Should this ability be recorded in its core? All modern chemistry will say no, but any unbiased philosopher will say yes, of course, yes.

Today, for this "yes", I, as a chemist, have nothing, but as the metachemist, I have a helium atom, as the alphabetical system.

And then, when each of the nucleon "nitrogenous bases" becomes the first in the "nucleons triplet" – in front of us is the nucleus of a carbon atom ($4 \times 3 = 12$).

So far I have nothing more to say. But this little paragraph about carbon, just one sentence about the triplet of nucleons – maybe that "spark" with which the complete transformation of chemistry will begin. From what is now – to Genetical Chemistry.

Always seemed strange – in the nucleus of the cell are chromosomes, with hereditary information, while in the nucleus of an atom is nothing with regards to genetics. Now we assume atomic "chromosomes" are made from nucleons.

8. GENERAL DISCUSSION AND CONCLUSIONS

Let us pay attention to several theses and try to reveal their meaning.

8.1. Explanation of the meaning of the title of this paper.

Fifteen years ago, a group of researchers (Miloje Rakočević, Đuro Koruga and others) called our concept – the second systematic approach in language theory. After the first – Ferdinand de Saussure (Rakočević et al, 2004). Five years ago, Milan Đorđević called our concept the "New Linguistic Paradigm" (Đorđević, 2014). Following these researchers, today we see our concept as the new – Alphabetical Paradigm, but – we add – which is not only Linguistic, but Universal and Synthetic (Holistic).

Of course, even referring to the opinions of others, to put it mildly, it is not customary to call the

¹⁸ Here, in an abridged version of the paper, we do not provide these images.

results of their research a paradigm. Yes, this is a challenge, because “normal science¹⁹” did not wait, does not wait and does not see our systems. We, in our other “normal science”, have long gone on to the solution of “problems - puzzles”.

8.2. Overcoming the cracks of a single Universum Pagoda.

Imagining the Ladder of the Universe (Figure APP - 9, left and right), and its image – the Pagoda of Peace (Figure APP - 9, in the middle), let us recall its ruptures, if you like, of dangerous cracks in the building (Figure APP - 9, on the left).

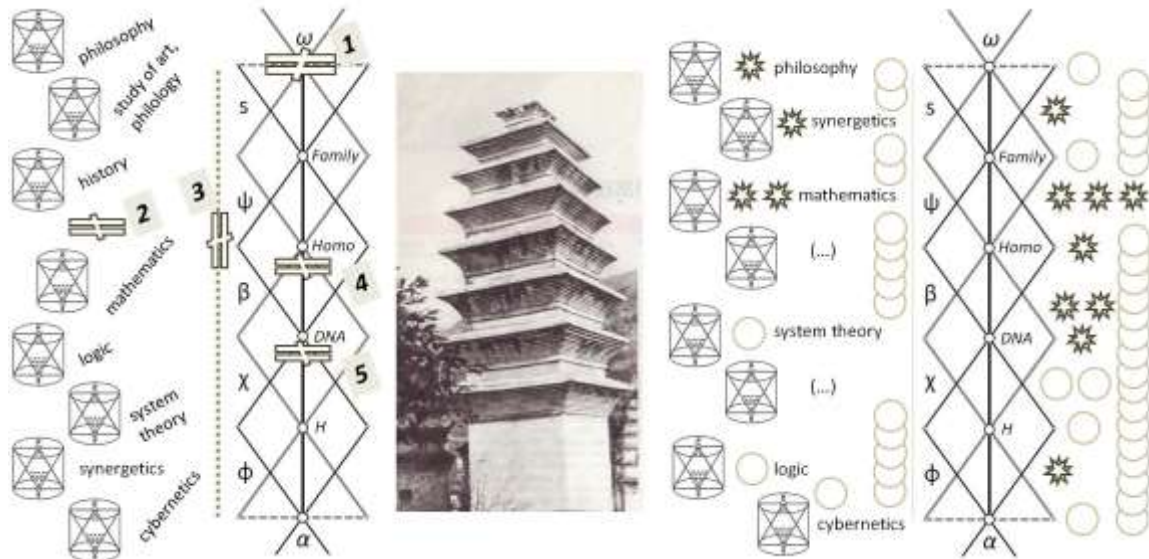


Figure APP - 9. Left: Five principal cracks in a single body of knowledge. In the middle: Pagoda from the Shaolin²⁰ Monastery. Right: Discovered Systems – here and in a parallel paper on mathematics. Unfilled circles indicate many yet undiscovered Systems

It seems to us that there are five (at least²¹) of these fundamental dangerous “cracks” of the Pagoda of the World that threaten its stability. We list them: First, the divine, the spiritual versus the mundane, the ordinary. Is "Jacob's Ladder" continuous or with an irresistible gap? (1). Secondly, the exact sciences against the humanities of "Physicists and Poets" (2). Thirdly, abstract, pure sciences versus concrete sciences – about nature and human (3). Fourth, a split in the secret of evolution of species in nature and the secret of human origin. Natural Selection or Creationism? The sciences of human versus the sciences of the rest of nature. Darwin (4). And, finally, fifthly, a split where the sciences of living nature are opposed to the sciences of inanimate (bone, inert) nature. The Secret of the Origin of Life. Panspermia? (5).

Opening the same systems on different floors of the Pagoda, we see that they are homologous to each other (the same Alphabet), that everything is endowment with intelligence, that everything is animated, and all Nature is whole. And knowledge of it is holistic.

By our breakthrough from only a few detected systems (from 1994 to 2013), to more than a dozen (from 2013 to the present), we give a good reason to overcome the “cracks” of the Pagoda. Our work restores the integrity of Knowledge. Let us repeat after Hermes Trismegistus: "As above so below".

¹⁹ In terms of Thomas Kuhn, the author of the scientific paradigm concept.

²⁰ Original signature: “Nameless pagoda 15 meters high”. Photo by Wei Dezhong (Huancheng, 1988, p. 41).

²¹ We are talking here about the main “cracks” that split the body of Knowledge itself. The number of “cracks” in science (and in individual sciences, and also inside them), as is known, is much larger.

The Storeys of the Pagoda, of course, are different, but these are "differences of unity." A remarkable image of such unity is "Lakshmi Traces" in the needlework of Indian women (Figure APP - 10).

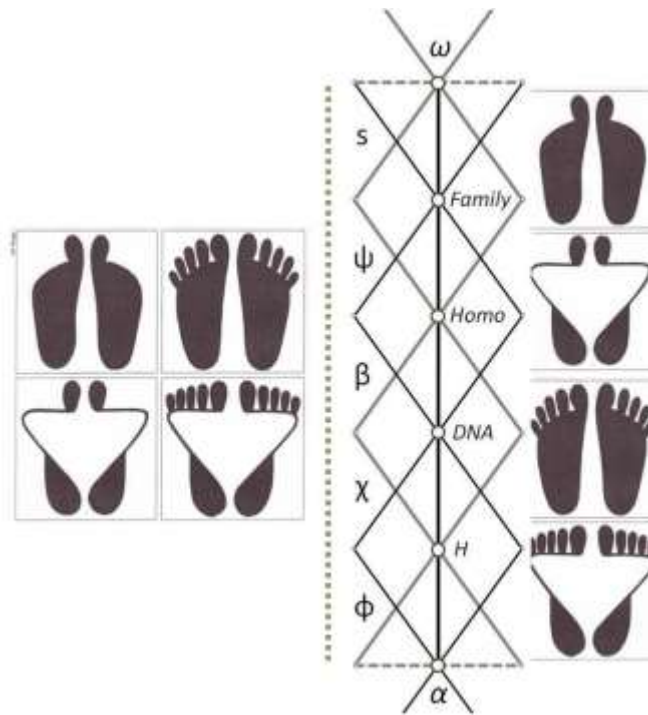


Figure APP - 10. Traces of Lakshmi²² (Left). On the Right are fragments of this image on the Plan of the Universe Floors. Everything is built on the basis of single "sample", everything is equally beautiful and everything is not good enough, everything is equally rational and spiritualized

The drawings are different from each other (women embroider them differently for the holiday) – but on each – this is an image of the same (*unity in difference*). So the World consists of different patterns, but the essence is one. These drawings are mundane, because these are traces on the "earth of transitory and fleeting life" – but these are traces of the goddess, that is, they are divine and sublime (*earthly and divine are inseparable*). And these are footprints like those of humans, that is, here we see not just unity, but the same anthropic structure (*confirmation of the anthropic principle*).

Once again, this is just the image, but it seems to us to be very accurate.

8.3. The same system on all Floors of the Pagoda – and this is neither reductionism nor transfer.

We also pay attention to the fact that in our Paradigm there is no reductionism or transfer of knowledge. As new systems discovered, learning more and more about the design of a single universal Alphabet, we find it on the next Floor of the Universe Pagoda.

I repeat, we made sure, that each Pagoda Floor has its own alphabet-system, and we just find it there.

8.4. Instant communication of alphabetical systems with each other.

Even in our first work on the Alphabet and Alathren, we suggested an instant connection of these

²² Original image title: "Feet (traces) Lakshmi. Women in different ways depict them during the Dipavali festival" (Dzheratk, 1989, p. 58)

systems, explaining the effect of attitudes, conspiracies and prayers on the human body. Then we formulated this idea as follows: “It turns out that from a word to genetic engineering is not one step, it is one and the same. We speak the language of our genes, but at the same time everything that we think and say is imprinted on these same genes” (Dlyasin, 1998, p. 124). Having discovered several new alphabetical systems here, we only once again confirmed the unconditional possibility and reality of such an Influence and Communication.

Incidentally, in physics, the influence of an observer on the result of an experiment is well known. This is a direct interaction of the phonetic alphabet (our thoughts) and the systems of essential characteristics of natural processes.

Now we have every reason to assume a more global picture – instant interaction-connection of all systems and through them – of all Floors of the World Pagoda.

We are talking about the connection of everything with everything that has long been obvious in modern ecology (Barry Commoner's first law: “Everything is connected to everything else”), but now – the connection of the direct universal and instantaneous through unified systems from thought and word – to a living organism, to society life, to the huge biosphere and small biogeocenosis in the forest, to the molecules and elementary particles of the Microworld, the influence of society on the biosphere, etcetera. This instant communication of various systems one on another happens through human and besides human. And all these connections are not one-sided, but directed both back and forth.

8.5. All alphabets-systems are anthropic.

In fact, the connection between human thoughts and physical phenomena is also related to our assumption that not only the three systems represented here (for example, paired organs), but all the alphabets-systems, like the Alphabet itself, are anthropic. Actually, as the anthropic principle known in modern science, is proclaiming. Note that the mind and soul of a person according to this logic should also find responses on these “floors”. In other words, everywhere there is its own "mind" and its own "soul".

8.6. All systems are genetic. Global Genetics or Pan-Genetics.

We note that all systems are arranged in the same way as alathren, the system of constituents of the genetic code (amino acids and nitrogenous bases). So, apparently, all systems are also genetic and also, by means of a universal triplet code, encode the device of their corresponding Floor of the Pagoda of the Universe (Figure 4 and 5).

We leave open the question of whether the genomes of the lower Floors of the Pagoda (the deeper Layers of the World, down to the microworld) encode only the structure of their Floors, or everything else above them. Is it like a bee swarm – its device does not have its own “chromosome” – is everything encoded in the genes of each bee? Or the "chromosome" of a bee swarm or human society is encoded in not material, but field structures.

Nevertheless, through the breakthrough made here in the discovery of many Alphabetical systems, we come to the possibility of explaining how in the First Point of the World, which through the Big Bang gives rise to the Universe, the whole Universe is packed. This is not package by way of a better arrangement of objects, like under the hood of a car or in a backpack of an experienced tourist, but genetically. The point that, when exploding, gives rise to everything is the Superchromosome.

So, Alphabetical Systems are those genetic structures which allow not only to the future live organism to be written down in a kernel of one cage, but to all World to be written down in one Point. Which allow all World to be rolled-up in one Point and again to be unwrapped from this Supergenetic Point in the World as a result of the Big Bang.

8.7. All alphabets are symmetrical.

This topic runs through our entire research program as “red thread”, including the most detailed analysis in the work of 2013 (Dlyasin, 2013).

8.8. All alphabets are periodic (emphasis on one of the types of symmetry).

Starting with the system of amino acids (Dlyasin, 1998), through the system of human speech sounds (Dlyasin, 2013) and up to the systems presented here – all of them are a manifestation of the one Alphabet on different Floors of the World. This Alphabet is periodic (two repeating periods of ten elements each, four rows of five – and these are also periods of their periodicity in sets of five). And in each row of five there are periodic fluctuations, for example, the alternation of “revolution” – “science” – “law machinery” – “education” – “business” (Figure 1, lower series).

This is the Second Periodic System of the Universe (Alphabet) – after the First – the Periodic System of chemical elements (Vortex).

8.9. All alphabetical systems are also semiotic.

The structure of the “alphabet-butterfly” is the Universal Code that is present in Nature, in Human and His Ideas. And there is no particular, abstract, ideal knowledge, separated from the knowledge of the concrete, from the knowledge of nature.

In conclusion, let us cite the thought already formulated earlier in our monograph Metachemistry (Dlyasin, 2013, p. 197): “The world is created from the alphabet, the world is ... the alphabet. Its structural elements are the alphabets (corporeal and incorporeal), on all floors.

Space itself is the Alphabet”.

REFERENCES

- Agapov, P. V. (2014) Sotsial'nye sistemy: teoriya, podkhody i dinamika [Social systems: theory, approaches and dynamic]. *Vestnik Moskovskogo universiteta [Moscow State University Bulletin]*. Series 18. Sociology and Political Science. (4), 60 – 75. (In Russian)
- Collins R. (1989) Sociology: proscience or antiscience? *Am. Soc. Rev.* V. 54. № 1, 124 – 139.
- Danilin A. G. (2010) Taro. Put' vo vnutrennyuyu real'nost' [Tarot. The path to inner reality]. Moscow: “Isolog” Publ., 80 p. (In Russian) Available at: <http://www.serebniti.com/pages/broshyura-taro-put-vo-vnutrennyuyu-realnost-/> (accessed 20 August 2019)
- Dlyasin, G. G. (1983) GalaktikaMendeleeva [Mendeleev Galaxy]. Manuscript. (In Russian, unpublished).
- Dlyasin, G. G. (1994a) Nekotorye printsipy postroeniya geneticheskikh znanievykh system [Some principles of building genetic knowledge systems]. In.: *Sistemogenetika i uchenie o tsiklichnosti razvitiya. Ikh prilozhenie v sfere obrazovaniya i obshchestvennogo intellekta: tez. dokl. Pervoy Mezhdunarodnoy nauchnoy konferentsii (pod red. N. N. Aleksandrova) [Systemogenetics and the doctrine of cyclical development. Their application in the field of education and public intelligence: Proc. 1th Int. Sc. Conf. (ed. N. N. Alexandrov)]*. Tolyatti: International Academy of Business and Banking Publ., 34 – 37. (In Russian)
- Dlyasin, G. G. (1994b) Organizatsiya znaniy na osnove simmetrii (Garmonicheskiy podkhod v teorii khimicheskoy sistemy i v obrazovatel'nom protsesse) [Organization of knowledge based on symmetry (Harmonious approach in the theory of the chemical system and in the educational process)]. In.: *Sistemogenetika i uchenie o tsiklichnosti razvitiya. Trudy Mezhdunarodnoy Akademii Biznesa i Bankovskogo Dela. Seriya: “Sistemogeneticheskie issledovaniya” (pod red. A. I. Subetto i N. N. Aleksandrova) [Systemogenetics and the doctrine of cyclical development. Proc. of the International Academy of Business and Banking. Series: “Systemogenetic Studies” (eds. A. I. Subetto and N. N. Alexandrov)]*. Tolyatti: International Academy of Business and Banking Publ., 33 – 124. (In Russian)
- Dlyasin, G. G. (1995) Spiral'no-tsiklicheskaya organizatsiya khimicheskogo znaniya, kak metodologicheskoe osnovanie prepodavaniya khimii v VUZakh [Spiral-cyclic organization of chemical knowledge as a methodological basis for teaching chemistry at universities]. In.: *Obshchestvennyy intellekt i obrazovanie na rubezhe tysyacheletiy. Tezisy 8-y sekti II Mezhdunarodnoy Kondrat'evskoy konferentsii (Pod nauch. red. A. I. Subetto) 15 – 17 marta 2015 g., SPb [Social intelligence and education at the turn of the millennium. Proc.*

- 8th section II Int. Kondratieff Conf. (ed. A.I. Subetto) March 15-17, 1995, St. Petersburg], Tolyatti: International Academy of Business and Banking Publ, 140 – 142. (In Russian)
- Dlyasin G. G. (1996) *Didakticheskaya organizatsiya znaniy na osnove kontseptsii simmetrii (na primere prepodavaniya obshchey khimii v vuze)* [Didactic organization of knowledge based on the concept of symmetry (for example, teaching general chemistry at a university)]. The PhD Diss. of pedagogical sciences: 13.00.01: defended April 12, 1996. Moscow, 254 p. (In Russian)
- Dlyasin, G. G. (1998) *Azbuka Germesa Trismegista ili molekuljarnaja tajnopis' myshleniya* [Hermes Trismegistus's alphabet, or the molecular cryptography of thinking]. Moscow: Belye al'vy Publ., 144 p. (In Russian)
- (Dlyasin) Dljasin G. G. (2007) *Azbuka Hermesa Trismegistosa ili molekularni tajnopis mičljenja* (prev. sa ruskog Sava Rosić). Beograd: Zepter Book World (Beograd: Zuhra), 186 s.
- Dlyasin, G. G. (2008) *Metakhimiya simvolizma* [The Metachemistry of Symbolism]. Manuscript. (In Russian, unpublished)
- Dlyasin, G. G. (2013) *Metahimija. Ot himii k Antropnoj Vselennoj* [Metachemistry. From Chemistry to Anthropic Universe]. Moscow: BUKI VEDI Publ., 680 p. (In Russian)
- Dlyasin, G. G. (2015). *Metahimija: smysl azbuki i azbuka smysla* [Metachemistry: the meaning of the alphabet and the alphabet of meaning] In.: PROC. *Speech and Language 2015, 5th Int. Conf. Fundamental and Applied Aspects of Speech and Language* (M. Sovilj, M. Subotić, eds.) 17 – 18 October, 2015, Belgrade: LAAC / IEPSP. – 396 p. (P. 7 - 26) (In Russian and Serbian) (http://www.iefpg.org.rs/Conference/2015/SL2015/2015_PROCEEDINGS_SPEECH_AND_LANGUAGE_2015.pdf) (accessed 8 March 2019).
- Dorđević, M. (2014) *Logosni (inte)gral jezika*. Beograd: Pešić i sinovii, 365 s.
- Frolov, S. S. (2000) *Sotsiologiya* [Sociology]. Moscow: Gardariki Publ., 344 p. (In Russian)
- Huancheng, Y. (1988) "Forest of Pagodas in the Shaolin Temple". *KITAY zhurnal (CHINA Magazine)*. Moscow: Embassy of China published. No. 1, p. 40 - 41. (In Russian)
- Dzheratk, A. (1989) "Folk Art of Kumaona". *INDIYA zhurnal (INDIA Magazine)*. Moscow: Embassy of India published. No. 3 - 4 (100 - 101), P. 56 - 60. (In Russian)
- Jenkins, R. (2013). *The future of sociology: extinction, stagnation or evolution?* [WWW]. University of Sheffield. Available from: <http://sociologicalstudies.dept.shef.ac.uk/?p=1349> [Accessed 05/12/2015].
- Jenkins, R. (2015) *Chto zhdet sotsiologiyu: vymiranie, zastoy ili evolyutsiya?* [The future of sociology: extinction, stagnation or evolution?] *SOTSIS Sotsiologicheskie issledovaniya [SOCIS Sociological research]* (ISSN 0132-1625) 3, 11 - 21. (In Russian)
- Luhmann, N. (1999) *Teoriya obshchestva (SanFoca'99)* [Theory of Society (SanFoca'99)] In the book: *Teoriya obshchestva. Sbornik [Theory of Society. Collection]*. Moscow: «KANON-press-Ts», «Kuchkovo pole », 416 p. (P. 196 – 235) (In Russian)
- Nevvazhay, I. D. (1995) *Svoboda i znanie [Freedom and knowledge]*. Saratov: Saratov State Academy Law Publ., 203 p. (In Russian)
- Plotinsky, Yu. M. (1992) *Matematicheskoe modelirovanie dinamiki sotsial'nykh protsessov* [Mathematical modeling of the dynamics of social processes]. Moscow: Publishing House of Moscow State University, 133 p.
- Rakočević, M., Ratkaj, Ž., Tomić, A., Simić-Krstić, J., Đurović, T., Koruga, Đ., (2004) *Bioinformacione osnove jezika: sistemski pristup. – Govor i jezik. Interdisciplinarna istrazivanja srpskog jezika*, urednici Slobodan T. Jovicih, Mirjana Sovilj. – Beograd: Institut za eksperimentalnu fonetiku i patologiju govora. Draslar partner, – 514 s. (S. 225 - 243)
- TsungHwa, J. (1984) *The Tao of I Ching. Way to Divination*. Tao Chi Foundation, 409 p.
- TsungHwa, J. (1996) *Dao I-Tszina. Put' k proritsaniyu [The Tao of I Ching. Way to Divination]*. Kiev: «Sofiya», Ltd. Publ., 368 p.
- Vasilkova, V. V. (1999) *Poryadok I khaos v razvitii sotsial'nykh system: Sinergetika i teoriya sotsial'noy samoorganizatsii [Order and Chaos in the Development of Social Systems: Synergetics and Social Self-Organization Theory]*, Saint-Petersburg: Lan' Publ, 478 p. (In Russian)

Materiality of Speech as a Virtual Component of Human Existence

Prof. Sh. Tashaev

“RPOSCSDS” Regional Public Organisation for Social, Cultural and Scientific Development of
Society

Saint Petersburg, Russian Federation

shamiltashaev@gmail.com

ABSTRACT

Three kinds of Matter are identified, which are corpuscular, field and virtual kinds. No one of them can exist independently. Special consideration is given to the virtual kind of Matter due to its ability to connect all other kinds of Matter in the past, present and future in all directions. Examples of the “programming languages” are: photon emission in any biochemical reaction; full set of chromosomes in any cell of the living organism, regardless of the functions and structure of that cell. Such “redundant design” might serve as an instrument for holographic application to the living matter. Human speech hierarchically resides at the very top of such “programming languages”. After thorough investigation of prenatal speech memory and publicly available scientific data we’ve made the following conclusions:

1. The virtual kind of Matter operates with several “programming languages”, by means of which it is able to interact with the other kinds of Matter and dynamically balance the Entropy and the Order.
2. Available features of programming language and its “competence” in dynamic balancing of Entropy and Order determines its position in the common hierarchy of programming languages.
3. Human speech resides at the very top of the hierarchical structure of these programming languages and, in its turn, has its own hierarchical structure – from the “mind diarrhoea” and various small talks to the speech as an act of creation.
4. Human speech is not a product of human brain, despite of the presence of speech areas (Broca’s area and Wernicke’s area) in the latter.
5. These areas serve for the retranslation of speech rather than its generation – by the analogy of the railway, which is not the source for train’s motion but just the tool for such motion and its optimisation in terms of energy costs.
6. The structure of speech and the meaning of separate words is evolving constantly over time, which serves as a proof for the existence of bidirectional feedback between the virtual reality and the time as such.

Key words: virtualization, materialization, existence, program languages of virtuality, perception.

1 INTRODUCTION

The Matter is everything that exists, and its way of existence is the absolute movement [1] as the interaction of beings. It should be noted that only the interaction “manifests” any living thing in the form of a certain material form. What is “materially manifested” forms certain thermodynamic systems [2], but in this case the way of existence of Matter as such is also the absolute movement. Absolute movement in an isolated thermodynamic system that does not exchange either energy or substance with the surrounding reality quickly leads to a dynamic equilibrium state within the system. The equilibrium state is the state of the thermodynamic system characterized by the equality of temperature, pressure and other macroscopic parameters of all its parts and the maximum entropy of the system as a whole. It can be assumed that at the maximum of entropy the particle’s property as a carrier of information is destroyed.

The interaction at this level can continue in the form of inverse destruction of material particles as carriers of information by maximizing the degrees of freedom and speed of their movement (reaching the maximum of entropy - isolated thermodynamic system), inevitably leading to the thermal death of the universe. The probability of existence of such a system in Nature is rather doubtful, so instead we would put a thermodynamic system that determines the state of informational exchange and partially redistributes the manifestations of entropy and order among the interacting parties [3].

Absolute motion in a closed thermodynamic system, exchanging with the surrounding reality only the energy through which to perform useful work, should inevitably lead to a gradual reduction of its energy (temperature), hence the conclusion about the future thermal death of the universe. Indeed, there are many reasons for that conclusion. However, in our opinion, due to the virtual part of the existence of Matter (for example, the ability to create false memories) the thermal death of the Universe becomes a little less inevitable. This area of research, despite its undoubted importance, is of course only in its infancy.

The absolute movement in an open thermodynamic system that exchanges with the surrounding reality both energy, matter and information leads, under certain conditions, to the formation and transformation of an ever-changing surrounding reality. In other words, the open thermodynamic system is a source for the evolutionary transformation of living and "solid" forms of matter.

As it follows from this expanded definition of Matter, it is not enough being a "being" to take a material form – the interaction of this being with another being is still required to form material forms and the variety of local and global scenarios of the universe that we perceive.

It follows from the "uncertainty principle" formulated by Heisenberg [4] (it is impossible to determine the exact location of a micro-object and its impulse at once) that we are never going to be able to reproduce an accurate, complete, three-dimensional picture of the material world. At the same time, we ourselves consist of such unique particles that not only don't correspond to any other particles, even the ones of the same name, but are also not identical even to themselves in each subsequent moment of time. In other words, everything in our reality is subject to constant changes of its content, form and meaning. Even the meaning of the words in our speech changes. For example, the stem of Russian word "*спор*" ("dispute") forms two words different by their meanings, which are "*спорить*" ("to argue") and "*спориться*" ("to be done smoothly and easily"). Recently, we have shown that even the Archetypes change over time.

Isn't it hard to imagine such an uncertain picture of the world, without any general Law for forming clear boundaries of any volume, and without any obvious meanings? Science tends to look for the root cause of everything, i.e. "the root of everything". Sometimes (especially in everyday life) it seems that such clear boundaries exist, and we can carry out rather precise measurements, on the basis of which we design and build the most complex, high-precision mechanisms and objects, on which our entire modern civilization is based. However, it seems to us that this construct is rather unstable because of its time-dependent existence [15]. It would be better to accept that the "root of everything" does not exist, but instead there is a certain reality at any given time, corrected by the virtual component of matter with the help of the program language of virtuality.

All objects of solid and living matter are short-lived, and their durability is predictable only with great approximation. It turns out that over a long period of time their properties are very similar to the properties of micro-objects in terms of the uncertainty principle. Is there any key(s) to unravel the mystery of finding certainty in uncertainty?

Let's think of a well-known example: a photon, passing through a hole, behaves both as a particle and as a wave. In the first case, we are observing it (establishing direct and backward relations, making some assessments, measurements...) and it behaves like a real particle. In the second case we (or our perception, to be more correct) are not interacting with it, and it manifests itself in the form of multiple probabilistic virtuality (the potential probability of finding a particle at a certain point in a certain volume of space at any given time) [5]. By the way, there is no equivalent of such probabilistic wave in physical reality.

What is "the Perception", actually? Is it inherent only in living material objects, or is it an integral property of any material object arising in the interaction of beings?

Let us assume the perception is:

1. simple mirroring (reflection) of characteristics and parameters of the interacting objects, i.e. "multiplication" of information in space and time without establishing direct and backward relations of objects with each other;

2. mutual recording (duplication) of characteristics and parameters of interacting objects without significant change of "settings" of interacting systems;

3. recording (embedding) of characteristics and parameters of interacting objects with establishment of forward and backward relations between them.

By Information in the broadest sense, we mean any formalizable characteristics of materialized forms and phenomena whose parameters can be quantified. An information unit is usually considered to be the one that allows you to select one of two equal-sized options (bits).

Such a definition of information allows its quantitative measurement and can be introduced into the formulas of entropy or various constructions and conclusions, connecting the function of information with the redistribution of Order and Chaos among interacting objects.

2 THEREFORE

In the first case (see P.1), despite of mutual reflection of characteristics and parameters of interacting objects, perception is not capable to influence their condition. Nevertheless, it is quite possible that the "multiplication" of information by means of mirroring is one of the reasons for the constant expansion of the Universe.

In the second case (see P.2), perception produces some kind of "snapshot" of interacting objects, i.e. fixes a virtual copy of the interaction process. In other words, perception creates something active and new – so to say, memory/imagination. At some elementary level, it is also characteristic of objects of solid matter (fossil footprints found during historical excavations, etc.). At the same time, a primitive virtual connection of the past with the present is formed through the perception of a person with the formation of a prototype of a program virtual language.

In the third case, perception affects the characteristics and parameters of the interacting objects through the formation of feedback with the objects of interaction. In this case, a lot of full-fledged program languages of virtual reality appear and perception becomes able to control the process of interaction through the use of a program virtual language. The latter indirectly implies that the method of control (consolidation, stabilization) of a material form in time and space is born in the process of formation of direct and backward relations in the process of interaction between the beings – with the manifestation of such material form. We consider the revealed form to be the ancestor of perception.

The perception is connected with the form with direct and feedback relations, due to which it identifies the given specific form out of the indistinctly differentiated background. There is an inversely proportional relationship between the background and the form selected from the it: the clearer the form is, the more uncertain is the background from which it is selected. The form acquires its clarity due to the narrowing the perception field to certain dimensions, corresponding to the scale of that form. At the same time, the "density" of the forward and backward lines increases. Perception is an inevitable component of materialized structures generated by the interaction of one being with another. It participates in every process of energetic and informational exchange, in giving the certain qualities to the material – up to the possibility (?) of their reverse dematerialization (the vector sum of impulses of all system bodies is a constant value, if the vector sum of external forces acting on the system of bodies equals to zero).

We have classified three forms of matter: corpuscular, field and virtual ones. No one of these forms can exist completely independently.

This paper focuses on the virtual form of matter [8]. This form provides a time connection for all forms of matter between past, present and future, in any direction. The latter comes from psychotherapeutic research in the field of directed imagination management, when one can get from the present to the past, add new impressions to the past (with false memories, for example), and return to the "altered" present [9].

Communication (initiation of interaction) is achieved with the help of "program languages" used by the virtual component of matter. Examples of such languages are: "populations" of photons and other radiating particles at any act of interaction of beings; a full set of chromosomes in each cell of a living organism regardless of its structure and functions; human speech and – probably – some other organized and mobile discrete "symbols" of program languages possessing potential ability to change results of interaction caused by previous conditions.

As a rule, program languages are usually "redundant" in their symbols (data carriers) [10], which makes their interaction with the virtual component of matter more stable and satisfies one of the main needs of all living things – the need for expansion. The gene material, as we mentioned earlier, is redundant too. Recent research on the comparative informative capacity of languages has shown a significant informative redundancy of their symbols. The use of regression methods in psychotherapy for searching the psychosomatic and emotionally non-verbalizable traumas in the past also requires some "redundancy" in the description of the past traumatic situation – even if this does not seem to be directly related to the trauma itself. However, this is still necessary to make the individual's perception of the past traumatic situation clearer. For example, in our researches we urge clients to feel the soil under the bare soles of their feet, describe their clothing in detail, and so on.

This topic is still very little investigated, although it is obvious that it is very important to establish the laws of materialization of program languages used by the virtual component of Matter to control a living form of matter. We can give reverse examples of information redundancy – its insufficiency. During the polar night (lack of natural light), for example, people are more likely to get pneumonia, which is commonly referred to as "dark pneumonia". When the body is infected with viruses (cloning viruses and naturally reducing the body's adequate set of chromosomes in its own cells), the body's immunity becomes less effective in protecting it from disease. The study of herring shoals revealed that the decrease in the number of fish (data carriers) in the shoal to a certain extent led to the decay and disappearance of the shoal [11, 12]. Recent empirical observations of beehives show that the death of a certain number of bees, despite the existence of a bee queen, leads to the death of the entire beehive [13, 14]. In this sense, the extinction of many species of animals and plants is very alarming, as it is difficult to assess their impact on the ecobiogeocenosis of the entire planet and, in general, on the possibility of life as such on our planet. Although man has a great advantage over other living inhabitants of our planet (mainly due to the speech as a virtual act of creation), the existence of mankind as a whole is under great threat.

The discontinuation of the national language usage by the majority of its native speakers leads to the erasure of the national identity of the given people and irrevocable loss of their culture, which inevitably affects the content of the Noosphere and, consequently, the future of our planet as a whole (and even the solar system itself). All this leads to the idea that quantitative characteristics of information carriers along with the volume of information contained by each carrier play an important role in the preservation of open thermodynamic systems of living matter. Human speech, being on the top of the hierarchy of program languages, has a great chance of correcting the situation prevailing nowadays. It also advantages from the fact that the speech itself is not a product of brain activity, and thanks to this a person (and society as a whole) can resist to a certain extent the unrestrained pressure of information hysteria affecting our psychosomatics. Human speech has a benefit of always being an act of creation of new things (in its higher manifestations) and by interacting with the human psyche (imagination, emotions, feelings) it serves as a powerful guarantor of the independence of the Reasonable Man in our universe.

3 CONCLUSION

1. Virtual form of existence of matter has a number of program languages that are able to control the interaction of material forms and maintenance of dynamic balance between entropy and order.

1 Normally, program languages are ""redundant" in their symbols and information carriers, which allows for selective interaction of the virtual component of Matter with objects of interaction and provides a variety of forms of existence of material forms.

2 In our studies, the psychotherapeutic process of directed control of imagination in the conscious state was much more complete and effective (while the age regression performed in order to search for psychosomatic and emotionally non-verbalized traumas in the past was of higher quality) with some redundancy in the psychotherapist's description of the moments of the past traumatic situation, even if it did not seem to be directly related to the trauma itself. For example, a description of the soil under the bare feet or a detailed description (visualization) of the environment, a sense of clothing on the body, and so on.

3 The limit of competence of the program language in maintaining a dynamic balance between entropy and order determines its location in the general hierarchy of program languages.

4 Human speech occupies the top position in the hierarchical structure of program languages and, in its turn, has a hierarchical structure of structure - from the "diarrhea of thoughts" and small talk to the speech as an act of creation of a new.

5 Human speech is not a product of human brain activity, even if it has speech centers (Broca and Wernick areas). These zones are used for speech retransmission, not for its generation, as rails are not the source of train movement, but rather just providing this movement with minimal energy consumption.

6 The structure of speech and the meaning of individual words is constantly changing over time, which proves the existence of feedback between virtual reality and time itself.

7 Human speech benefits from the fact that in its higher manifestations it is always an act of creation of a new, and by interacting with the psyche (imagination, emotions, feelings) it serves as a powerful guarantor of the independence of the Reasonable Man in our universe.

8 In our reality, everything is subjected to constant changes of its content, form and meaning and is an a priori given due to a set of constantly changing circumstances.

REFERENCES

- Novikov I. I. — *Termodinamika. Osnovnyye ponyatiya. Terminologiya. Bukvennyye oboznacheniya velichin* / Otv. red. AN SSSR. Komitet nauchno-tehnicheskoy terminologii. Sbornik opredeleniy. Vyp. 103. — M.: Nauka, 1984. — 40 s.
- Vol'kenshteyn M. V. — *Entropiya i informatsiya*. — M.: Nauka, 2006
- Geyzenberg — «*Fizika i filosofiya*» *Chast' i tseloye*. Izdatel'stvo: M.: Nauka God: 1989. Stranits: 400
- Shakhriyar S. Afshar — «*Ostro-Dopolnitel'noye*» *povedeniye voln i chastits v welcher weg-eksperiment* Fzicheskii fakul'tet, universitet Garvard, Kembridzh, Massachusetts, SSHA
- Eddington, Arthur — *The Expanding Universe: Astronomy's 'Great Debate'*, 1900-1931. Press Syndicate of the University of Cambridge, 1933.
- Solonenko M.A. — Koevolutsionnaya slozhnost' okruzhayushchego mira i mnogoobraziye form vospriyatiya vremeni (Sovremennyye napravleniya i podkhody v izuchenii problemy vospriyatiya vremeni) // *Vestnik Tomskogo gosudarstvennogo pedagogicheskogo universiteta*. № 1. 2013. S. 163–168
- Malyshko A. A — *Filosofskie problemy virtual'noi real'nosti (istoriko-filosofskii analiz)* Dissertatsiya na soiskaniye uchenoi stepeni kandidata filosofskikh nauk Murmansk – 2008
- Shamil S. Tashaev — Study of the unconscious, pre- and postnatal individual perception by means of the age regression model. *The international journal of prenatal and perinatal psychology and medicine*. P.34-48. 2007. ISSN 0943-5417
- Voyeykova M. D. — Proyavleniye yazykovoy izbytochnosti v oblasti russkikh padezhnykh protivopostavleniy (na materiale spontannoy rechi vzroslykh i detey s privilecheniyem dannykh rechevoy patologii) // *III Mezhdunarodnyy kongress issledovateley russkogo yazyka «Russkiy yazyk: istoricheskiye sud'by i sovremennost'»* (MGU im. M. V. Lomonosova, filologicheskii fakul'tet, 20–23 marta 2007 g.). M., 2007.
- Makris N. C. — Critical population density triggers rapid formation of vast oceanic fish shoals // *Science*. – 2009. – T. 323. – №. 5922. – C. 1734-1737.
- Herbert-Read J. E. — Inferring the rules of interaction of shoaling fish // *Proceedings of the National Academy of Sciences*. – 2011. – T. 108. – №. 46. – C. 18726-18731.
- Khoury D. S., Myerscough M. R., Barron A. B. — A quantitative model of honey bee colony population dynamics // *PloS one*. – 2011. – T. 6. – №. 4. – C. e18491.
- Kribs-Zaleta C. M., Mitchell C. — Modeling colony collapse disorder in honeybees as a contagion // *Mathematical Biosciences and Engineering*. – 2014. – T. 11. – №. 6. – C. 1275-1294.
- Dornberger L. — Death of the bees: A mathematical model of colony collapse disorder // *Mathematics Preprint Series. Technical Report*. The University of Texas, Arlington, USA. Available online: <http://citeseerx.ist.psu.edu/viewdoc/download>. – 2012.
- Shamil S. Tashaev — Contradiction of the “Interests” as an Important Factor of Human and Social Development. “*Health of the family — health of the society*”. *Congress materials; 2010, May 29 — 30, Saint-Petersburg*. en.iptp.ru/publications/contradiction-of-the-interests-as-an-important-factor-of-human-and-social-development

How the Advent of Machine Learning Transforms Speech Technologies

**Milan Sećujski¹, Tijana Nosek¹, Siniša Suzić¹, Darko Pekar²,
Edvin Pakoci¹, Branislav Popović^{1,3}, Vlado Delić¹**

University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Serbia¹

AlfaNum – Speech Technologies Ltd., Novi Sad, Serbia²

Alfa BK University, Academy of Arts, Belgrade, Serbia³

secujski@uns.ac.rs¹

ABSTRACT

Until recently, speech technologies have been considered as an interdisciplinary area spanning a range of areas, such as linguistics, psychoacoustics, speech generation and perception, as well as engineering disciplines such as signal processing. In a classical system for automatic speech recognition (ASR) or text-to-speech synthesis (TTS), specific components in the process of speech recognition or generation had to be identified and explicitly modelled. However, the recent advent of machine learning has brought a significant shift of this perspective from combining explicitly modelled components to a more end-to-end approach, in which the system, typically based on a deep neural network (DNN), would eventually be directly trained on speech data and corresponding text transcription, which can be compared to the human acquisition of abilities of reading aloud or taking dictation. Due to extreme language dependence of both ASR and TTS, some of the steps in the conversion of text to speech or vice versa are more predisposed to such an approach in some languages than in others. Furthermore, due to the fact that a shift to such an approach dramatically increases the quantity of data needed for training, significant results have so far been obtained only for a small number of major world languages. However, the shift of the paradigm is evident in the entire research and development community, and it can be expected that more and more of the existing components of ASR and TTS systems would be encompassed into single neural networks in the future. This review article aims to give an overview of the state of the art in the area as well as to give an insight into the advantages and disadvantages of the increasing impact of machine learning paradigms, particularly the end-to-end concept, on the development of speech technology.

Keywords : speech recognition, text-to-speech synthesis, machine learning, end-to-end

1. INTRODUCTION

Humans have been using speech as means for communication with others for hundreds of thousands of years, and among other living species they are exceptional for exploiting mechanisms intended for respiration and ingestion to a radically different requirement of encoding their thoughts in sound (MacNeilage, 2008). It is thus not surprising that we would consider it convenient to extend this mode of communication to other elements of our environment. Indeed, since humans started using machines powered by draft animals, they soon discovered that those same animals exhibited a level of intelligence sufficient to understand simple commands and to respond to them (Schafer, 1994). This has revealed many of the advantages of using speech as a channel for communication with a non-human collocutor. Namely, besides being most natural to a human, speech is particularly efficient in case one's hands or eyes are otherwise occupied. With technological development in the field of computers, the use of speech to issue commands or receive information from different types of devices has become more ubiquitous. Besides the already mentioned efficiency and naturalness of this interface, it is also potentially very useful to persons with various types of disabilities, including the visually impaired, hearing impaired and otherwise physically impaired (Delić, 2014). While in a not so recent past, the predominant position in the speech research community was that “fundamental knowledge of the speech signal – how it is produced, how

information is encoded in it, and how it is perceived – is critically important” (Schafer, 1994), this knowledge seems to have lost some of its importance in the meantime. This review article aims to give a brief overview of the development of automatic speech recognition (ASR) and text-to-speech synthesis (TTS) as basic speech technologies, with a particular focus on the shift of their respective paradigms that has arisen from the recent technological progress in machine learning. Namely, while earlier systems explicitly modelled particular components in the speech perception/processes, the research and development effort is now mainly focused on obtaining end-to-end solutions, requiring as little domain knowledge as possible. In other words, it is becoming less and less important to analyze natural processes and develop models for them, given a sufficient quantity of training data for a machine learning system.

The following two sections will give a brief review of the developments in ASR and TTS respectively, while the final section will focus on the main common points that can be identified and draw appropriate conclusions from them.

2. THE EVOLUTION OF AUTOMATIC SPEECH RECOGNITION

Automatic speech recognition (ASR) is defined as a speech technology which enables a machine to convert recorded human speech into a string of words. These words can, in turn, be interpreted as a query, command or other speech act, by a speech technology termed spoken language understanding (SLU), which is outside the immediate scope of automatic speech recognition. ASR can, thus, be roughly treated as the machine equivalent of a human process of taking dictation.

2.1. Early development

From its very beginning ASR was based on electronic equipment, and the first documented ASR system was developed in 1952 by Bell Labs researchers S. Balashek, R. Biddulph, and K. H. Davis. This system, named “Audrey”, was fully analogue, and it was designed to recognize the names of digits in English, spoken with pauses in between, and in its task it achieved the accuracy above 97% when tuned to a particular speaker (Lea, 1980). It performed the recognition based on the extraction of formants from the power spectrum of the recorded audio signal, and as such, it is a prime example of the use of expert knowledge in speech technology.

A scientific breakthrough in ASR came in 1960 with the introduction of the source-filter model of speech production. According to this model, the activity of vocal folds defines the excitation and the remainder of vocal tract, including the radiation characteristic, acts independently as a filter and shapes the sound spectrum (Jovičić, 1999; Rabiner and Schafer, 2007). This model, related to linear prediction, has since been widely used in both ASR and TTS systems, and encompasses expert knowledge of areas from physiology to signal processing. The ASR systems that were to follow soon exploited to a lesser or greater degree the knowledge from acoustical phonetics and phonology. In 1962, IBM demonstrated the Shoebox, a machine that could recognize up to 16 spoken words in English, at the Seattle World's Fair, and further scientific development came in 1966, with the introduction of Linear predictive coding (Gray, 2010), proposed by experts from the Nagoya University and Nippon Telegraph and Telephone (NTT). This technique, used mostly in audio and speech processing to represent the spectral envelope of a digital speech signal in a compressed form based on a linear predictive model, has since become the basis of most widely used parameterization methods in speech recognition as well as speaker recognition. These years also mark the first attempts at continuous word recognition, while the challenge of obtaining speaker independence remained unsolved for some time to come. Another significant step in the development of ASR in the late 1960s came with the invention of Dynamic time warping (DTW) algorithm, which was used to create an ASR system capable of handling a vocabulary of 200 words (Benesty et al., 2008). Dynamic time warping represents a technique for measuring the similarity between two temporal sequences, a general scientific result which was later used not only in ASR but in relatively unrelated areas such as cryptography.

2.2. Beginnings of machine learning in ASR

The end of 1960s also marked the progress in the development of the mathematics of Markov chains, stochastic models describing sequences of possible events in which the probability of each event depends only on the state reached in the previous event (Markov, 1906). A version of particular interest for the speech research community were hidden Markov models (HMM), whose basic assumption is that the states of the system which is being modelled are not directly observable, but that the system output in the form of some data item which is dependent on the state, is visible (Baum & Petrie, 1966). This is in agreement with the process of human production of speech, in which the speaker is assumed to traverse a sequence of phonemes that compose an utterance (which corresponds to the hidden sequence of states), emitting a particular sequence of acoustical events in each state. In this interpretation, phonemes correspond to states that are “hidden” from the listener, but can be retrieved from the acoustical signal which changes its statistical properties over time in a manner that is perceived as discrete by the listener. This assumption of a discrete nature of changes in the speech signal is, of course, far from reality, but it represents a good starting point, especially having in mind that states may not correspond to phonemes themselves, but to certain phases in the pronunciation of a corresponding phone (e.g. the beginning, the middle – where an assumption of signal stationarity is reasonable in many cases – and the end). The speech signal is thus viewed as a piecewise stationary signal, which can be approximated by a stationary process in a short time-scale (e.g. 10 ms).

The appeal of HMMs, besides their simplicity and computational feasibility, is in their ability to learn the statistics of the acoustical properties of particular phonemes directly from speech data, with far less human expert involvement. The human involvement is reduced to defining the set of acoustical features that can be extracted from a speech signal, and that are sufficient for reconstruction of the speech signal from a sequence of acoustic feature sets. These traditionally include *cepstral coefficients*, which are obtained from the spectrum of a short time window of speech, decorrelated using a cosine transform, *fundamental frequency* (if speech is voiced) as well as *dynamical features*, which describe the changes in the features mentioned above. Each state will have a different output distribution, and HMMs of words or sequences of words are obtained by concatenating single-state HMMs, each of which is trained on a speech corpus. In this way, the system automatically “learns” the statistical properties of each state, which is traditionally modelled by a mixture of diagonal covariance Gaussian distributions. In the recognition phase this will give a likelihood that an observed sequence of acoustic events corresponds to a particular sequence of phonemes, and ultimately to a particular sequence of words. In order to arrive from possible sequences of phonemes and their likelihoods to the most likely utterance, i.e., for the decoding process, a *language model* is needed. However, the creation of language models used for ASR requires little expert knowledge, as they can be easily made from large text corpora, using the *N*-gram approach, which is a simple extension of Markov chains to allow for the dependence of the probability of a state on the previous *N*–1 states instead of just one (Manning & Schütze, 1999). In spite of their poor acceptance by the linguistic community, which considers them too simplistic to account for many common features of human languages, hidden Markov models remained to be the state of the art in ASR for a long time to come. By mid-1980s, ASR systems were able to handle vocabularies of up to 20,000 words relying on HMMs, and decoding was usually performed by some form of Viterbi algorithm (Viterbi, 1967). Further improvements included the use of *N*-gram based language models of different lengths (Katz, 1987), and the challenge of obtaining a speaker independent, large vocabulary ASR was not overcome until 1992, with the Sphinx series of speech recognizers, developed at the Carnegie Mellon University (Lee & Huo, 2000).

2.3. Most recent trends

A new technological breakthrough in the field of ASR came with the advent of artificial neural networks (NN). Inspired by biological neural networks, and composed of a large number of simple computational units named *neurons*, these systems embody the true meaning of the term “machine learning” in that they adjust the weights of the interconnections between neurons in a similar way and with the similar aim as biological neural networks of living organisms. Although their theoretical base was laid as early as in the 19th century (Bain, 1873), and their computational model was defined in mid-1940s already (McCulloch & Pitts, 1943), two key factors that enabled them to reach the state-of-the-art status in a range of fields including speech technology were the development of an efficient training algorithm (Werbos, 1974), as well as general technological development in the computer industry, particularly towards the end of the century. As regards the task of ASR, neural networks have been shown to outperform hidden Markov models (HMMs) in acoustic modelling (Hinton et al., 2012), but have also clearly outperformed standard *N*-gram language models in terms of generalization, using either architectures based on long short-term memory (LSTM) neurons (Sundermeyer et al., 2015) or recurrent neural networks (RNN) (Irie et al., 2016). Solutions based on neural networks have been shown to reach the human level of performance in tasks as complex as casual conversational speech recognition (Xiong et al., 2016).

The principal components of traditional ASR systems – acoustic, pronunciation and language models – are all trained separately, each of them with a different objective in mind. On the other hand, most recent trends in this area follow a particularly challenging line of research, oriented towards obtaining an end-to-end solution for ASR, namely, one that would be able to learn the relationships between patterns in speech data and corresponding text without having to rely on any language resources or hand-designed components. Such a system would not even need concepts such as “phoneme”, but would operate directly on text and speech, nor it would need any knowledge of speech production and perception mechanisms to choose which features to extract from the speech signal in order to perform recognition. A significant step in that direction has been made in the research described in (Hannun et al., 2014), which is based on a simple RNN architecture, great processing power as well as a set of novel techniques for the augmentation of training data, i.e. producing a significantly larger amount of diverse data from the existing training corpus. Another effort worth mentioning is the research presented in (Chan et al., 2016), based on a pyramidal recurrent network encoder (the “listener”) and an attention-based recurrent network decoder (the “speller”), which do not rely on any dictionary or language model. Although the aforementioned two systems achieve word error rates of 16.0% and 14.1% respectively (in different experimental conditions, and thus the results are not directly comparable), which is insufficient for commercial application, the shift of the paradigm towards complete independence from expert knowledge is clearly indicated. The only linguistic knowledge that these systems still require is in that they both obtain their acoustic inputs from filter banks, instead of working directly on a sequence of samples of a discrete-time speech signal.

3. THE EVOLUTION OF TEXT-TO-SPEECH SYNTHESIS

Text-to-speech synthesis (TTS) is the speech technology complementary to ASR, as its task is to convert a text into a speech signal which could have come from a human speaker. However, human speech carries much more than just the message coded in the string of words itself. The same text may correspond to a theoretically infinite number of utterances, which would all be considered quite acceptable by a human listener. Different renditions of the same string of words may depend on a range of factors of different nature, which have been classified in different ways in the literature. For instance, Marasek (1997) identifies the following layers of speech as a medium; the *linguistic* layer for semantic information and phonetic representation, the *paralinguistic* layer for non-linguistic and non-verbal information about the speaker's attitudes, emotions, regional dialect and sociolect, and the *extralinguistic* layer for physical and physiological (including organic) features, such as the speaker's sex, age and habitual factors. This suggests that, just as conventional ASR can be regarded as a process whose aim is to discard the superfluous information and to recover the message coded in a string of words, TTS can be regarded as the process of

(re)construction of a speech signal with all the missing information somehow recovered. For that reason, the systems aimed at the conversion of raw text into speech have traditionally been divided into two main modules. The first one, referred to as *front-end* and based on natural language processing (NLP) is charged with text analysis aimed at recovering as much as possible of the information needed for the resulting speech to sound intelligible and natural. The second one, referred to as *back-end*, is far less dependent on the language and is concerned with the production of a speech signal according to the linguistic (and possibly paralinguistic) specifications provided by the front end. While this division is quite clear in earlier TTS systems, it is becoming increasingly blurred in state-of-the-art TTS, based principally on neural networks trained on large quantities of text and speech data.

3.1. Early development

The very first experiments with producing artificial speech date back in the 18th century, when a mechanical apparatus was created by C. Kratzenstein, based on resonators able to produce five long vowels (/a/, /e/, /i/, /o/, and /u/) artificially (Flanagan, 1972). This was soon followed by a demonstration of the “Acoustic-Mechanical Speech Machine” by von Kempelen, which was able to produce single sounds and some sound combinations (Klatt, 1987) and a number of other similar efforts. The research and experiments with mechanical and semi-electrical analogues of the human speech production system continued with no remarkable success well into the 20th century. The first full electrical synthesis device was introduced by Stewart in 1922 (Klatt, 1987), but the first device that can be considered as a speech synthesizer was VODER (Voice Operating Demonstrator), introduced by H. Dudley in 1939 at the World's Fair in New York (Klatt, 1987). It consisted of a wrist bar for selecting a voicing or noise source, a foot pedal which controlled the fundamental frequency, and of ten bandpass filters whose output levels were controlled by fingers, and to which the source signal was routed. In 1951, F. Cooper developed a Pattern Playback synthesizer, able to reconvert optically recorded spectrograms into speech, and in 1953 the first formant synthesizer was introduced by W. Lawrence, consisting of three electronic formant resonators connected in parallel and fed by either periodic excitation or noise (Flanagan 1972; Klatt, 1987). A series of efforts more or less based on mimicking the human speech production system following the source-filter model ensued. The first full TTS for English was developed in 1968 by N. Umeda (Klatt, 1987), relying on an articulatory model and a set of sophisticated heuristics for syntactic analysis. It was based on an articulatory model and included a syntactic analysis module with sophisticated heuristics, and its output was synthesized speech of high intelligibility, but quite lacking in naturalness. The 1970s and the 1980s saw a number of commercial TTS products based on these approaches, and the development of computer technology also allowed the emergence of systems that produced speech by concatenation of pre-recorded speech segments. The first examples of such systems concatenated very short speech segments, leading to frequent audible artefacts in synthetic speech, which degraded its intelligibility. However, with further technological progress in the computer industry and the emergence of efficient algorithms for selecting the optimal sequences of segments at runtime (Hunt & Black, 1996), the concatenative approach became the state of the art and it is still widely used by many commercial TTS systems. However, the main drawback of this approach is that it merely reproduces the data instead of learning from it, which makes it quite inflexible and unable to meet the challenges such as adaptation to another speaking style or the voice of a particular speaker.

3.2. Machine learning in TTS

Near the end of the century, it has been realized that hidden Markov models, owing to their generative nature, are actually more convenient for speech synthesis than for recognition. In the case of TTS, the model would learn the acoustic representation of particular phones or particular phases thereof in a manner quite similar to that used in ASR training. However, at synthesis stage, the model would be forced to traverse a sequence of *known* instead of hidden states, and the sequence of acoustic feature sets that the model generates on its path would be converted back into speech (Yoshimura et al., 1999). Realistic feature vector trajectories are generated from trained HMMs owing to the introduction of dynamic features into the HMM

framework (Tokuda et al., 1995), and the problem of features that are not present or are not observable in all frames (notably the fundamental frequency) was efficiently solved using multi-space probability distributions (Tokuda et al., 1999). Speech synthesis based on HMMs has thus reached the quality comparable with the concatenative approach, with the principal shortcomings related mostly to oversmoothing performed by the models, as well as the muffled character of synthesized speech due to parameterization, i.e. the use of a vocoder to extract features from speech during training and to reconstruct speech from predicted features at synthesis phase. Nevertheless, unlike the concatenative approach, HMM based speech synthesis was suitable for adaptation to other speakers (Tamura et al., 2001) and/or speaking styles (Yamagishi et al., 2004), and thus represented a true step forward with respect to the concatenative approach, as the first technique able to actually learn from data, exhibiting a much greater degree of flexibility.

It did not take long before neural networks were applied to the problem of speech synthesis, and it was soon shown that they outperform HMM-based synthesis in almost every aspect. Owing to their ability to learn complex mappings between input linguistic representation of text and corresponding acoustic features of speech, deep neural networks (DNN) were used most notably for acoustic modelling (Zen et al., 2013), which led to a better intelligibility and higher naturalness of synthesized speech. It should, nevertheless, be noted that the standard versions of both these approaches relies on some form of front-end, i.e., linguistic features recovered from raw text have to be supplied to the speech synthesis module for it to be able to synthesize speech with satisfactory prosodic features (accents, phrase breaks etc.). A significant difference is, however, in the way linguistic context is supplied to the model at synthesis time. While HMM TTS principally uses decision tree-based state tying to ensure accurate estimation of probability distributions of acoustic features for each context-dependent model, and thus the proper model for a context-dependent phone is selected on the basis of the actual values of linguistic features at synthesis time, in case of DNN TTS linguistic features provided by the front-end are directly supplied as inputs to the network. Deep neural networks, more precisely restricted Boltzmann machines and deep belief networks, have also shown good results in modelling output probabilities of HMMs (Zen & Senior, 2014), and DNNs have also been used for other speech synthesis tasks, such as prosody modelling (Fernandez et al., 2014), modelling of acoustic trajectories (Fan et al., 2014), extraction of low dimensional excitation parameters by auto-encoders (Vishnubhotla et al., 2010), as well as DNN-based post-filtering, aimed at the recovery of fine spectral structure of speech that is lost during acoustic modelling (Chen et al., 2014). Text-to-speech systems based on DNNs also possess all the flexibility of HMM-based synthesizers. Notable attempts at obtaining DNN TTS in the voices of multiple speakers and/or the adaptation of the existing DNN TTS to voices of other speakers are described in (Fan et al., 2015; Wu et al., 2015), and similar approaches were later used to handle speaking styles.

3.3. Most recent trends

In the recent past there were several notable efforts towards achieving an end-to-end neural network based TTS. For instance, WaveNet (van den Oord et al., 2016) addresses the most widely cited deficiency of parametric speech synthesis, which is a somewhat muffled character of synthesized speech due to the use of a vocoder, by operating on raw speech waveforms. This model deals with autoregressive prediction of speech sample values, based on predictive distributions for each audio sample conditioned on all previous ones. The model is based on new architectures based on dilated causal convolutions, which exhibit very large receptive fields, and when applied to text-to-speech, it yields state-of-the-art performance, with human listeners rating it as far more natural sounding than the best HMM-based and concatenative systems for both English and Mandarin. On the other hand, it is still not end-to-end, since it is conditioned not only on text but on linguistic features as well, and due to its sample-autoregressive nature, it requires too much computational processing power for real life applications. In the meantime, significant effort has been put into addressing this problem, and it is now possible to generate high-fidelity speech samples at more than 20 times faster than real-time, relying on massive parallelization (van den Oord et al., 2018). One of the most recent contributions to this field is described in (Ping et al., 2019) which builds on

the data on which they operate, and this is precisely what deep learning does not offer. Neural network based solutions do not allow us to take a glimpse “into the black box”, much as looking at the functioning of a single neuron would tell us little about how we understand speech or encode our thoughts into it. To conclude, whether we like it or not, the current technological trends seem to be providing us with solutions with exceptional performance, but force us to accept that in the future we will understand less and less of them.

REFERENCES

- Bain, A. (1873). *Mind and Body: The Theories of Their Relation*. New York: D. Appleton and Company.
- Baum, L.E., Petrie, T. (1966). Statistical Inference for Probabilistic Functions of Finite State Markov Chains. *The Annals of Mathematical Statistics*. 37 (6): 1554-1563.
- Benesty, J., Sondhi, M.M., Huang, Y. (2008). *Springer Handbook of Speech Processing*. Springer Science & Business Media.
- Chan, W., Jaitly, N., Le Q.V., Vinyals, O. (2016). Listen, attend and spell: a neural network for large vocabulary conversational speech recognition, *Proc. of 2016 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, Shanghai, China, 4960-4964.
- Chen, L.-H., Raitio, T., Valentini-Botinhao, C., Yamagishi, J., Ling, Z.-H. DNN-based stochastic postfilter for HMM-based speech synthesis. *Proc. Interspeech 2014*, 1954-1958.
- Delić, V., Sečujski, M., Vujnović Sedlar, N., Mišković, D., Mak, R., Bojanić, M. (2014). How Speech Technologies Can Help People with Disabilities, *Proc. of 16th Int. Conf. Speech and Computer (SPECOM)*, Novi Sad, Serbia, 243-250.
- Fan, Y., Qian, Y., Xie, F., Soong, F.K. (2014). TTS synthesis with bidirectional LSTM based recurrent neural networks. *Proc. of Interspeech 2014*, 1964-1968.
- Fan, Y., Qian, Y., Soong, F.K., He, L. (2015). Multi-speaker modeling and speaker adaptation for DNN-based TTS synthesis. *Proc. ICASSP 2015*, 4475-4479.
- Fernandez, R., Rendel, A., Ramabhadran, B., Hoory, R. (2014). Prosody contour prediction with long short-term memory, bidirectional, deep recurrent neural networks. *Proc. of Interspeech 2014*, 2268-2272.
- Flanagan, J. (1972). *Speech Analysis, Synthesis, and Perception*. Springer-Verlag.
- Gray, R. M. (2010). A History of Realtime Digital Speech on Packet Networks: Part II of Linear Predictive Coding and the Internet Protocol. *Foundations and Trends in Signal Processing*. 3 (4), 203-303.
- Griffin, D., Lim, J. (1984) Signal estimation from modified short-time fourier transform. *IEEE Transactions on Acoustics, Speech, and Signal Processing*, 32(2), 236-243.
- Hannun, A., Case, C., Casper, J., Catanzaro, B., Diamos, G., Elsen, E., Prenger, R., Satheesh, S., Sengupta, S., Coates, A., Ng, A.Y. (2014). Deep Speech: Scaling up end-to-end speech recognition, *Baidu Research – Silicon Valley AI Lab Technical Report*.
- Hinton, G., Deng, L., Yu, D., Dahl, G., Mohamed, A.-R., Jaitly, N., Senior, A., Vanhoucke, V., Nguyen, P., Sainath, T., Kingsbury, B. (2012). Deep neural networks for acoustic modeling in speech recognition: the shared views of four research groups. *IEEE Signal Processing Magazine*, 29 (6), 82-97.
- Hunt A., Black, A. (1996) Unit selection in a concatenative speech synthesis system using a large speech database, *Proceedings of ICASSP-96*, vol. 1, 373-376.
- Irie, K., Tüske, Z., Alkhoul, T., Schlüter, R., Ney, H. (2016). LSTM, GRU, highway and a bit of attention: an empirical overview for language modeling in speech recognition. *Proc. of Interspeech 2016*, 3519-3523.
- Jovičić, S. (1999) *Speech Communication—Physiology of Psychoacoustics and Perception*, Nauka, Belgrade, Serbia (in Serbian).
- Katz, S.M. (1987). Estimation of probabilities from sparse data for the language model component of a speech recognizer. *IEEE Transactions on Acoustics, Speech, and Signal Processing*, 35(3), 400-401.
- Klatt, D. (1987) Review of Text-to-Speech Conversion for English. *Journal of the Acoustical Society of America*, JASA vol. 82 (3), pp.737-793.
- Lea W.E. (1980). *Trends in Speech Recognition*, Prentice-Hall, Englewood Cliffs, NJ.
- Lee, C., Huo, Q. (2000). On adaptive decision rules and decision parameters adaption for ASR. *Proceedings of the IEEE 88*, 8 (2000), 1241-1269.
- MacNeilage, P. (2008). *The Origin of Speech*. Oxford: Oxford University Press.
- Marasek, K. (1997). EEG & voice quality (Tutorial). University of Stuttgart, Germany.

- McCulloch, W., Pitts, W. (1943). A Logical Calculus of Ideas Immanent in Nervous Activity. *Bulletin of Mathematical Biophysics*, 5 (4), 115-133.
- Manning, C.D., Schütze, H. (1999). *Foundations of Statistical Natural Language Processing*, MIT Press.
- Markov, A.A. (1906). Extension of the law of large numbers to random variables dependent on each other. *Herald of the Physical and Mathematical Society of the Kazan University*, 2 (15), 135-156.
- van den Oord, A., Dieleman, S., Zen, H., Simonyan, K., Vinyals, O., Graves, A., Kalchbrenner, N., Senior, A. W., Kavukcuoglu, K. (2016). WaveNet: A generative model for raw audio. *Computing Research Repository*, arXiv:1609.03499v2.
- van den Oord, A., Li, Y., Babuschkin, I., Simonyan, K., Vinyals, O., Kavukcuoglu, K., van den Driessche, G., Lockhart, E., Cobo, L.C., Stimberg, F., Casagrande, N., Grewe, D., Noury, S., Dieleman, S., Elsen, E., Kalchbrenner, N., Zen, H., Graves, A., King, H., Walters, T., Belov, D., Hassabis, D. (2018). Parallel WaveNet: Fast High-Fidelity Speech Synthesis, *Cornell University*.
- Ping, W., Peng, K., Gibiansky, A., Arik, S.O., Kannan, A., Narang, S., Raiman, J., Miller, J. (2018). Deep Voice 3: Scaling text-to-speech with convolutional sequence learning. *ICLR*.
- Rabiner L.R., Schafer, R.W. (2007). Introduction to digital speech processing, *Foundations and Trends in Signal Processing*, 1(1-2), 1-194.
- Schafer, R.W. (1994) . Scientific bases of human-machine communication by voice. In: *Voice Communication between Humans and Machines* (David B. Roe and Jay G. Wilpon, eds.), National Academy of Sciences, National Academy Press, Washington DC, 15-33.
- Sundermeyer, M., Ney, H., Schlüter, R. (2015). From feedforward to recurrent LSTM neural networks for language modeling. *IEEE/ACM Transactions on Audio, Speech, and Language Processing*, 23 (3), 517-529.
- Tamura, M., Masuko, T., Tokuda, K., Kobayashi, T. (2001). Text-to-speech synthesis with arbitrary speaker's voice from average voice, *Proc. of Eurospeech*, 345-348.
- Tokuda, K., Masuko, T., Yamada, T., Kobayashi T., Imai, S. (1995). An Algorithm for Speech Parameter Generation from Continuous Mixture HMMs with Dynamic Features, *Proc. of EUROSPEECH*, 757-760.
- Tokuda, K. Masuko, T. Miyazaki N. and Kobayashi, T. (1999). Hidden Markov Models Based on Multi-Space Probability Distribution for Pitch Pattern Modeling, *Proc. of ICASSP*, 229-232.
- Vishnubhotla, R., Fernandez, S., Ramabhadran, B. (2010). An autoencoder neural- network based low-dimensionality approach to excitation modelling for HMM-based text-to-speech. *Proc. ICASSP 2010*, 4614-4617.
- Viterbi, A.J. (1967). Error bounds for convolutional codes and an asymptotically optimum decoding algorithm. *IEEE Transactions on Information Theory*, 13 (2): 260-269.
- Werbos, P.J. (1974). Beyond Regression: new tools for prediction and analysis in the behavioral sciences, Ph.D. Thesis, Harvard University, Cambridge, MA.
- Wu, Z., Swietojanski, P., Veaux, C., Renals, S., King, S. (2015). A study of speaker adaptation for DNN-based speech synthesis. *Proc. Interspeech 2015*, 879-883.
- Xiong, W., Droppo, J., Huang, X., Seide, F., Seltzer, M., Stolcke, A., Yu D., Zweig, G. (2016). Achieving human parity in conversational speech recognition, *Microsoft Research Technical Report MSR-TR-2016-71*.
- Yamagishi, J., Masuko, T., Kobayashi, T. (2004). HMM-based expressive speech synthesis – Towards TTS with arbitrary speaking styles and emotions, *Proc. of Special Workshop in Maui (SWIM)*.
- Yoshimura, T., Tokuda, K., Masuko, T., Kobayashi, T., Kitamura, T. (1999) Simultaneous modeling of spectrum, pitch and duration in HMM-based speech synthesis. *Proc. of Eurospeech*, 2347-2350.
- Zen, H., Senior, A., Schuster, M. (2013). Statistical parametric speech synthesis using deep neural networks. *Proc. ICASSP 2013*, 7962-7966.
- Zen, H., Senior, A. (2014). Deep mixture density networks for acoustic modelling in statistical parametric speech synthesis. *Proc. ICASSP 2014*, 3844-3848 (2014).

Percepcija govora u nepovoljnim komunikativnim uslovima: savremeni pogledi

Slobodan Jovičić

APSTRAKT

Govorna komunikacija se odvija svakodnevno u različitim okolnostima koje utiču pre svega na kvalitet komunikacije a potom i na razumljivost. Najranija istraživanja su se odnosila na nepovoljan uticaj ambijenta u kome se komunikacija odvija (buka, reverberacija, izobličenja telekomunikacionog kanala). Kasnije su se istraživanja proširila na produkciju i percepciju govora imajući u vidu artikulaciona odstupanja (patologija u glasu) i probleme slušnog mehanizma (uz upotrebu slušnih aparata i kohlearnih implanta). Sa razvojem istraživanja moždanih funkcija produkcija i percepcija govora su počele da se sagledavaju sa kognitivnog nivoa. Ovaj pregledni rad je posvećen integralnom prikazu nepovoljnih uslova komuniciranja sa naglaskom na adaptivnu plastičnost kognitivnih funkcija. U prvom delu rada napravljen je osvrt na uslove komuniciranja koji utiču na varijabilnosti u produkciji i percepciji govora. Zatim je na modelu pre-leksičke percepcije analiziran proces detekcije akustičkih karakteristika u govornom signalu, njihova integracija u distinktivne karakteristike i prepoznavanje osnovnih lingvističkih jedinica, stavljajući ovaj proces u kontekst neuralne organizovanosti. Drugi deo rada analizira uticaj kognitivnih funkcija na govor u nepovoljnim uslovima komuniciranja. Obuhvaćene su kognitivne funkcije kao što su prediktivno kodovanje u percepciji govora, redukcija pažnje, redukcija memorijskog kapaciteta, perceptivno učenje i perceptivne interferencije. Posebno su interesantni brzi adaptivni mehanizmi u percepciji govora koji prihvataju kratkovremene devijacije u ulaznom govoru balansirajući između potrebe za stabilnošću i adaptivne plastičnosti u funkciji očuvanja naučenih dugovremenih normi maternjeg jezika.

Ključne reči: govor, percepcija govora, adaptivna plastičnost, kognitivne funkcije

1 UVOD

U svakodnevnoj govornoj komunikaciji slušalac percipira govor u veoma širokom spektru suboptimalnih ili nepovoljnih okolnosti. Pod optimalnim uslovima slušanja podrazumeva se komunikacija na maternjem jeziku zdrave osobe sa fokusiranom pažnjom u tihom ambijentu. Sa druge strane, pod nepovoljnim okolnostima podrazumevaju se svi faktori koji utiču na otežanu ili smanjenu razumljivost govora. Na primer, u nepovoljne okolnosti spada bučni ambijent, devijacije u produkciji govora ili u slušnom mehanizmu, pojava stresa u komunikaciji, komunikacija sa osobom sa drugim maternjim jezikom i slično (Assmann, P., & Summerfield, Q., 2004). Takve okolnosti prouzrokuju kratkotrajne devijacije u govoru koje odstupaju od dugotrajno usvojenih normi (znanja) datog jezika. Slušalac je u tom slučaju prinuđen da brzo mapira govorni akustički signal u dugotrajno znanje. Ove adaptivne promene u percepciji govora pod dejstvom izobličenja govornog signala u nepovoljnim uslovima komuniciranja u literaturi su na različite načine definisane kao "perceptivno učenje", "adaptacija", "rekalibracija", "ponovno podešavanje" sa najnovijim terminom "adaptivna plastičnost" (Guediche et al., 2014) i idejom da on može biti generalno prihvatljiv u različitim oblastima gde god se analizira govor, od akustike do kognicije.

Cilj ovog rada je da prikaže formalnu klasifikaciju nepovoljnih uslova u kojima se govorna komunikacija može naći, kao i kognitivne efekte u okviru kojih se adaptivna plastičnost manifestuje tokom percepcije govora.

Klasifikacija nepovoljnih uslova komuniciranja

Nepovoljni uslovi komuniciranja mogu biti mnogobrojni i raznovrsni ali se mogu generalno klasifikovati prema poreklu i efektu. Kada je poreklo u pitanju oni mogu biti spoljašnji u odnosu na slušaoca, recimo buka ili nepravilan izgovor govornika, ili unutrašnji, na primer kognitivno opterećenje ili redukcija memorijskog kapaciteta. Njihovi efekti se primarno odražavaju na degradaciju percepcije govora u domenu mentalnih predstava, lingvističkih funkcija, kognitivnih mehanizama, sa efektima adaptivne plastičnosti. Drugačiji pristup u klasifikaciji je moguć već prema mestu u komunikativnom lancu, gde se nepovoljni uslovi mogu pojaviti na strani govornika, u komunikacionom kanalu i na strani slušaoca. Ovaj pristup će biti elaboriran u daljem tekstu.

Degradacije u produkciji govora

U pravilnom spontanom govoru, bez patoloških manifestacija, mogu se pojaviti disfluencije kao što su redukcija, izostavljanje ili brisanje segmenata, ili promena tempa i ritma (Ernestus et al., 2002; Smiljanic & Bradlow, 2009), što u krajnjem slučaju može uticati na razumljivost govora. Poseban oblik disfluencija su ponavljanje, ponovno startovanje ili ubacivanje govornih segmenata, što sve zajedno utiče na kvalitet glasa i govora.

Kada se govori o akcentovanom govoru mogu se pojaviti dve situacije percepcija stranog govora i percepcija nefamilijarnog maternjeg govora (Bradlow & Bent, 2008). U oba slučaja akcentuacija se manifestuje varijacijama na segmentnom i suprasegmentnom planu, čiji rezultat jeste segmentna i leksička dvoznačnost, otežano mapiranje, i povećan napor perceptivnog procesiranja.

Odstupanja neurogene i anatomske prirode u produkciji govora mogu uneti značajne degradacije u govorni signal. Za posledicu neurogenih odstupanja, kao što su dizartrija i apraksija, javljaju se problemi sa kvalitetom glasa, koartikulacijom, izmenjenim formantnim strukturama, ritmom, itd. Kao posledica anatomske odstupanja javljaju se artikulacioni poremećaji ili dislalije zbog kojih nastaju distorzije glasova (razni oblici sigmatizama), omisija i supstitucija glasova, nazalizacija, hiper-glotalizacija, itd. (Vladislavljević, 1981).

Na produkciju govora utiču i mnoge psihoemotivne reakcije čovekovog organizma. Bez obzira da li se radi o eustresu ili distresu nastale varijacije u govoru mogu biti veoma značajne (Rajković et al., 2018; Zdravković et al., 2019).

Poseban oblik degradacije u produkciji govora je šapat. To je govor bez zvučnosti (bez laringealnih vibracija), u tihom ambijentu veoma dobro razumljiv ali je slabog intenziteta i lako podložan maskiranju ambijentalnim smetnjama (Grozdić & Jovičić, 2017). Značajan je u govornim tehnologijama kod prepoznavanja govora.

Degradacije komunikacionog kanala

Pod komunikacionim kanalom se podrazumeva medijum između govornika i slušaoca. To može biti akustički ambijent ili bilo koji telekomunikacioni kanal. Poznato je da razumljivost govora opada sa rastojanjem između govornika u otvorenom ambijentu. Da bi očuvali razumljivost govornici podižu intenzitet govora. Slično se dešava i kada je govor maskiran ambijentalnom bukom a podizanje intenziteta govora je poznato kao Lombardov efekat. Poseban oblik maskiranja nastaje usled efekta reverberacije u zatvorenim prostorima. U ovom slučaju identitet vokala je bolje očuvan u odnosu na identitet konsonanata.

Kvalitet percepcije maskiranog govora zavisi od karakteristika maskirajućeg signala. Percepcija govora može biti značajno očuvana u slučaju stacionarnog maskirajućeg signala (šum, buka) i značajnije zavisi od njegovih spektralnih karakteristika. Međutim, ako je maskirajući signal govorni signal, tzv. "cocktail party" situacija, tada se percepcija značajno usložnjava, sve zavisi od broja govornika u maskirajućem signalu. U koliko je reč o prostornoj raspodeli govornika onda se percepcija bazira na prostornoj separaciji maskirajućih govornika i na selektivnoj pažnji. Prostorna separacija se bazira na lokalizaciji govornika na bazi vremensko-spektralnih karakteristika, dok selektivna pažnja podrazumeva lingvističko praćenje aktuelnog govornika. U ovom drugom slučaju reč je o informacionom maskiranju.

Posebnu degradaciju u govorni signal mogu uneti karakteristike prenosnog telekomunikacionog kanala. Najčešće je reč o frekvencijsko-amplitudskim karakteristikama.

Treba napomenuti važnu činjenicu da kada su sagovornici svesni degradacije govornog signala oni pokušavaju da ih u svom govoru kompenzuju. Ali i to zavisi od okolnosti u kojima se konverzacija obavlja. Na primer, u telefonskom razgovoru sagovornici retko pokušavaju da kompenzuju degradacije, dok u bučnom ambijentu instiktivno koriguju svoju artikulaciju. Slične kompenzacije kod govornika nalazimo u komunikaciji sa slušaocem oštećenog sluha ili sa slušaocem ne maternjeg jezika, kada govornik adaptira svoj govor u cilju poboljšanja razumljivosti u komunikaciji (Smiljanic & Bradlow, 2009; Hazan & Baker, 2011).

Degradacije u percepciji govora

Na nepovoljne komunikativne uslove utiču i perceptivne i kognitivne sposobnosti slušaoca. Prvi kontakt sa govornim akustičkim signalom uspostavlja slušni mehanizam. Oštećenje sluha može značajno degradirati komunikaciju a nivo degradacije zavisi od stepena slušnog oštećenja kao i od vrste upotrebljenog slušnog pomagala (slušni aparat, kohlearni implant). Za razliku od ambijentalnih degradacija koje su varijabilne u vremenu, degradacije slušnog mehanizma su stabilne.

U komunikaciji sa osobom koja je izvorni govornik stranog jezika česti su problemi nedovoljnog poznavanja tog stranog jezika (Garcia Lecumberri et al., 2010). Ova degradacija u komunikaciji se pojačava ako se ona odvija u bučnom ambijentu (Rogers et al., 2006).

Neurološki deficiti nastali povredama mozga, kao što su auditorna verbalna agnozija, kortikalna gluvoća, Wernicke-ova afazija, mogu značajno otežati prepoznavanje govora (Badecker, 2005). Efekti ovih povreda se mogu ispoljiti u akustičko-fonetskoj diskriminaciji, kategorizaciji fonema, prozodijskom opažanju, leksičkoj aktivaciji i/ili inhibiciji, kratkovremenoj memoriji, sintaksičkom parsiranju, semantičkom razumevanju, itd.

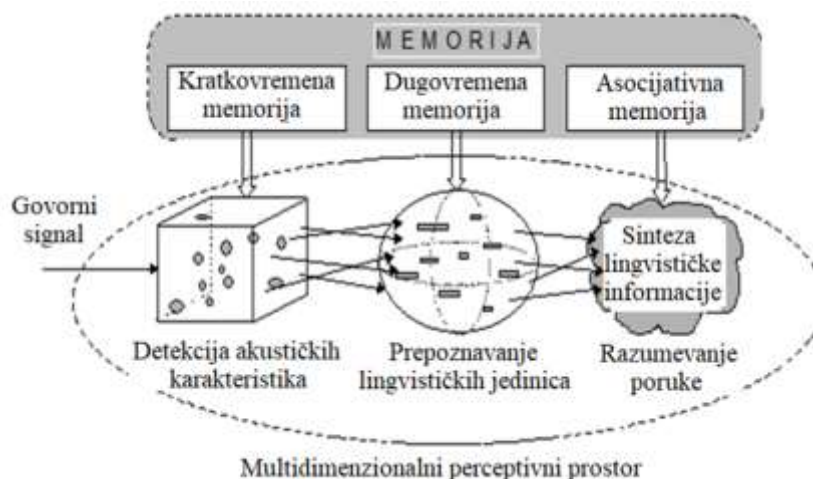
Degradaciji u percepciji i razumevanju govora doprinosi i kognitivno opterećenje, što podrazumeva angažovanje kognitivnih resursa na druge procese a ne na govor. Ono može biti nesvrishodno kada su mentalne aktivnosti angažovane u percepciji buke pored govora ili svrshodno kada se tokom slušanja govora angažuju memorijska pažnja i mnemonički resursi u tumačenju lingvističkih kompleksnosti kao što su kompleksna sintaksa ili diskursne strukture (Mattys, & Wiget, 2011).

Poznato je da stres utiče na funkcije celog organizma (Henckens et al., 2009; Jovićić & Zdravković, 2019) a posebno na mozak. Pod dejstvom stresa mnoge funkcije mozga su pobuđene, kao na primer koncentracija, radna memorija, učenje, rezonovanje, mišljenje, kao i mentalno zdravlje (psihoze, depresija, anksioznost, fobija), disorijentacija, itd. Dakle, stres utiče kako na produkciju tako i na percepciju govora.

Pre-leksički nivo percepcije

Da bismo bolje razumeli adaptivnu plastičnost u percepciji govora pogledajmo najpre šta se dešava na prvom nivou percepcije, na pre-leksičkom nivou percepcije, gde se vrši konverzija akustičkog govornog signala u neuralne predstave osnovnih perceptivnih jedinica.

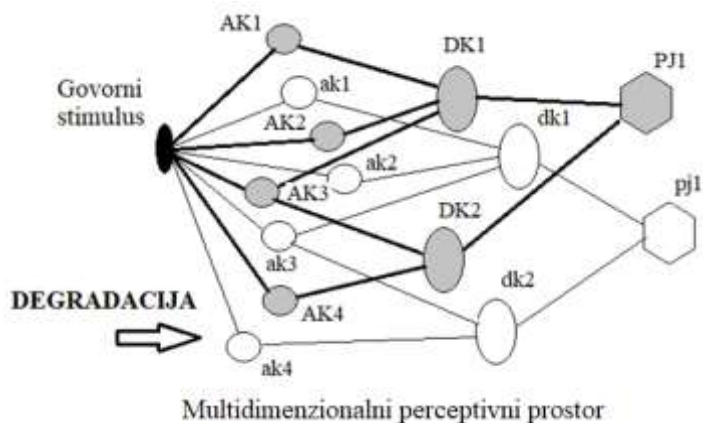
Govorni signal stiže do uva slušaoca kao akustički signal koji se uvom prihvata i prosleđuje u kohleu (unutrašnje uvo) gde se konvertuje u neuralne impulse. Ovi impulsi se slušnim nervima sprovode do slušnih centara u mozgu gde se detektuju određene karakteristike govornog signala i dalje konvertuju (mapiraju) u određene lingvističke pojmove. Na slici 1 prikazan je osnovni model percepcije govora (adaptacija slike iz Jovićić, 1986).



Slika 1. Model percepcije govora.

U govornom signalu se najpre detektuju akustičke karakteristike (osnovna frekvencija zvučnih glasova i njena kontura, položaj i tranzicije formanta vokala, spektralni koncentri konsonanata, trajanje i intenzitet glasova, VOT kod ploziva, itd.) koje se dalje integrišu u lingvističke jedinice (foneme, slogove, reči). Na kraju se vrši sinteza lingvističke informacije i razumevanje govorne poruke. U celom ovom procesu učestvuju kratkovremena memorija, dugovremena memorija i asocijativna memorija. Treba imati u vidu da se govorni akustički (fizički) signal detekcijom akustičkih karakteristika mapira u multidimenzionalan perceptivni prostor.

U teoriji percepcije govora poznato je da je odnos distinktivnih karakteristika (na primer: zvučnost, nazalnost, kompaktnost, strujnost, itd.) i akustičkih karakteristika 1:n, što znači da u prepoznavanju distinktivne karakteristike učestvuje nekoliko, tj. n , akustičkih karakteristika (Jovićić, 1999). Nakon integracije akustičkih karakteristika (AK) sledi integracija distinktivnih karakteristika (DK) u prepoznavanju osnovnih lingvističkih jedinica (PJ), itd. (slika 2). Ovo je sekvencijalni postupak u pre-leksičkom prepoznavanju, kao prvom nivou u prepoznavanju govora.

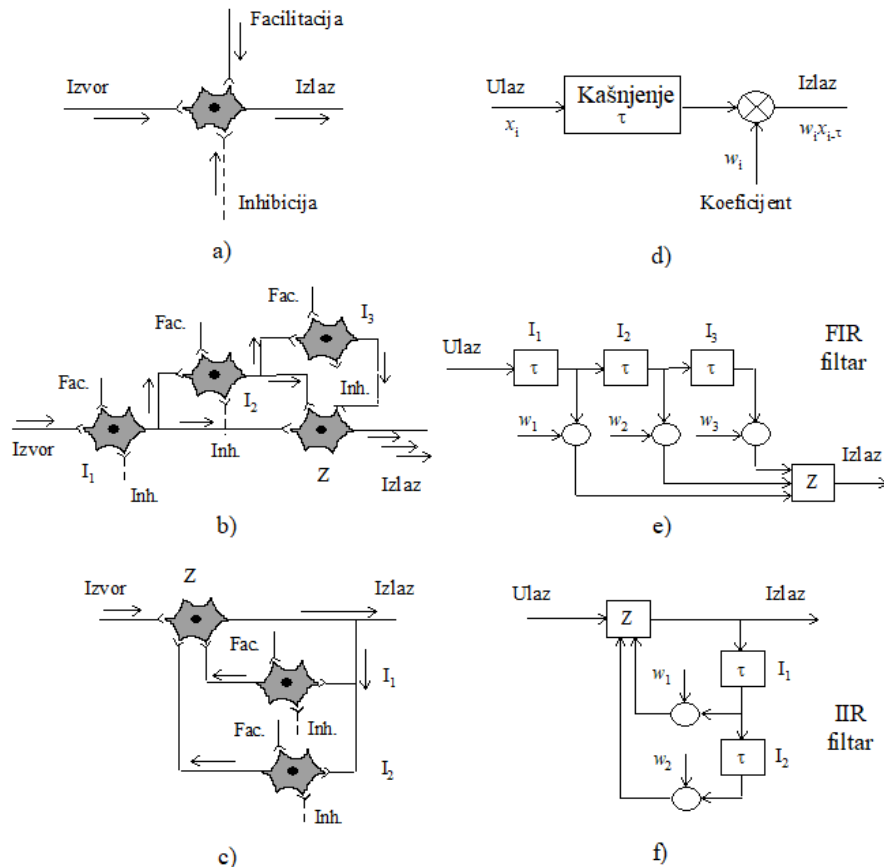


Slika 2. Uticaj degradacije na akustičke karakteristike i proces pre-leksičkog prepoznavanja.

Šta se dešava kada degradacija deluje na govor u ovoj fazi prepoznavanja? Degradacija, na primer buka, kao aditivna smetnja na govorni signal deluje na akustičke karakteristike koje u procesu detekcije dobijaju nove vrednosti (ak), slika 2, prouzrokujući njihovo dislociranje u multidimenzionalnom prostoru.

Dalja njihova integracija dovodi do pomeranja distinktivnih karakteristika (dk) te do pogrešne interpretacije perceptivne jedinice (pj). Zbog toga se u eksperimentima sa razumljivošću reči u šumu često čuje umesto *kuće* - *kuče*, umesto *taj* - *daj*, itd. Ova konfuzija u percepciji zavisi primarno od karakteristika degradirajućeg signala ali i od koncentracije slušaoca, njegovog kognitivnog opterećenja i slično, o čemu će biti više reči u daljem tekstu.

Značajno je u ovom kontekstu ukazati na analogiju neuronskih struktura kod detektora akustičkih karakteristika i elektronskih struktura digitalnih filtara. Na slici 3 prikazano je nekoliko ovih struktura (Jovičić, 1999). Na slici 3a šematski je predstavljen jedan neuron sa jednim aksonskim izlazom i tri dendridska ulaza od kojih dva imaju funkciju facilitacije i inhibicije prolaza nervnog impulsa kroz neuron. Na slici 3d prikazana je elektronska analogija neurona sa ponderišućim težinskim koeficijentom w_i koji aproksimira funkcije inhibicije i facilitacije i elementom za kašnjenje τ koji aproksimira vreme propagacije nervnog impulsa kroz neuron. Ovakav model neurona odgovara osnovnoj ćeliji digitalnih filtara.



Slika 3. Analogija između struktura neuronskih veza (a, b, c), i elektronskih struktura (d, e, f) (Jovičić, 1986).

Propagaciju nervnih impulsa, sa aspekta detekcije akustičkih signala u govornom signalu, obezbeđuju lančane veze neurona u formi paralelnih veza i oscilatornih veza (tzv. reverberantni krugovi) (Pašić, 1987), koje imaju potpunu analogiju u elektronskom domenu sa FIR i IIR digitalnim filtrima, slike 3b, 3e, 3c i 3f (Milić & Dobrosavljević, 2004). Pomoću ovakvih filtara moguće je realizovati detektore akustičkih karakteristika, na primer za detekciju osnovne frekvencije govora, formanta vokala, spektralnih koncentrata konsonanata i slično (Delgutte & Kiang, 1984).

Važno je u kontekstu diskusije o adaptivnoj plastičnosti u percepciji govora u nepovoljnim komunikativnim uslovima, a imajući u vidu i neuroplastičnost mozga, uočiti da se različite strukture neuronskih mreža mogu formirati, kontrolisati i/ili menjati funkcijama inhibicije i facilitacije.

Adaptivna plastičnost u percepciji govora

Percepcija glasova podrazumeva "mapiranje" akustičkih karakteristika govornog signala, koje kontinualno variraju duž svojih dimenzija u multidimenzionalnom prostoru, u dugovremene reprezenate (foneme, reči) maternjeg jezika. Sa aspekta adaptivne plastičnosti, posebno u nepovoljnim uslovima komuniciranja, ovo mapiranje je veoma kompleksno. Kompleksnost mapiranja zavisi od prirode i količine izgubljenih informacija u govornom stimulusu nastalih dejstvom nepovoljnih uslova komuniciranja. Gubitak informacija najčešće dovodi do višeznačnosti govornog stimulusa. Na primer, glas sa dvoznačnim akustičkim obeležima koji se perceptivno nalazi između glasova /k/ i /g/ prepoznaće se kao /k/ u kontekstu *_uca* (*kuca* je reč a *guca* nije) a kao /g/ u kontekstu *_ađa*. Značajno je uočiti da kontekst odlučuje o pravoj interpretaciji glasova /k/ i /g/.

Sledeći primer pokazuje kako gubitak informacije utiče na perceptivnu restauraciju nedostajućeg fonema (perceptivna iluzija) u zavisnosti od lingvističkog okruženja (Antešević & Jovičić, 2000). U eksperimentu je analizirana razumljivost reči sa nedostajućim (izbrisanim) inicijalnim fonemom; obuhvaćene su jednosložne, dvosložne i trosložne reči. Razumljivost reči je iznosila: kod jednosložnih 51% a kod dvosložnih i trosložnih 89%. Vidi se kako viši jezički nivoi (fonološki i morfološki) utiču na restauraciju nedostajućeg fonema. U drugom eksperimentu analiziran je uticaj tri tipa rečeničnog okruženja na percepciju reči sa nedostajućim inicijalnim fonemom. Prvi tip stimulusa čine gramatički ispravne i smislene rečenice (rečenice sa korektnom sintaksom i semantikom, tip rečenice I). Drugi tip stimulusa su rečenice sa korektnom sintaksom i nekorektnom semantikom (tip rečenice II), i treći tip stimulusa čine rečenice sastavljene od nepovezanih reči, odnosno, sa nekorektnom i sintaksom i semantikom (tip rečenice III). Rezultati su dati u tabeli 1a.

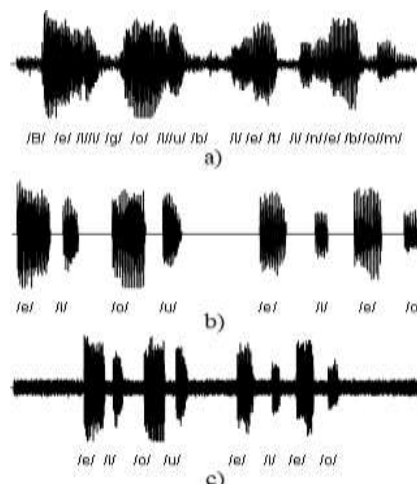
Tabela 1a Rezultati analize uticaja tri tipa rečeničnog okruženja na percepciju reči

Razumljivost	I	II	III
Rečenice	94%	85%	59%
Ključne reči	95%	88%	68%

Dakle, kontekstualne informacije na različitim lingvističkim nivoima mogu doprineti znatnom poboljšanju razumljivosti govornog stimulusa. Međutim, izvor kontekstualnih informacija može biti ne samo akustički, leksički ili na nivou rečenice, već i vizuelni. Poznat je McGurk-ov efekat kada se dodatkom vizuelne informacije može značajno povećati razumljivost govora u buci visokog nivoa (McGurk & MacDonald, 1976). Takođe, u eksperimentu Jovičić & Antešević (2000) pokazano je da dodatna informacija može biti sasvim druge prirode u odnosu na govornu poruku. Na slici 4a prikazana je talasna forma jedne rečenice, na slici 4b u datoj rečenici su izbrisani svi konsonanti a na slici 4c je celokupna rečenica bez konsonanata maskirana šumom. Dakle, dodatkom akustičkog šuma određenog nivoa, u normalnoj komunikaciji to je smetnja, povećana je razumljivost i reči i rečenica. Ovakav rezultat je protumačen ne samo kao restauracija konsonanata, u smislu prethodnog eksperimenta, već i restauracija kontinuiteta artikulacije što jeste prirodan tok u produkciji govora (Tabela 1b).

Tabela 1b Tabela 1a Rezultati analize uticaja tri tipa rečeničnog okruženja na percepciju reči

Razumljivost	Rečenice	Reči
Izbrisani konsonanti	58%	81%
Maskirane rečenice	77,5%	89%



Slika 4. Perceptivna restauracija konsonanata u rečenici.

Kognitivni efekti u percepciji govora u nepovoljnim uslovima

Jedan od kognitivnih efekata koji izaziva degradirani govor jeste *redukcija pažnje*. Na primer u slučaju informacionog maskiranja (u pitanju je semantički sadržaj), kada imamo kao smetnju drugog govornika ili više govornika (tzv. "cocktail party" efekat), slušalac mora svoju pažnju da fokusira na aktuelnog govornika (Cooke et al, 2008). To je tzv. "selektivna pažnja" ili "podeljena pažnja" kada je više ometajućih govornika u pitanju. Međutim, nije samo u pitanju redukcija pažnje na lingvističkom planu već i povećan napor u slušanju govora u nepovoljnim uslovima. Ovaj napor je veći ukoliko je razumljivost govora manja (na primer, govor u buci).

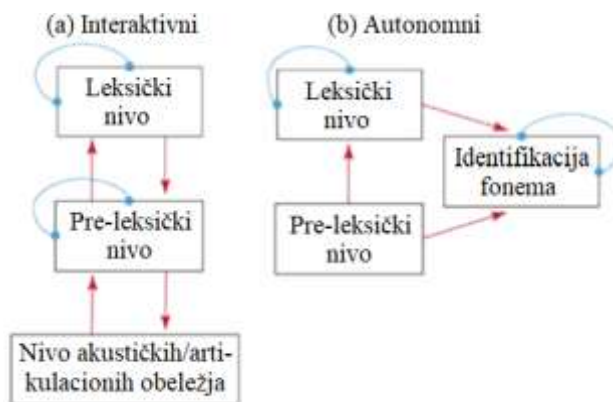
Sledeći kognitivni efekat pod dejstvom nepovoljnih uslova slušanja govora jeste *redukcija memorijskog kapaciteta*. Termin "redukcija" upotrebljen je u literaturi u smislu zahteva za angažovanjem većih resursa radne memorije u nepovoljnim uslovima komuniciranja; samim tim ostaje manje memorijskog prostora za druge aktivnosti. Na primer, slušanje više govornika zahteva više radne memorije nego kada se sluša samo jedan govornik, ili prepoznavanje degradiranog govora, govora u šumu ili žamoru (Francis, 2010), itd. Ovi efekti su posebno izraženi kod starijih osoba.

Prethodni efekti nastaju kao trenutna posledica dejstva nepovoljnih uslova slušanja. Međutim, postoji jedan kognitivni proces koji se javlja posle procesa prepoznavanja govornog stimulusa a koji podešava perceptivni sistem za bolje razumevanje ne aktuelnog stimulusa već narednih stimulusa. Reč je o *perceptivnom učenju* koga je Goldstone (1998) definisao kao "relativno dugovremene promene čovekovog perceptivnog sistema koje mu omogućavaju da poboljša njegov odgovor na ambijent u kome se nalazi a koji je izazvao te promene." Perceptivno učenje se tiče viših nivoa znanja i pojavljuje se nakon uspešnog prepoznavanja (Samuel & Kraljic, 2009). Međutim može izostati, na primer, u slučaju nestacionarnosti maskirajućih efekata na govorni stimulus što sprečava efektivno podešavanje procesa perceptivnog učenja. Dva mehanizma perceptivnog učenja su značajna u realizaciji adaptivne plastičnosti: *nadgledano učenje* i

nenadgledano učenje (Wolpert et al, 2011). Algoritam nenadgledanog učenja učestvuje u formiranju sadržaja dugovremene memorije, koji se može dopunjavati ili menjati dugotrajnim treninzima. Nadgledanim učenjem optimizira se predikciona greška u percepciji govornog stimulusa aktivnošću malog mozga (Guediche et al, 2014; Vias & Dick, 2017). Obe vrste učenja doprinose adaptivnoj plastičnosti perceptivnog mehanizma u njegovom naporu da prepozna ulazni stimulus koji odstupa od jezičke norme datog jezika.

Istraživanja u oblasti neuronauka koja se odnose na adaptivnu plastičnost u percepciji govora u nepovoljnim uslovima uglavnom su doskora bila fokusirana na aktivnosti velikog mozga a manje na subkortikalne strukture kao što su talamus ili mali mozak (Erb et al, 2013). Poznata je uloga malog mozga u generisanju i kontroli motornih funkcija organizma, uključujući i produkciju govora, u interakciji sa prirodnim okruženjem (Ebner, 2013), ali njegova uloga u precepciji govora i razumevanju jezika je još uvek misterija. Produkcija govora zahteva preciznu vremensku kontrolu u pokretima artikulacionih organa, kako bi se produkovao razumljiv govor, koja se može ostvariti putem kognitivnih aktivnosti brze adaptacije i predikcije. Moberget i Ivry (2016) su dokazali da mali mozak doprinosi procesima tajminga, adaptacije i predikcije ne samo kod motornih funkcija već i kod percepcije govora i razumevanja jezika. Na primer, precizno vremensko procesiranje je važno u fonemskoj diskriminaciji kod percepcije okluzije kod ploziva u medijalnoj poziciji u rečima "meta" i "meda", i zbog toga osobe sa lezijom malog mozga ne mogu napraviti ovu diskriminaciju. Najnovija gledišta o istovetnoj ulozi malog mozga u kontroli motornih funkcija organizma i u kognitivnim funkcijama mišljenja i emocija (Schmahmann et al, 2019) ima značajne reperkusije na tumačenje produkcije i percepcije govora, odnosno na upotrebu istih kognitivnih mehanizama u njihovim realizacijama. Samim tim i adaptivna plastičnost je prisutna u mnogim kognitivnim funkcijama.

McClelland et al, (2006) su razmatrali pitanje dva modela percepcije govora (slika 5) sa aspekta funkcije leksičkih informacija, posebno kada su glasovi dvosmisleni ili degradirani. U interaktivnom modelu tok informacija je bidirekcionalan omogućavajući leksičkom znanju da utiče na pre-leksičke procese. U autonomnom modelu tok informacija je jednosmeran dok leksičko znanje utiče nakon post-perceptualnog procesa. U nepovoljnim uslovima komuniciranja prednost su dali interaktivnom modelu.



Slika 5. Interaktivni i autonomni model percepcije govora.

Imajući u vidu hijerarhijsku strukturu modela percepcije govora (slika 5a) najnovija gledišta (Guediche et al, 2014) ističu da bi model prediktivnog kodovanja mogao biti koristan okvir za razumevanje procesiranja govora pa samim tim i adaptivne plastičnosti. Naime, hijerarhijska struktura podrazumeva povratne veze sa viših na niže nivoe percepcije. Perceptivni mehanizam vrši predikciju ulaznog stimulusa koji se na nižem nivou poredi sa aktuelnim ulaznim stimulusom i bilo kakvo nesaglasje, ili razlika, generiše signal interne predikcione greške. Ovaj signal vrši adaptivno podešavanje interne predikcije kako bi se u narednom ciklusu smanjila predikciona greška. Ovakva gledišta mogu objasniti adaptivnu plastičnost kod rapidnih promena u percepciji govora u nepovoljnim uslovima.

Poznato je da mozak integriše ulaznu senzorsku informaciju sa prethodnim perceptivnim, motornim i kognitivnim znanjima da bi postigao jedinstveno perceptivno iskustvo. Korišćenjem najnovijih tehnika funkcionalne vizualizacije mozga (*functional neuroimaging*) opisani kognitivni efekti tokom percepcije govora u nepovoljnim komunikativnim uslovima počinju da otkrivaju kortikalne mreže angažovane u ovim zadacima pre svega u frontalnim i temporalnim regijama mozga (Obleser et al, 2007; Obleser & Kotz, 2011; Davis et al, 2011; Guediche et al, 2013).

2 ZAKLJUČAK

Cilj ovog rada je bio da sagleda savremene trendove u istraživanjima percepcije govora u nepovoljnim komunikativnim uslovima pre svega u kognitivnom domenima. Bilo kakva degradacija govornog signala na ulazu u auditorni sistem dovodi do odstupanja od naučenih, usvojenih i memorisanih jezičkih normi datog jezika. Razlike između ovih normi i karakteristika ulaznih stimulusa mozak svojom plastičnošću, koristeći predikciju, predikcionu grešku i adaptabilnost, pokušava da razume ne narušavajući jezičke norme. Pri tome očuvanje balansa između stabilnosti i plastičnosti je od primarne važnosti. Mnogi detalji o predikciji, predikcionih grešci i učenju tek treba da budu otkriveni. Uprkos mnogim saznanjima kako pojedine kortikalne regije doprinose dinamičkom adaptivnom procesiranju govora, uz korišćenje najnovijih tehnika funkcionalne vizualizacije mozga kao što su PET (pozitronska emisiona tomografija), fMRI (funkcionalna magnetna rezonanca), EEG (multikanalna elektroencefalografija), MEG (magnetoencefalografija), nema još formalnog modela percepcije govora koji bi objasnio ove neuralne mehanizme. Sledeće generacije modela treba da protumače kako se adaptivne promene u percepciji govora reflektuju na moždane aktivnosti i kako, što je možda još najvažnije, ove promene ne narušavaju stabilnost sadržaja dugovremene memorije.

Zahvalnost: Ovo istraživanje je urađeno u okviru projekta OI178027 finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.

REFERENCE:

- S. Antešević, S., & Jovičić, S.T. (2000). Analiza uticaja viših lingvističkih nivoa na perceptivnu restauraciju fonema. Konferencija Digitalna Obrada Govora i Slike, DOGS, Novi Sad.
- Assmann, P., & Summerfield, Q. (2004). The perception of speech under adverse conditions. In S. Greenberg & W. Ainsworth (Eds.), *The auditory basis of speech perception* (pp. 231-308). Berlin: Springer.
- Badecker, W. (2005). Speech perception following focal brain injury. In D.B. Pisoni & R.E. Remez (Eds.), *The handbook of speech perception*, 524-545. Oxford: Blackwell Publishing.
- Bradlow, A. R., & Bent, T. (2008). Perceptual adaptation to non-native speech. *Cognition*, 106, 707-729.
- Cooke, M. P., Garcia Lecumberri, M. L., & Barker, J. (2008). The foreign language cocktail effect party problem: Energetic and informational masking effects in non-native speech perception. *Journal of the Acoustical Society of America*, 123, 414-427.
- Davis, M. H., Ford, M. A., Kherif, F., & Johnsrude, I. S. (2011). Does semantic context benefit speech understanding through “top-down” processes? Evidence from time-resolved sparse fMRI. *J. Cogn. Neurosci.* 23, 3914–3932.
- Delgutte, B., & Kiang, N.Y.S. (1984). Speech coding in the auditory nerve: I. Vowel - like sounds; II. Processing schemes for vowel-like sounds; III. Voiceless fricative consonants; IV. Sounds with consonant-like dynamic characteristics; V. Vowels in background noise. *J. Acoust. Soc. Am.*, 75, 866-918.
- Ebner, T.J. (2013). *Cerebellum and Internal Models: Handbook of the cerebellum and cerebellar disorders*. Springer Netherlands, 1279–1295.
- Erb, J., Henry, M., Eisner, F., & Obleser, J. (2013). The brain dynamics of rapid perceptual adaptation to adverse listening conditions. *J. Neurosci.* 33, 10688–10697.
- Ernestus, M., Baayen, H., & Schreuder, R. (2002). The recognition of reduced word forms. *Brain and Language*, 81, 162-173.
- Francis, A.L. (2010). Improved segregation of simultaneous talkers differentially affects perceptual and cognitive capacity demands for recognizing speech in competing speech. *Attention, Perception, Psychophysics*, 72, 501-516.

- Garci Lecumberri, M.L., Cooke, M., & Cutler, A. (2010). Non-native speech perception in adverse conditions: A review. *Speech Communication*, 52, 864-886.
- Goldstone, R.L. (1998). Perceptual learning. *Annual Review of Psychology*, 49, 585-612.
- Grozdić, Đ.T., & Jovičić, S.T. (2017). Whispered speech recognition using deep denoising autoencoder and inverse filtering. *IEEE-ACM Transactions on Audio, Speech and Language Processing*, 25(12), 2313-2322.
- Guediche S, Holt LL, Sungjoo Lim, Patryk Laurent, & Fiez JA. (2015). Evidence for cerebellar contributions to adaptive plasticity in speech perception. *Cerebral Cortex*, 7(25), 1867-77.
- Guediche, S., Blumstein, S.E., Fiez, J.A., & Holt, L.L. (2014). Speech perception under adverse conditions: insights from behavioral, computational, and neuroscience research. *Frontiers in Systems Neuroscience*, 7:126. doi: 10.3389/fnsys.2013.00126
- Guediche, S., Salvata, C., & Blumstein, S. E. (2013). Temporal cortex reflects effects of sentence context on phonetic processing. *J. Cogn. Neurosci.* 25, 706-718.
- Hazan, V., & Baker, R. (2011). Acoustic-phonetic characteristics of speech produced with communicative intent to counter adverse listening conditions. *Journal of the Acoustical Society of America*, 130, 2139-2152.
- Henckens, M.J.A.G., Hermans, E.J., Pu, Z., Joëls, M., & Fernández, G. (2009). Stressed memories: How acute stress affects memory formation in humans. *The Journal of Neuroscience*, 29, 10111-10119.
- Jovičić, T.S. (1986). *Prilog analizi razumljivosti govornog signala u prisustvu akustičkog šuma*. Doktorska disertacija, Elektrotehnički fakultet, Univerzitet u Beogradu.
- Jovičić, T.S. (1999). *Govorna komunikacija: fiziologija, psihoakustika i percepcija*. Nauka, Beograd.
- Jovičić, T.S., & Antešević, S. (2000). Uticaj perceptivne restauracije fonema na razumljivost govora. *TELFOR 2000*, Beograd.
- Jovičić, S., & Zdravković, S. (2019). Uticaj stresa na verbalnu ekspresiju: fiziologija, psihologija i praktične implikacije. *Tematski zbornik: Jezici i kulture u vremenu i prostoru*, Novi Sad, Vol 8, 525-538.
- Kolb, B., Muhammad, A., & Gibb, R., (2011). Searching for factors underlying cerebral plasticity in the normal and injured brain. *Journal of Communication Disorders*, 44(5), 503-514.
- Mattys, S.L., & Wiget, L. (2011). Effect of cognitive load on speech recognition. *Journal of Memory and Language*, 65, 145-160.
- McClelland, J.L., Mirman, D., & Holt, L.L. (2006). Are there interactive processes in speech perception? *Trends in Cognitive Sciences*, 10(8), 363-369.
- McGurk, H., & MacDonald, J. (1976). Hearing lips and seeing voices. *Nature*, 264, 746-748.
- Milić, Lj., & Dobrosavljević, Z. (2004). *Uvod u digitalnu obradu signala*. Akademski misao, Beograd.
- Moberget, T., & Ivry, R.B. (2016). Cerebellar contributions to motor control and language comprehension: Searching for common computational principles. *Annals of the New York Academy of Sciences*, 1369, 154-71.
- Obleser, J., Wise, R., Dresner, M., and Scott, S. (2007). Functional integration across brain regions improves speech perception under adverse listening conditions. *J. Neurosci.* 27, 2283-2289.
- Obleser, J., and Kotz, S. A. (2011). Multiple brain signatures of integration in the comprehension of degraded speech. *Neuroimage* 55, 713-723.
- Pašić, M. (1987). *Fiziologija nervnog sistema*. Naučna knjiga, Beograd.
- Rajković, M., Jovičić, S.T., Grozdić, Đ.T., Zdravković, S., & Subotić, M. (2018). A note on acoustic features in pitch contours for discrimination of happiness and anger. *Acta Acustica United with Acustica*, 104, 369-372.
- Rogers, C.L., Lister, J.J., Febor, D.M., Besing, J.M., & Abrams, H.B. (2006). Effects of bilingualism, noise, and reverberation on speech perception by listeners with normal hearing. *Applied Psycholinguistics*, 27, 465-485.
- Samuel, A.G., & Kraljic, T. (2009). Perceptual learning for speech. *Attention, Perception, Psychophysics*, 71, 1207-1218.
- Schmahmann, J.D., Guell, X., Stoodley, C.J., & Halko, M.A. (2019). The Theory and Neuroscience of Cerebellar Cognition. *Annual Review of Neuroscience*, 42, 337-364.
- Smiljanic, R., & Bradlow, A.R. (2009). Speaking and hearing clearly: Talker and listener factors in speaking style changes. *Linguistics and Language Compass*, 3, 236-264.
- Vias, C., & Dick, A.S. (2017). Cerebellar Contributions to Language in Typical and Atypical Development: A Review. *Developmental Neuropsychology*, 42(6), 404-421.
- Vladisavljević, S. (1981). *Poremećaji izgovora*. Privredni pregled, Beograd.
- Wolpert, D., Diedrichsen, J., & Flanagan, J. (2011). Principles of sensorimotor learning. *Nat. Rev. Neurosci.* 12, 739-751.
- Zdravković, S., Jovičić, S.T., & Gudurić, S. (2019). The voice and speech quality correlates of psychological observations in jungian active imagination experiment. *Journal of Psycholinguistic Research*, 48(4), 859-876.

Specifičnosti jezičkih poremećaja kod traumatskih povreda mozga¹

Mile Vuković

Univerzitet u Beogradu – Fakultet za specijalnu edukaciju i rehabilitaciju

APSTRAKT

Traumatska povreda je jedan od najčešćih uzroka oštećenja mozga u savremenom društvu. To je istovremeno i jedan od vodećih uzroka smrtnosti i morbiditeta, uz stalnu tenedenciju povećanja broja povređenih. Javlja se kod ljudi svih starosnih doba, s tim što su mladi ljudi znatno češće žrtve traumatske povrede mozga u odnosu na druge starosne grupe. Zahvaljujući napretku u medicini i tehnologiji, stepen preživljavanja povređenih je danas znatno povećan. Međutim, kod preživelih se uočavaju brojne, često dugoročne posledice na kognitivnom, govornom, jezičkom i psihosocijalnom planu. Iako su jezički poremećaji kod traumatske povrede mozga odavno dokumentovani, njihova priroda još uvek nije dovoljno razjašnjena. U početku su se jezički poremećaji ove etiologije izjednačavali s afazijom, ali je s akumulacijom empirijskih podataka utvrđeno da se oni razlikuju od klasičnih afazičkih sindroma koji se javljaju kod drugih oblika neuropatologije, kao što su cerebrovaskularna oboljenja, na primer. Jezički poremećaji kod traumatskih oštećenja mozga su obično klinički neupadljivi i ne otkrivaju se standardizovanim baterijama testova za afazije, zbog čega pacijenti često ostaju izvan procesa jezičke i kognitivne rehabilitacije. U ovom radu su razmatrani afazički i neafazički poremećaji jezika kod osoba sa traumatskom povredom mozga. Posebno je diskutovano o odnosu oštećenja jezika i drugih aspekata kognicije: pamćenja, mišljenja i egzekutivnih funkcija. Istaknute su karakteristike kognitivno-komunikacionog poremećaja. U fokusu rada je i uticaj jezičkih i kognitivnih oštećenja na funkcionisanje osobe u obavljanju profesionalnih i svakodnevnih životnih aktivnosti.

Ključne reči: afazija, neafazički poremećaj jezika, kognitivno-komunikacioni poremećaj, traumatska povreda mozga

1 UVOD

Traumatska povreda mozga (eng. *Traumatic brain injury*–TBI) podrazumeva strukturne promene moždanog tkiva i oštećenje moždanih funkcija usled delovanja spoljašnje sile (Menon et al., 2010). To je tip nedegenerativnog stečenog oštećenja mozga. Može da se javi kod ljudi svih životnih doba, s tim što su mladi muškarci najčešće žrtve moždane traume. TBI je veoma čest oblik neuropatologije. Spada u grupu vodećih uzroka smrtnosti i morbiditeta kod ljudi mlađih od 45 godina. Procenjuje se da oko 10 % povređenih završava smrtnim ishodom, dok u oko 40 % preživelih ostaju teške dugoročne posledice.

Zahvaljući napretku u medicini i tehnologiji, stopa preživljavanja nakon TBI poslednjih godina značajno je povećana. Međutim, kod većine preživelih ostaju posledice na fizičkom, govornom, jezičkom, kognitivnom i psihosocijalnom domenu. Pored povređenih, posledice povrede osećaju porodica i socijalna zajednica u kojoj osoba živi. Rehabilitacija povređenih, posebno onih s teškom povredom iziskuje velike materijalne troškove (Ponsford et al., 2013). Stoga trauma mozga, pored zdravstvenog, predstavlja i veliki socioekonomski problem.

Najčešći uzroci moždane traume u mirnodopsko vreme su saobraćajne nesreće, zatim slede padovi, fizički napadi i sportske povrede. Pored toga, sporadično se dešavaju povrede iz vatrenog oružja.

Prema težini, povreda mozga može da bude blaga, umerena i teška. Za određivanje težine moždane povrede koristi se Glasgovska skala kome - *Glasgow Coma Scale* (Teasdale & Jannet, 1974). Na osnovu te skale izračunava se *Glasgow Coma Score* (GCS) koji predstavlja zbir poena dobijenih posmatranjem

¹ Rad je proistekao iz projekta „Evaluacija tretmana stečenih poremećaja govora i jezika“ (br. 179068), finansiranog od Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije

sledeće tri funkcije: 1) otvaranje očiju, 2) govor i 3) motorni odgovori. Kod blage povrede, GCS se kreće od 13 do 15, kod umerene povrede GCS je između 9 i 12, a kod teške povrede između 3 i 8.

Osnovne karakteristike *lake povrede glave* su kratak gubitak svesti (manje od 30 minuta) i kratko trajanje postraumatske amnezije (PTA). Laka povreda obično nije praćena fokalnim znacima neurološkog oštećenja, niti oštećenjem intrakranijalne mase (CT nalaz mozga ne pokazuje promene). Bolesnici s lakom povredom u prva 24 sata ispoljavaju konfuznost, „ošamućenost“, a mogu da se jave nemir i iritabilnost. Kasnije se mogu ispoljiti slaba koncentracija, zaboravnost, usporenost, izmene ritma spavanja, anksioznost, apatija i dr. Kod nekih pacijenata ovi simptomi disfunkcije mozga brzo iščezavaju, kod drugih traju nekoliko nedelja ili meseci, dok se kod manjeg broja slučajeva oni uočavaju i nekoliko godina posle povrede.

Umerene povrede glave karakterišu duži gubitak svesti (od 30 minuta do 24 sata), višerasovno trajanje PTA, izraženi neurološki i neuropsihološki simptomi: hemipareza/hemiplegija, oštećenje kranijalnih nerava, oštećenje senzibiliteta, poremećaj ravnoteže, poremećaj govora, pamćenja i drugih kognitivnih funkcija.

Kod *teške povrede glave* javlja se gubitak svesti u dugim intervalima (preko 24 sata) i višednevno trajanje PTA. Po dolasku svesti, osobe ispoljavaju žarišne neurološke ispade: hemiparezu/hemiplegiju, oštećenje kranijalnih nerava, oštećenje senzibiliteta, poremećaj ravnoteže, poremećaj govora, spasticitet. Pacijenti su dezorijentisani u vremenu, prostoru i prema ličnostima, a mogu da se ispolje i epileptički napadi. Oporavak od teške povrede mozga može da traje godinama. Kod značajnog broja pacijenata neke funkcije (govor, jezik, pamćenje, sposobnost obrade informacija, egzekutivne funkcije) ostaju trajno oštećene. U najtežim slučajevima deterioracija kognitivnih funkcija dostiže stepen demencije (Vuković, 2012; 2019).

Simptomi oštećenja moždanih funkcija zavise od mesta i obima povrede mozga. Neki simptomi se ispoljavaju neposredno nakon povrede, dok se drugi razvijaju kasnije. Simptomatologija zavisi od anatomskih i funkcionalnih promena nervnih struktura i komorbidnih stanja (povrede drugih organa i sistema).

Tipovi traumatskog oštećenja mozga

Traumatska povreda mozga dovodi do oštećenja moždane kore po tipu kontuzije ili oštećenja bele mase hemisfera velikog mozga (difuzna aksonalna lezija). *Kontuzija (nagnječenje)* je fokalno oštećenje koje obično nastaje kontaktom između površine mozga i ispućenja kosti baze lobanje ili brze akceleracije-deceleracije (Graham, Gennarelli & Mcintosh, 2002). Uglavnom se javlja u fron-talnim i temporalnim režnjevima. Kontuziona žarišta mogu da nastanu na mestu delovanja mehaničke sile (*coup lezija*), ili na dijametralno suprotnoj strani od mesta udara (*contrecoup lezija*). Kontuzija dovodi do poremećaja stanja svesti, žarišnih neuroloških ispada i dr. U nekim slučajevima dolazi do krvavljenja u moždanom stablu, bazalnim ganglijama, talamusu i oblasti oko treće moždane komore (Gentry, 1996).

Difuzna aksonalna povreda mozga je tipična za zatvorene povrede glave. Obično je uzrokovana akceleraciono-deceleracionom povredom u saobraćajnim nesrećama, a javlja se i kao posledica pada s velike visine. Karakteriše je široko rasprostranjeno oštećenje aksona u beloj masi mozga. Oštećenjem mogu biti zahvaćene obe hemisfere, moždano stablo i cerebelum. Difuzna aksonalna povreda uzrokuje brojne neurološke i neuropsihološke poremećaje, koji obično nisu povezani sa makroskopski vidljivim lezijama mozga. Oko 30 % slučajeva s ovim tipom povrede završava smrtnim ishodom, kod jednog broja preživelih ostaju dugoročne posledice na fizičkom i psihosocijalnom planu, a kod nekih nastaje trajno vegetirajuće stanje (Graham, 1996).

Jezički poremećaji kod traumatskih oštećenja mozga

Iako se odavno zna da trauma mozga uzrokuje poremećaje jezičkih i komunikacionih sposobnosti, ovi poremećaji su počeli da privlače naučnu pažnju tek osamdesetih godina XX veka. U početku su jezički poremećaji uzrokovani traumatskom povredom mozga izjednačavani s klasičnim afazičkim sindromima, koji su tipični za cerebrovaskularna oboljenja. Međutim, brz oporavak jezičkih funkcija i nekonzistentnost simptoma karakterističnih za afazičke sindrome naveli su autore na drugačiji pristup u interpretaciji

poremećaja jezika kod osoba s moždanom traumom, od pristupa koji je uobičajen u kliničkoj afaziologiji. Tome je doprinelo i saznanje o povezanosti jezičkih poremećaja s oštećenjem kognitivnih funkcija. Poremećaji jezika kod traumatskih povreda mozga se mogu grubo podeliti na afazičke i neafazičke.

Afazije

Afazijom se označavaju jezički poremećaji uzrokovani oštećenjem mozga. Afazija primarno pogađa jezik, kao sistem objektivnih znakova koji se koriste za interpersonalnu komunikaciju, tj. sporazumevanje među ljudima. Manifestuje se fonološkim, gramatičkim i semantičkim deficitima i obično zahvata više modaliteta jezičke funkcije (spontani govor, razumevanje, ponavljanje, imenovanje, čitanje, pisanje). Primer afazičkih poremećaja jezika su dobro poznati sindromi, kao što su Brokina afazija, Vernikeova afazija, konduktivna afazija i dr.

Podaci o učestalosti afazije kod traumatskih povreda mozga variraju i kreću se između dva (Heilman, Safran & Geschwind, 1971) i trideset procenata (Sarno & Levita, 1986). Preovlađuje stav da se afazija javlja u malom procentu slučajeva, a da većina povređenih ima poremećaj jezika neafazičke prirode. Afazije se uglavnom opisuju kod projektilnih povreda ili kontuzije mozga. U populaciji s traumatskom povredom mozga, češće se dijagnostikuju fluentni nego nefluentni oblici afazija. Od klasičnih afazičkih sindroma najčešće se opisuju anomička, transkortikalna senzorna i Vernikeova afazija (Vuković, 1998; 2007; Sarno & Levita, 1986; Chabok et al., 2012), dok se nefluentni tipovi afazija, kao što je Brokina afazija, ređe ispoljavaju (Vuković, 1998; Dell et al., 1983). Najčeći tip afazije kod traumatskih povreda mozga je anomička afazija koju karakterišu deficiti pronalaženja reči tokom spontane jezičke produkcije i na zadacima konfrontacionog imenovanja. Kod nekih pacijenata sa TBI ispoljava se težak oblik afazije po tipu žargona. Diskurs pacijenata s ovom afazijom je ispunjen ne-rečima ili rečima koje su udaljene od teme konverzacije i naracije.

Podrobnija neuropsihološka analiza ukazuje na specifičnosti kliničke slike afazija traumatske etiologije u odnosu na afazije uzrokovane cerebrovaskularnim oboljenjima. Pokazano je da „suštinu kliničke slike traumatskih afazija čine: fluentan, semantički oskudan i parafazičan spontani govor, poremećaji auditivnog razumevanja, anomija, disleksija i oštećenje sposobnosti razumevanja pisanog jezika” (Vuković, 1998, str. 172). Česta abnormalnost u govoru pacijenata s afazijom jeste eholalija, tj. automatsko ponavljanje reči i fraza drugih osoba.

Iako se kognitivni deficiti ispoljavaju kod afazija različite etiologije, neuropsihološke studije pokazuju da postoji jača povezanost između oštećenja jezičkih i kognitivnih funkcija kod traumatskih afazija nego kod afazija vaskularne etiologije. Pored razlika u kliničkoj slici, pokazano je da afazije uzrokovane zatvorenim povredom glave imaju bolju prognozu od afazija vaskularne etiologije (Vuković, 1998).

Neafazički poremećaji jezika

Prema savremenim empirijskim studijama, traumatske povrede mozga karakterišu jezički poremećaji koji ne reprezentuju klasične afazičke sindrome. Drugim rečima, većina pacijenata s moždanom traumom ne ispoljava oštećenje formalnih lingvističkih oblasti, niti specifičnih jezičkih modaliteta, kao što su ponavljanje, razumevanje, imenovanje, spontani govor. Nasuprot tome, kod njih se javljaju neafazički poremećaji jezika, koji su opisani pod različitim nazivima, kao što su *supklinička afazija* (Sarno & Levita, 1986), *konfuzan jezik* (Halpern et al., 1973), *post-traumatski deficiti procesiranja jezika* (Vuković et al., 2008) i dr. Prema nekim podacima, suštinu kliničke slike neafazičkih poremećaja jezika čine izražena konceptualna konfuzija, teškoće u pronalaženju reči, nemogućnost povezivanja misli i ideja, oštećenje apstraktnog mišljenja i tendencija skretanja sa teme konverzacije, uz očuvanost fonologije, morfolofgije i sinatske (Vuković, 1998). Kvalitativna analiza odgovora na jezičkim testovima i analiza uzoraka vezanog govora pokazuje da pacijenti s neafazičkim poremećajima jezika imaju teškoće u obradi i upotrebi jezičkih informacija, što doprinosi lošoj organizaciji diskursa i teškoćama u konverzaciji. Neki pacijenti ispoljavaju deficite u upotrebi specifičnih sintaksičkih konstrukcija, iako im je gramatika u osnovi očuvana. Takođe, mnogi pacijenti ispoljavaju teškoće u pronalaženju i upotrebi odgovarajućih leksičkih jedinica tokom diskursa, iako ne pokazuju deficite na zadacima konfrontacionog imenovanja.

Treba imati u vidu da znatan broj pacijenata koji su u akutnoj i subakutnoj fazi imali afaziju ne ispoljava afazičke simptome u kasnijim fazama oporavka, dok se neafazički poremećaji kod njih uočavaju i nekoliko godina posle povrede. Poremećaji se manifestuju preteranom govornjivošću, tangencijalnim govorom i lošom organizacijom diskursa. Ovi poremećaji remete socijalno funkcionisanje osobe (Prigatano, Roueche, Fordyce, 1985). Važno je imati u vidu i to da jezički poremećaji mogu biti udruženi s dizatrijom, što dodatno remeti sposobnost verbalne komunikacije pacijenta s njegovom okolinom. Složenosti jezičkog poremećaja doprinose i oštećenja kognitivnih sposobnosti: pažnje, pamćenja, mišljenja i egzekutivnih funkcija.

Kognitivno- komunikacioni poremećaj

Jezik i kognicija su suštinski povezani i međusobno uslovljeni procesi, kako u pogledu razvoja, tako i funkcionisanja. Stoga oštećenje jezika može da poremeti jedan ili više kognitivnih procesa, kao što i oštećenje nekog kognitivnog procesa može da poremeti jezičko funkcionisanje.

Jezički poremećaji su česte posledice traumatske povrede mozga. Oni narušavaju socijalno funkcionisanje i kvalitet života povređenih. Međutim, traumatska povreda često dovodi i do oštećenja kognitivnih sposobnosti koje su uključene u proces razumevanja i produkcije jezika. S obzirom na to, nekada oštećenje kognitivnih funkcija remeti funkcionisanje jezika, iako je njegova struktura u osnovi očuvana. Poremećaji pamćenja, mišljenja i egzekutivnih funkcija mogu da oštete sintaksičko i semantičko procesiranje na nivou diskursa i upotrebe jezika u komunikaciji. Ovakav poremećaj jezičkih funkcija označava se terminom kognitivno-komunikacioni poremećaj. Poremećaji kognitivno-komunikacionih veština mogu da dovedu do nesporazuma i konflikata povređenog s osobama iz okruženja, kao i do lošeg uspeha u obavljanju akademskih i profesionalnih zadataka (Krug & Turkstra, 2015). Osnovne karakteristike kognitivno-komunikacionog poremećaja jesu tangencijalni i irelevantni iskazi u konverzaciji, deficit u kvalitetu i kvantitetu narativnog diskursa i poremećaji pragmatike.

Tangencijalni govor

Tangencijalni govor predstavlja jednu od karakteristika verbalnog ponašanja osoba s traumatskom povredom mozga. To je u suštini formalno lingvistički uredan diskurs, ali sa izraženom konceptualnom konfuzijom, koja remeti davanje adekvatnog odgovora tokom konverzacije. Drugim rečima, pacijent počne da odgovara na pitanje, ali govor teče u drugom pravcu i tangentan je sa osnovnom idejom. Pretpostavlja se da se u osnovi tangencijalnog govora nalazi tangencijalno mišljenje s fragmentacijom toka misli, intruzijama, konfuznim mešanjem ideja i emocija (Prigatano & Fordyce, 1986).

Oštećenje diskursa

Diskurs se definiše kao vezani deo jezika, kojim se izražavaju ideje, želje, misli, to jest prenose i razmenjuju informacije. Sastoji se od niza rečenica koje imaju koherentnu organizaciju i značenje. Ova forma jezičke produkcije zahteva očuvano gramatičko i semantičko procesiranje, kao i pragmatiku sposobnost, kako bi se saopštila i razumela verbalna poruka. Takođe, diskurs zahteva očuvanu pažnju, pamćenje, mišljenje i egzekutivne funkcije. Prema tome, diskurs predstavlja veoma kompleksnu komunikacionu sposobnost koja se realizuje govornim i pisanim putem.

Većina pacijenata s traumatskim povredom mozga ima poremećaj diskursa. Poremećaj se manifestuje teškoćama u integrisanju elemenata priče u koherentnu celinu, što ometa adekvatan prenos poruke. Oštećena je sposobnost izražavanja sopstvenih potreba i razumevanja komunikativne namere drugih. Takođe se ispoljavaju teškoće držanja teme i redosleda kazivanja. Kod nekih pacijenata se uočava preopširnost, loša organizovanost i tangencijalnost u govoru (Glosser, 1993), dok drugi imaju veoma oskudan nivo jezičke produkcije (Bond & Godfrey, 1997). Konfabulacije i oštećenje semantike takođe karakterišu diskurs nekih pacijenata s traumatskom povredom mozga.

Formiranje i razumevanje diskursa ostvaruje se aktivnošću obe moždane hemisfere, pri čemu je leva hemisfera značajna za prepoznavanja reči i sintaksičku obradu, a desna za integraciju informacija u koherentnu celinu. Pored toga, desna hemisfera je aktivnija u pronalaženju manje očiglednih semantičkih informacija od leve hemisfere. S obzirom na to, oštećenje diskursa može da se javi kod levohemisfernih ili desnohemisfernih lezija mozga, ili kada su lezijom zahvaćene obe hemisfere. Poremećaji diskursa se javljaju nezavisno od težine moždane povrede.

Osobe s poremećajima diskursa često imaju probleme u socijalnoj komunikaciji. Međutim, problemima u socijalnoj komunikaciji doprinosi i oštećenje teorije uma koje se takođe uočava u ovoj populaciji (Turkstra et al., 2018). Pored toga, socijalnim teškoćama doprinose i deficiti drugih kognitivnih funkcija. Tako na primer, neki empirijski podaci pokazuju da pacijenti s teškom povredom imaju veoma loša postignuća na zadacima verbalnog pamćenja, složene pažnje i egzekutivnih funkcija (Ponsford, 2013; Ponsford et al., 2014).

Pragmatski deficiti

Kao što smo već rekli, TBI uzrokuje niz deficita u komunikaciji, koji se ne mogu objasniti oštećenjem jezičke strukture. Drugim rečima, mnogi pacijenti sa TBI imaju očuvane sintaksičke i leksičke sposobnosti, te ostvaruju normalne performanse na standardizovanim baterijama testova za afazije. Međutim, oni ispoljavaju niz deficita u upotrebi jezika, što se ispoljava teškoćama u svakodnevnoj komunikaciji.

Pored razumevanja i produkcije ispravnih leksičkih i sintaksičkih struktura, na sposobnost komunikacije utiču paralingvistički i ekstralingvistički znaci, kao i kognitivno funkcionisanje osobe. Prema tome, oštećenje bilo koje od navedenih oblasti može uzrokovati deficite u pragmatškoj upotrebi jezika. Stoga pragmatške sposobnosti osoba sa TBI variraju. Neki pacijenti pokazuju teškoće u držanju teme i redosleda tokom konverzacije (Dardier et al., 2011), a neki ispoljavaju oštećenja ekstralingvističkih sposobnosti, tj. komuniciranja putem gesta (Bara et al., 2001). Takođe su utvrđeni deficiti paralingvističkih sposobnosti (upotrebe tona, prozodije i ritma), koji onemogućavaju pacijente da na adekvatan način istaknu sopstvene komunikativne namere. Pored toga, pacijenti ispoljavaju teškoće u produkciji i upotrebi jezika kod odgovaranja na pitanja, prezentovanja novih informacija, uvođenja novih tema, organizovanja diskursa i prilagođavanja jezika sagovorniku (Rousseau et al., 2010). S aspekta neverbalne komunikacije, oni pokazuju teškoće u razumevanja i produkciji gesta, u ekspresiji emocija, usmeravanju pogleda i dr. Pokazano je da osobe koje su pretrpele povredu mozga imaju lošija postignuća u lingvističkim i ekstralingvističkim modalitetima u svim komunikativnim činovima u poređenju s kontrolnom grupom. Takođe je pokazano da su neke pragmatške sposobnosti očuvanije od drugih. Tako na primer, direktni i indirektni govorni činovi su očuvaniji od ironije (Angeleri et al., 2008).

Pacijenti s pragmatškim poremećajima često bukvalno shvataju značenje iskazanog, to jest oni ne razumeju implicitni jezik, kao što su sarkastične izjave (McDonald & Pearce, 1996), humor i dr. (Docking, Murdoch & Jordan, 2000). Takođe, neki pacijenti imaju teškoće u produkciji jasnih zahteva, a neki previše detaljišu pri odašiljanju informacija.

Pored napred navedenog, osobe s kognitivno-komunikacionim poremećajem ispoljavaju i *deficite u razumevanju jezika*, koji se javljaju usled teškoća u shvatanju implicitnog i apstraktnog sadržaja i povećane dužine verbalne poruke (Ferstl et al., 2005; McDonald, Togher & Code, 2013). Kognitivno-komunikacioni poremećaj dovodi i do *socijalnih problema u komunikaciji*, kao što su teškoće u iniciranju teme, ispravljanja tokom konverzacije i nemogućnosti tačnog dešifrovanja verbalnih i neverbalnih socijalnih znakova (Bracy & Douglas, 2005). Ovi poremećaji mogu da naruše porodične i prijateljske odnose, da otežaju zaposlenje i umanje uspeh u učenju (Turkstra & Isaki, 2000; Ponsford et al., 2003). Rezultati ispitivanja socijalnog ishoda pokazuju da osobe s poremećajima komunikacije traumatske etiologije imaju smanjenu mogućnost da se ponovo vrate na svoje radno mesto, dok nezaposlene osobe otežano nalaze posao (Douglas, Bracy & Snow, 2016). Takođe je pokazano da ove osobe imaju smanjen broj i kvalitet međuljudskih odnosa, te da često zapadaju u stanje depresije, usamljenosti i anksioznosti (Ylvisaker, Turkstra & Coelho, 2005).

Procena jezičkih poremećaja kod traumatskih oštećenja mozga

Procenu jezičkih sposobnosti kod osoba s traumatskom povredom mozga treba usmeriti u dva pravca. Prvi podrazumeva primenu standardizovanih testova za afazije. Ovi testovi se koriste kod pacijenata koji ispoljavaju klasične afazičke simptome, kao što su nefluentna produkcija, agramatizam, anomija, oštećeno ponavljanje i oštećeno razumevanje. Cilj njihove primene je da se utvrdi da li pacijent ima neki oblik afazije ili ne. Drugi pravac procene podrazumeva testiranje viših nivoa jezičke organizacije, tj. diskursa s ciljem utvrđivanja kvantiteta i kvaliteta produkovanog jezika. Takođe se procenjuje kvalitet i sposobnost održavanja konverzacije pacijenta s drugim osobama. Klinički podaci pokazuju da neki pacijenti ispoljavaju teškoće u obradi jezičkog materijala i više godina nakon povrede, što ih remeti u normalnom funkcionisanju na profesionalnom, akademskom i socijalnom domenu. Ova zapažanja iznedrila su potrebu ispitivanja viših nivoa jezičke organizacije, to jest diskursa, kod hroničnih pacijenata s traumatskom povredom mozga. S obzirom na to, poslednjih godina učinjen je veliki pomak u oblasti istraživanja poremećaja jezika uzrokovanih traumatskim oštećenjem mozga. Pokazano je da ranije primenjivani testovi jezičkih sposobnosti daju oskudne podatke, te da nedostaju čvrsti dokazi o kognitivno-lingvističkom funkcionisanju osoba s moždanom traumom. U cilju prevazilaženja tih nedostataka, oblikovan je poseban test (*Functional Assessment of Verbal Reasoning and Executive Strategies* - FAVRES) za ispitivanje jezičkih i komunikacionih sposobnosti kod traumatskih oštećenja mozga. Testom se procenjuju složena komunikacija, verbalno rezonovanje i egzekutivne funkcije. FAVRES je standardizovani test za otkrivanje suptilnih kognitivno-komunikacionih poremećaja kod osoba s traumatskom povredom mozga (McDonald, 2005).

Govorno-jezička rehabilitacija

Posledice povrede mozga kreću se od blagih (kratkotrajne promene psihičkog stanja i svesti) do veoma teških poremećaja stanja svesti i kognicije. Oštećenja govora, jezika i kognicije često zahtevaju dugoročnu terapiju u cilju reintegracije osobe u radnu i socijalnu sredinu, što iziskuje značajna finansijska sredstva, posebno kod teških povreda (Ponsford et al., 2013).

Tradicionalno se u rehabilitacionom tretmanu akcenat stavlja na remedijaciju jezika. Ovakav pristup je opravdan kada su govorni i jezički poremećaji klinički uočljivi, to jest kada pacijenti ispoljavaju afaziju. Međutim, većina pacijenata ne ispoljava poremećaje jezika po tipu afazije, već teškoće u upotrebi jezika tokom diskursa i konverzacije. Stoga se u terapiji ovih pacijenata preporučuje pragmatički pristup, koji je usmeren na uspostavljanje funkcionalne komunikacije. Tokom terapije, pacijenti se suočavaju sa simuliranim situacijama iz svakodnevnog života i obučavaju za upotrebu različitih komunikativnih strategija (Aten, Caligiuri & Holland, 1982). Ovaj oblik terapije je kasnije dopunjen uvođenjem kratkih monologa, s ciljem da se pacijent obuči da prilagodi sopstveni diskurs različitim slušaocima, kao što su, na primer, blizak rođak, prijatelj, nepoznata osoba i dr. (Holland, 1991). Terapija može da se izvodi individualno ili grupno. Budući da pacijenti s traumatskom povredom mozga posebno ispoljavaju probleme u socijalnoj komunikaciji, veoma je koristan grupni oblik terapije, koja se bazira na diskusiji, uz jasno formulisanje komunikacionih ciljeva, definisanje uloga i davanje povratne informacije (Struchen, 2005). Krajnji cilj ove terapije je postizanje planiranog, cilju usmerenog i efikasnog verbalnog ponašanja (Ilvisaker, 2006). Takođe se vrši obuka partnera koji komuniciraju s osobom pogođenom povredom mozga (Togher et al., 2004). Cilj tog oblika terapije je poboljšanje konverzacije i sposobnosti sagovornika da razume komunikacione poruke pacijenta. Pretpostavka je da stav slušaoca/sagovornika može da doprinese oblikovanju pacijentove jezičke poruke, njegovom komunikativnom ponašanju, motivaciji i smanjenju društvene izolovanosti.

U rehabilitaciju osoba s jezičkim i kognitivnim poremećajima treba da bude uključen tim stručnjaka (logoped-afaziolog, bihevioralni neurolog, psihoterapeut). Rehabilitacija je izazov posebno za afaziologa, budući da osobe s povredom mozga mogu da ispolje dizatriju, afaziju i kognitivno-komunikacioni poremećaj. Afaziolog već u akutnoj fazi procenjuje govorno-jezičke i komunikacione sposobnosti i utvrđuje

teškoće u izražavanju potreba povređene osobe. Takođe se procenjuje sposobnost gutanja s ciljem preveniranja, smanjivanja ili eliminisanja mogućih posledica neidentifikovanih smetnji i poremećaja. Rana procena ima poseban značaj s aspekta rehabilitacije, koju treba započeti još u akutnoj fazi (Vuković, 2007).

Prisustvo jezičkih i komunikacionih poremećaja negativno utiče na celokupan oporavak pacijenata, njihovu reintegraciju u socijalnu sredinu, nezavisnost, porodične odnose, profesionalni i akademski uspeh. Rehabilitacija doprinosi poboljšanju oštećenih funkcija i unapređenju kvaliteta života povređenih i njihovih porodica. Pacijentima je često potrebna rehabilitacija u dužem vremenskom intervalu, jer se neka poboljšanja u govoru, jeziku i komunikaciji uočavaju i u kasnijim fazama oporavka.

2 ZAKLJUČAK

Kod osoba s traumatskom povredom mozga javljaju se različiti oblici jezičke patologije, s tim što kognitivno-komunikacioni poremećaj predstavlja dominantan oblik oštećenja jezika u ovoj populaciji. Manifestuju se oštećenjem viših nivoa jezičke organizacije, kao što su diskurs, pragmatika upotreba jezika u socijalnoj komunikaciji, upotreba jezika u akademske svrhe, regulisanje ponašanja tokom obavljanja profesionalnih i svakodnevnih životnih aktivnosti. Karakteristično je da se ova oštećenja jezika ispoljavaju u kontekstu deficita pažnje, pamćenja, mišljenja i egzekutivnih funkcija. Specifičnost kliničke slike jezičkih poremećaja kod traumatskih oštećenja mozga zahteva primenu testova za dijagnostikovanje afazije, kao i posebno konstruisanih testova kojima se vrši procena složenih aspekata komunikacije, verbalnog rezonovanja i egzekutivnih funkcija. Tretman govornih i jezičkih poremećaja treba započeti čim se stabilizuje opšte zdravstveno stanje povređenog. Tretman se usmerava na saniranje deficita koji remete komunikaciju pacijenta s njegovom okolinom, i njegovu reintegraciju u radnu i socijalnu sredinu. Efekti govorno-jezičke i kognitivne rehabilitacije vidljivi su u svim fazama oporavka.

LITERATURA

- Angeleri, R., Bosco, F. M., Zettin, M., Sacco, K., Colle, L., Bara, B. G. (2008). Communicative impairment in traumatic brain injury: a complete pragmatic assessment. *Brain Lang*, 107(3):229-45.
- Aten, J., Caligiuri, M. & Holland, A. (1982). The efficacy of functional communication therapy for chronic aphasic patients. *Journal of Speech and Hearing disorders*, 47, 93-96.
- Bara, B. G., Cutica, I. & Tirassa, M. (2001). Neuropagmatics: Extralinguistic Communication after Closed Head Injury. *Brain and Language* 77(1):72-94.
- Bond, F. & Godfrey, H. P. (1997). Conversation with traumatically brain injured individuals: A controlled study of behavioural changes and their impact. *Brain Injury*, 11(5):319-30.
- Bracy, C. A. & Douglas, J. M. (2005). Marital dyad perceptions of injured partners' communication following severe traumatic brain injury. *Brain Impairment*, 5, 6(1):1-12.
- Chabok, S., Y., Kapourchali, S., R., Leili, E., K., Saberi, A., Mohtasham-Amiri, Z. (2012). Effective factors on linguistic disorder during acute phase following traumatic brain injury in adults. *Neuropsychologia*, 50, 1444-1450.
- Dardier, V., Bernicot, J., Delanoë, A. et al. (2011). Severe traumatic brain injury, frontal lesions, and social aspects of language use: A study of French-speaking adults. *Journal of Communication Disorders*, 44(3):359-78.
- Dell, S.O., Batson, R., Kasdon, D. L., Peterson, T. (1983). Aphasia in subdural hematoma. *Arch Neurol*, 40(3), 177-9.
- Docking, K., Murdoch, B. E. & Jordan, F. M. (2000). Interpretation and comprehension of linguistic humor by adolescents with head injury: A group analysis. *Brain Injury*, 14, 1, 89-108.
- Douglas, J. M., Bracy, C. A. & Snow, P. C. (2016). Return to work and social communication ability following severe traumatic brain injury. *J Speech Lang Hearing Res*, 59(3):511-20.
- Ferstl, E. C., Walther, K., Guthke, T. & von Cramon, D. Y. (2005). Assessment of story comprehension deficits after brain damage. *J Clin Exp Neuropsychol*, 27(3):367-84.
- Gentry, L. R. (1996). Head trauma. In S. W. Atlas (Ed.), *Magnetic resonance imaging of the brain and spine*. Philadelphia: Lippincott-Raven.

- Gloser, G. (1993). Discourse production patterns in neurologically impaired and aged populations. In H. H. Brownell, Y., Joanette (Eds.). *Narrative discourse in neurologically impaired and normal aging adults*. San Diego CA: Singular (pp. 191-212).
- Graham, D.I.(1996). Neuropsychology of head injury. In R. K. Narayn, J. E., Wilberger and J. T. Povlishock (Eds.), *Neurotrauma*. Philadelphia: W.B. Saunders.
- Graham, D. I., Gennarelli, T. A. & McIntosh, T. K. (2002). Trauma. In D.I. Graham and Lantos (Eds.), *Geefield's neuropsychology*, 7th ed., London: Arnold.
- Halpern, H., Darley, F. L. & Brown, J. R. (1973). Differential language and neurologic characteristics in cerebral involvement. *Journal of Speech and Hearing Research*, 38 (2), 162–173.
- Heilman, K. M., Safran, A. & Geschwind, N. (1977). Closed head trauma and aphasia. *Journal of neurology, neurosurgery and psychiatry*, 34, 265-269.
- Holland, A. L. (1991). Pragmatic aspects of intervention in aphasia. *Journal of Neurolinguistics*, 6, 2, 197-211.
- Krug, H. & Turkstra, L. (2015). Assessment of Cognitive-Communication Disorders in Adults with Mild Traumatic Brain Injury. *Perspectives on Neurophysiology and Neurogenic Speech and Language Disorders*, 25(1), 17-28.
- McDonald, S., Togher, L. & Code, C. (2013). *Social and communication disorders following traumatic brain injury*. London: Psychology press.
- MacDonald, S. (2005). Functional assessment of verbal reasoning and executive strategies (FAVRES). Guelph, Ontario : CCD Publishing.
- McDonald, S. & Pearce, S. (1996). Clinical insights into pragmatic theory: frontal lobe deficits and sarcasm. *Brain Lang*, 53(1),81-104.
- Menon, D. K., Schwab, K., Wright, D. W., Maas, A. I. (2010). Position statement:definition of traumatic brain injury. *Arch Phys Med Rehabil*, 91(11),1637–40.
- Turkstra, L. S., Norman, R. S., Mutlu, B. & Duff. M. C. (2018). . Impaired Theory Of Mind In Adults With Traumatic Brain Injury: A Replication And Extension Of Findings. *Neuropsychologia*, 111, 117–122.
- Ponsford, J., Olver, J., Ponsford, M. & Nelms, R. (2003). Long-term adjustment of families following traumatic brain injury where comprehensive rehabilitation has been provided. *Brain Injury*, 17(6):453–68.
- Ponsford, J. (2013). Factors contributing to outcome following traumatic brain injury. *NeuroRehabilitation*, 32(4):803–15.
- Ponsford, J. L., Spitz, G., Cromarty, F., Gifford, D., Attwood, D. (2013). Costs of care after traumatic brain injury. *J Neurotrauma*, 30 (17),1498–505.
- Ponsford, J. L., Downing, M. G., Olver, J., Ponsford, M., Acher, R., Carty, M., Spitz, G. (2014). Longitudinal follow-up of patients with traumatic brain injury: outcome at two, five, and ten years post-injury. *J Neurotrauma*, 31(1),64–77.
- Prigatano, G.P., Roueche, J.R. & Fordyce, D. J. (1985). Nonaphasic language disturbances after closed head injury. *Language Sciences*, 7, (1), 217-229.
- Prigatano, G. P. & Frodyce, D. J. (1986). Cognitive dysfunction and psychosocial adjustment after brain injury, In: G. P. Prigatano et al. (Eds.), *Neuropsychological rehabilitation after brain injury*. Baltimore: The Johns Hopkins University.
- Rousseaux, M., Vérigneaux, C. & Kozlowski, O. (2010). An Analysis Of Communication In Conversation After Severe Traumatic Brain Injury. *Eur J Neurol.*, 17(7):922-9.
- Sarno, M. T. & Levita, E. (1986). Characteristics of verbal impairment in closed head- injured patients. *Journal of Nervous and Mental Diseases*, 172, 475–479.
- Struchen, M. A. (2005). Social Communication Interventions. *Rehabilitation For Traumatic Brain Injury*, 88-117.
- Teasdale, G. and Jennett, B. (1974). Assessment of coma and impaired consciousness. *Lancet*, 1, 81.
- Togher, McDonald, D., Code, C., Grant, S. (2004). Training communication partners of people with traumatic brain injury: A randomised controlled trial. *Aphasiology* , 18(4):313-335.
- Turkstra, L. & Isaki, E. (2000). Communication abilities and work re-entry following traumatic brain injury. *Brain Injury*, 14(5):441–53.
- Вуковић, М. (1998). *Трауматска афазија*. Београд: Дефектолошки факултет Универзитета у Београду.
- Vuković, M. (2007). Fluentna afazija uzrokovana zatvorenom povredom mozga: Značaj rane procene i tretmana. *Beogradska defektološka škola*, 2, 53–59.
- Vukovic, M., Vuksanovic, J., Vukovic, I. (2008a). Comparison of the recovery patterns of language and cognitive functions in patients with posttraumatic language processing deficits and in patients with aphasia following a stroke. *Journal of communication disorders*, 41: 531–552.

- Vuković, M. (2012). *Poremećaji komunikacije kod traumatskih oštećenja mozga*. Beograd: Univerzitet u Beogradu – Fakultet za specijalnu edukaciju i rehabilitaciju.
- Vuković, M. (2019). *Poremećaji komunikacije kod traumatskih oštećenja mozga*. Beograd: M. Vuković.
- Ylvisaker, M., Turkstra, L. S. & Coelho, C. (2005). *Behavioral and social interventions for individuals with traumatic brain injury: a summary of the research with clinical implications*. New York, NY: Thieme Medical Publishers.
- Ylvisaker, M. (2006). Self-coaching: a context-sensitive, person-centered approach to social communication after traumatic brain injury. *Brain Impairment*, 7(3), 246-258.

Oral presentations

Prosodic Text Rhythm And Comic Effects: The Possibility Of Correlation

Viktoria Vasileva

St Petersburg State University

13B Universitetskaya Emb., St Petersburg 199034, Russia

v.v.vasileva@spbu.ru

ABSTRACT

The study is based on proposition that the rhythmic organization of a discourse is the result of interaction of its prosodic characteristics. The text rhythm is understood as the quasiregular repeatability of rhythmic structures, constituting intonational-semantic blocks within syntagma and phrase (minimal semantic units). The search for the connection between rhythm and humor - as a scientific problem - arose due to the sharp increase in comic content in contemporary Russian media with a simultaneous increase in the share of oral speech in the media space. This article is the first attempt to the study this problem on the material of the Russian language.

The main objective of the study displayed in the article is to detect in the delivery of radio news (emotionally neutral message) such rhythmic structures that would correlate with a humorous assessment which does not have a lexical-semantic expression. The analysis was carried out by the non-experimental method of comparing the news delivered on the air by the newscaster (precedent) with a phonetic record of the same news text, made by the author of the article on the basis of previously obtained data (standard). An important concomitant purpose was to demonstrate the method of detecting rhythmic structures: ways of processing empirical material, intonational and thematic-rhematic qualification of syntagmas, detecting their interaction, and then – interpreting the semantic and evaluative differences of the standard and precedent and searching for humorous content in the latter. The results of the analysis allow confirming the possibility of finding correlation between prosodic rhythm and humor.

In the analyzed message, we identified the following rhythmic markers of humor. Creatable rhematization of the initial syntagma forms a symmetrical rhythmic structure within the phrase, which focuses the listener's attention on the unexpected phrase fragment. The contrast is thus the basis of a humorous assessment. The grouping of syntagmas within a phrase and the choice of IF for the design of these syntagmas demonstrates a newscaster's assessment, such as mockery. Symmetric phrases formed around "IF-3+contrast" syntagma type create an intrigue regarding new fact for the audience.

Further empirical analysis will help to deepen our ideas about humor as a communicative resource in a digital news environment and to identify new mechanisms for the rhythmic organization of media texts.

Key words: media speech, humor, prosodic, radio news rhythm, prosodic markers of humor.

1 INTRODUCTION

Our interest in humor expressed in mass media is determined by the sharp increase in comic content in contemporary Russian media. Moreover, in conditions of a significant increase in the share of oral speech, including its spontaneous form, the communicative content of the media speech is formed primarily by prosodic means. The question we are trying to answer is: are there any prosodic signals indicating the humorous content in the oral Russian media speech?

The rhythmic organization of a discourse is the result of interaction of its prosodic characteristics. Earlier, we examined the rhythmic organization of a prosaic text (Vasileva, 1992–2018) and revealed the rhythmic types of syntagmas that are being formed during author's reading a work of fiction and its spontaneous retelling; we have shown that the rhythmic structure of the prosaic text correlates with its contents. Basing on works by other authors (Prokhvatilova & Sinitsyna, 2014) and on the studies conducted

by the author in a seminars with students, the specifics of the news rhythm in radio message was revealed allowing us to speak about the existing standard of reading news on the air.

It is supposed that there are certain characteristic qualities within the rhythmic organization of a radio news, which, in spite of having standard (neutral) content allows the listener to recognize the humorous assessment expressed by the speaker (journalist, reporter). We should now clarify the question formulated above: is it possible to detect within the media text certain rhythmic structures that correlate with the emotional-semantic content of a humorous assessment in cases where the lexical-semantic analysis does not reveal such assessment.

Concerning the objective of our research, i.e. the search for correlations between form and content, the most important component of the analysis is the cognitive and understanding personality of the researcher himself (Cheyff, 1994–2008). Therefore, in this article we use non-experimental analysis, although we understand the importance of objective research methods applied to the speech processes which can be instrumentally “measured” (rhythmic structures are, of course, measured entities).

In the Section 2 a brief review of prosodic studies of humor and rhythm in Russian media speech is given. At the same time the author is not aware of any studies of Russian prosaic rhythm in the aspect of humor. Still, the multilevel hierarchical nature of the Russian speech rhythm is recognized by researches starting from the first years of studying (Girshman, 1982; Matveeva, 1997; Potapov, 2011 and others): the rhythmic (i.e. accentually designed) phrase structure, which, in its turn, is formed by the rhythmic structures of syntagma, etc., is involved in the rhythmic organization of the complete (text, discourse).

At this stage of the study, we turn to the phrase level and consider intonation as the most important rhythm-forming means (Torsuyeva, 1979–2009; Prokofyeva, 2000). We propose to take a phonetic syntagma (Zlatoustova, 1981) as a rhythmic unit. The phonetic syntagma in this case is understood as an intonational-semantic unity participating in the actual division of a phrase (Mathesius, 1967) as a theme or a rheme.

The article presents an analysis of news media text taken from radio broadcasts; its prosodic design will be shown in comparison with the standard modeled by the author on the basis of our previous studies. The purpose of the article is to identify (detect) rhythmic markers (as understood by S.Attardo in context of humor) of the humorous tonality within a news radio text and try to find a semantic-expressive correlation of the rhythmic structures of the text and its author’s humorous assessment.

2 RESEARCH CONTEXT

The question of whether the speakers demonstrate their intention to make a joke and the presence of humor in their speech with prosodic means remains open in current studies. According to the humorous remark of W.Chafe, if there are such signals, then “humor in conversation would be delivered “with bells and whistles”” (Chafe, 1994, p. 131). The belief that humor must necessarily have paralinguistic marks (laughter, high pitch) is ascribed to folk theories of humor (Attardo & Pickering, 2011). However, researchers are trying to identify how “prosodic features such as pauses, pitch height and range, etc., are used by speakers to organize and structure their texts, and by hearers to interpret and parse these texts” (Gironzetti, 2017, p. 400).

A number of facts have been established with the help of auditory (non-experimental) methods using the listening method and intuition of a scientist. Among prosodic features, a higher pitch, louder volume and pauses are noted (Bauman, 1986; Audieth, 1998), used, in particular, to indicate quoted speech and attract the attention of the listener. In spontaneous jokes, a connection was found between the speed of speech and the climax of the narrative (Norrick, 2001).

Examining the organization of a discourse, A. Wennerstrom (2011) suggested that there may be a correlation between the structural components of narratives and characteristic prosodic features. She also drew attention to the assessment, expressed lexically and prosodically. Later, studying the English material it was found that jokes’ presenter can use two intonations to create a humorous effect: contrast intonation and ascertaining intonation (Wennerstrom, 2011).

In recent years, empirical studies of prosodic markers of humor have begun to appear. In his review of instrumental studies of humor, E. Gironzetti (2017) indicates that the first empirical study in order to test whether humor in the English language is marked prosodically was performed by Pickering et al. (2009) and then by Attardo & Pickering (2011), Attardo et al. (2013). Empirical studies of prosodic markers of humor were performed on the basis of the Japanese (Kadooka, 2012), Greek (Archakis et al., 2010) and Portuguese languages (Flamson et al., 2011).

Acoustic measurements carried out during the studies showed that there are no significant “physical” differences between humorous and non-humorous speech, that is, there are no prosodic parameters that could be reliably used to identify the presence of humor in a narrative. Thus, many researchers of the English language material (for example, Attardo et al., 2013) deny any certainty of humor within a conversation or an experimental situations being marked with any kind of prosodic attribute.

To the author’s knowledge, in Russian-language works the question on possible connection of humor and prosodic characteristics of speech has not yet been raised. Previously, we showed (Vasileva, 1992–2018) that the limits of opposing prosodic units in the complete text lie within its rhythmic organization. Since our sphere of interest lies in humor within the Russian media language, we will give a brief review of works on rhythm in non-fiction texts (Zlatoustova, 1981; Antipova, 1984; Potapov, 2011 at al.).

Since speech rhythm is associated with the concepts of duration and regularity, the main question in the study of rhythm is the question of rhythm-forming units. Western school traditions are based on “stress-timing” (accent synchronization) and “syllable-timing” (syllabic synchronization) introduced by K. Pike back in 1945. If basing on the K. Pike concept developed by D. Abercrombie (1967), Russian language refers to languages with an accent-counting rhythm, where the accent group is the main unit. However instrumental studies have shown that there is no objective isochronism of these structures in speech. Therefore, searches in the field of measuring rhythmic patterns continue (see, e.g., a review by Shevchenko et al., 2012), and linguists cannot yet agree which parameter or parameters of the rhythm are the most informative.

Russian linguistics emphasizes the fact that all components of prosody participate in forming the rhythm (Zlatoustova, 1981; Antipova, 1984; Potapov, 2011, at al.). Russian and foreign researchers agree that rhythm is, first of all, prominence, which is achieved not only due to the periodic repetition of time intervals, but also due to other prosodic characteristics.

Regarding our approach to the study of rhythm, it is important that performing instrumental (electronic-acoustic) studies one can not do without “manual” preliminary processing of speech material. Thus, the boundaries of intonation groups, pauses, stressed syllables, boundaries of accent groups, boundaries of vocal and consonant intervals are distinguished using auditory marking (Shevchenko et al., 2012; Demina, 2013). Consequently, moving to a significant semantic level of prosodic organization of a discourse, i.e. phrase level, the researcher scarcely needs any “physical” methods of calculation. In addition, experts point out “shortcomings associated with the imperfection of the syntactic analysis of modern text analyzers and the inability to isolate all elements of intonation due to the lack of systems that allow the semantic analysis of sentences” (Chemerilov et al., 2016).

Of all the prosodic characteristics of Russian speech, the most thoroughly developed system of Russian intonation is developed in the works by E.A. Bryzgunova (1980 and the last), N.D. Svetozarova (1982 and the last), N.V. Cheremisina (1982 and the last), I.G. Torsuyeva (2009). To maintain terminological clarity, we should note that concerning the Russian language (in contrast to tonal and syllabic languages) it is important to distinguish between the concepts of “tone” and “intonation”: “The linguistic functions of speech melody are very varied, but of two fundamental different kinds. In one case, the function of the speech melody patterns is to be part of the structure of sentences; in the other case, their function is to one part of the structure of words. In former case, the patterns are called intonation, and in the latter case they are called tone” (Abercrombie, 1967).

Researchers point out that the musicalness of Russian melodics is created largely due to the specific sharp high ascending and calm descending intonations, forming a common zigzag intonation pattern. Therefore, syntagma, understood as the minimal intonationally complete semantic speech segment, is most often chosen as the main observation unit in non-instrumental studies (Prokhvatilova, 1999, Prokhvatilova

& Sinitsyna 2014; Rodionova, 2014). In doing so, the rhythm of prosaic speech is defined as “quasiregular repeatability of rhythmic structures most frequent for a given chronological state of the language and varying under the influence of the grammatical structure of the language, characterized by specific prosodic design and forming intonational-semantic blocks within the syntagma” (Potapov, 2011, p. 184).

3 RADIO NEWS RHYTHM & HUMOROUS MARKERS

This section explains methodology and analysis. As previously noted in the Introduction, the most important rhythm-forming means building up the communicative level of the language system, is intonation. The latter acts in the speech flow as an alternation of intonation models: alternating syntagmas form a rhythmic structure within a phrase. Another important means of organizing the sentence is the thematic-rhematic structure of discourse, which we consider the implementation of intonations’ interactions within the phrase structure. The author of the actual division theory stated that rhythm plays a more important role in the process of organizing discourse than the actual division itself (Mathesius, p. 155), thereby recognizing the leading role of prosody in speech interactions. Indeed, when we turn to the rhythm of a finished (completed) text, we leave the area of thematic-rhematic structure of the discourse and come to the sphere of new relevance – the semantic structure of the complete text. In this article, however, we remain within the limits of rhythmic structures of the intonationally organized syntagma. We now proceed to presenting our positions concerning intonation and demonstrating the empirical analysis.

3.1 Intonation for text rhythm

Within the unity of communicative characteristics of the sentence and its rhythmic organization taken as a structure of communicative implications carried by the intonation, arises a certain “standard for speaking” on the air: the standard for reading political or criminal news, presenting a broadcast announcement or a weather forecasts, the standard for live reporting inserts, even the standard for an urgent lightning message about the tragedy (we stop here on the news, specifically – on a short message, the latter being the main journalistic genre). Yet, the deviations from the current standards and certain professional practice of today immediately attract the attention of the sensitive audience that shows its sensibility to intonation innovations within the rhythmic structure at least by listening to the sound of the radio or television.

The rhythmic structure of news media text is understood as the prosodic interaction of discursive components: phrase rhythm - as an interaction of syntagmas, text rhythm – as interaction of phrases.

Let us recall the characteristics of intonation that cannot be dispensed with when describing the rhythm. These characteristics are necessary when looking for explanations of the speaker’s (correspondent’s, newscaster’s) choice of a certain intonation designing the syntagma.

The communicative purpose of intonation is that, by using it, the speaker organizes and selects semantic parts (the complete discourse or its fragments – syntagmas) in the speech flow, in order to “communicate” to the listener a certain general purpose of his discourse (illocutions of the narrative, expression of will, questioning) and his subjective attitude to the expressed. The acoustic components of intonation are the same as those of speech sounds: the main intonation and overtones (timbre), the intensity and duration of the sound. But of all the intonation components, the most significant for expressing and perceiving semantic differences are changes in the basic intonation, which is sometimes referred to as melodics (there is a tradition to refer to the intonation itself as “melodics”; hereafter, we will use the term “intonation” and talk about its “movement”).

When dealing with a particular language taken in a particular cultural and historical period, researchers distinguish certain models, types of correlation of intonation, timbre, intensity and duration of the sounding speech. Such models are able to oppose the semantic differences of discourses E. A. Bryzgunova (1980b) and are known in Russian linguistics as ‘intonacionnye konstrukcii’ (IK). In this article

we shall refer to them as Intonation Frame (hereinafter IF). E. A. Bryzgunova identified seven types of intonation structures in the Russian language (the researchers further propose various versions of these structures instead of proposing altogether new ones). These concepts are the basis of teaching oral Russian speech to foreigners.

IF differ in level and direction of intonation movement on the exact syllable in which the methodical change (break, turn) within the borders of syntagma begins. This syllable, being a place of changing the direction of intonation movement, is otherwise called an accent (= emphasis). It is part of a certain word called an accent bearer. A turn can appear in any part of the syntagma depending on the expressed meaning - at the beginning, in the middle and in the end of the structure on the stressed syllable of the intonationally distinguished word. A IF consists of three parts: pre-turn – turn – post-turn. It is clear that in cases when the syntagma begins or ends with stressed syllable of an accent bearer, the pre-turn (or post-turn) part can be considered equal to zero. Although physically, acoustically that is not the case, such a condition can be accepted for acoustic analysis. We are going to show the Tone Frame models in Table 1, after giving explanation of the used symbols.

In the IF turn, a change in the intonation movement occurs: increase or decrease relative to the pre-turn part. The direction of the intonation in the Tone Frame turn is shown by an arrow in front of the stressed syllable: ↑ – ascending intonation, ↓ – descending intonation. In the post-turn part, the IF intonation may be higher or lower than the pre-turn intonation (these levels are marked by horizontal lines on both sides of the arrows). And one more important comment. The tone level in the pre-turn and post-turn parts does not suppose an even intonation movement. Speech does not move from start to finish by steps of the intonation (for example: started from a low level, then increased and remained at the achieved level). The movement of the intonation around the turn has a wave-like character (more uniform and calm or fluctuating intensely up and down). The semantically significant intonation levels of pre-turn and post-turn are determined only in comparison with each other and with the turn. When taken in isolation, these structural components of IF are unable to express meanings.

Intonation, like any prosodic means, is based on the presumption of co-relation within the syntagma. Tone Frame is being performed and completed within the syntagma or within the whole discourse when it is pronounced as if bearing a single syntagma. In practice, one and the same discourse can be divided into unequal number of syntagmas, while the same syntagma can be pronounced using different types of IF. If a discourse consists of a series of syntagmas, intonation structures build certain relations between syntagmas, thus realizing their own functions, (incompleteness, contrast, relativity, etc.). Strictly speaking, the interaction of IF within complete discourse forms its communicative meaning in a certain rhythmically organized structure (note that in works on sounding speech discourse is typically referred to as a phrase). The boundaries between phrases are usually marked with a double slash //, and the boundaries between syntagmas – with a single one /.

We now show (Table 1) the IF models determined by E. A. Bryzgunova and give examples (IK-1 - IK-5 were taken from radio news; IK-6 and IK-7 – from the "non-news" radio), in which the standard communicative values of intonation structures are being implement (syllables of the turn are put in bold type).

Table 1: Intonation Frame (IF)

Mod els	Relations pre turn – turn– post turn	Standard implications, example
IF-1	— ↓ — Post turn is significantly lower than pre turn.	Ascertainment, soft completion, headline <i>Interv'yu nakonec sosto↓yalos'</i> // [The interview took place at last]
IF-2	— ↓ — Post turn is a little lower than pre turn.	Completion, interrogation, comparison. The stress on the climax is being strengthened. <i>Vsya stra↓na pomnit etot den'</i> // [The whole country remembers this day] <i>Chto mozhet is↓pravit' polozhenie (?)</i> // [What could be done to improve the situation?]
IF-3	— ↑ — The ascent till the turn level is followed by descent even lower than the beginning.	Completion, listing, question <i>Obeshchanij ↑mnogo / mnogo razgo↑vorov / bumazhnoj volo↑kity</i> // [Lots of promises, lots of talk, official red tape] <i>Zakonodatel'noe so↑branie / <otklonilo zakononoproekt></i> // [The legislature <rejected the bill>].
IF-4	— ↓ ↑ — The mean tone level on the pre turn is followed by succession of descent and immediate ascent with maintenance of high tone on the post turn (sounds like Ye-es! when answering the phone).	Incompletion, official style, “importance” of the rendered information <i>Odn↓a↑ko / <na moment proverki nikogo ne okazalos'></i> // [However , by the time of inspection everybody was gone] <i>Ofici↓a↑l'noe zayavlenie / <budet sdelano pozzhe></i> // [An official announcement will be made later]
IF-5	— ↑ — ↓ — The scheme includes two turns with the rising tone on the first one and the falling tone – on the second.	Completion, evaluativity. The word stress is being strengthened in both turns. <i>V e↑fire ↓novosti (!)</i> // [On the air news !] <i>Na «↑Ekhe» ↓noch' (...)</i> // [On " Echo " night ...] <i>Kak↑oj prekrasnyj ↓prazdnik sostoyalsya (!)</i> // [What a beautiful celebration we've had!]
IF-6	— ↑ — The post turn preserves the constant height of the turn till the end of saying.	Incompletion, pathetic, expressive emotionality <i>Zvuchat fan↑fary (!)</i> // [Sound fanfare !] <i>Parad ot↑kryt (!)</i> // [The parade is opened !]
IF-7	— ↑ ↓ — The harsh tone rise joined by almost complete cutting off voice (occlusion of cords previous to posstonic vowel sounding like an answer Na-ah!) followed by harsh tone fall on the post turn.	Completion, expressive emotionality <i>Ot↑lich↓-nyj byl vratar' (!)</i> // [He was a great goalkeeper!] <i>Ka↑ka↓-ya tam pobeda / <ele-ele vytyanuli igru></i> // [It was far from any triumph, we barely pulled the game]

3.2 IF interaction in the rhythmic structure of the phras

We now show the interaction of different IF in the rhythmic structure of a phrase on the example of a standard pronunciation of a news message (the text is given in interlinear translation for the convenience of comprehending the analysis):

Khamovnichesky court of Moscow today will consider the merits of the claim for trade in the Cathedral of Christ the Savior. On its territory actually operates a business center with many violations of the law, according to the consumer rights protection Society. According to its representatives, the Cathedral has a car wash, tire service, car service, paid Parking, dining room, dry cleaning, stalls and pavilions. At the same time there are no cash registers, on many goods there are no price tags. Meanwhile, the ROC says that all commercial activity on the territory of the Cathedral is carried out by the Cathedral of Christ the Savior Foundation, the Cathedral itself being not the founder of the latter.

Let us divide the text into syntagmas defining Intonation Frame for each one with the functional purpose of IF matching its communicative task. Thus, we will present the pronunciation standard for the text given above. For the convenience of analysis, we number the phrases, put in bold both the syllable of each IF's intonation center (as in Table 1) and the entire accent bearer (in the form of word). The number of IF implemented on the syntagma is indicated next to the arrow showing the direction of the intonation on the accent bearer.

(1) *Hamovnicheskij sud **Moskvy** ↑3 / segodnya rassmotrit **po sushchestvu** ↑3 / isk **o trgovle** v Hrame Hrista Spasitelya ↓1 //*

[Khamovnichesky court **of Moscow** today will consider **the merits** of the claim **for trade** in the Cathedral of Christ the Savior]

(2) *Na ego territorii fakticheski dejstvuet biznes-**centr** ↑3 / **so mnogimi** narusheniyami **zakona** ↓2+contrast / utverzhdaet obshchestvo zashchity prav **potrebitelej** ↓1 //*

[On its territory actually operates a business **center** with **many** violations of the law, according to **the consumer** rights protection Society]

(3) *Po slovam ego **predstavitelej** ↓2 / v hrame est' **avtomojka** ↑3 / **shinomontazh** ↑3 / **avtoservis** ↑3 / platnaya **avtostoyanka** ↑3 / **stolovaya** ↑3 / **himchistka** ↑3 / **torgovye lar'ki** ↑3 / **i pavi'ony** ↓1 //*

[According to its **representatives**, the Cathedral has **a car wash, tire service, car service, paid Parking, dining room, dry cleaning, stalls and pavilions**]

(4) *Pri etom otsutstvuyut kassovye **apparaty** ↑3 / na mnogih **tovarah** net **cennikov** ↓1+contrast //*

[At the same time there are no cash **registers**, on many **goods** there are no **price tags**]

(5) *Mezhdu tem v RPC **govoryat** ↑3 / chto vsyu kommercheskuyu deyatel'nost' na territorii **hrama** ↑3 / osushchestvlyayet **Fond** hrama Hrista Spasitelya ↓2 / ch'im uchreditelem **sam hram ne yavlyaetsya** ↓1+contrast //*

[Meanwhile, the ROC **says** that all commercial activity on the territory of **the temple** is earned out by **the Foundation** of the Cathedral of Christ the Savior Foundation, the Cathedral itself being not the founder of the latter.]

All components of the text are presented in the form of narrative statements, which in terms of speech acts are referred to as messages (in contrast to the question and expression of will). Considering the semantic structure of the mass media text (Dridze, 1984; Duskaeva & Konyaeva, 2017) and traditional media genres (see, for example, Kazak, 2014; Prokofeva & Vasileva, 2016) this is a short news report

normally constructed as follows: (1) a stating thesis (2) the first developing thesis, (3) the first illustration to the developing thesis, (4) the second illustration to the developing thesis, (5) the second developing thesis. The given news text is unfolded from the fact, as for example, there are informational texts unfolded from the authors' conception (Muravyova, 1998). The fact is reported in the first phrase: ... *court ... today will consider ... the claim for trade in the Cathedral of Christ the Savior*. However, it is clear that the text reports at least two facts: a new case in the Khamovnichesky court and claims to the Cathedral on its illegal trade. Which of these facts is being unfolded in the text? Let us analyze the actual division of the beginning of the news text, i.e. the first phrase, consisting of three syntagmas. First it should be noted that the theme-rheme structure of the discourse is predetermined by two circumstances explained in the next paragraph.

Firstly, positionally. The Russian language is dominated by structures in which the theme precedes the rheme. In addition, studies show that when perceiving a sounding text, it is important that the listener first assimilates the theme, in other words, the object of the speech should precede what is being said about it (Yagunova, 2008). Secondly, the theme and the rheme are marked intonationally: ascending intonation is one of the means of expressing the theme (in such a case the sentence may have more than one theme separated by a pause and having characteristic intonation), while the descending intonation marks the rheme. If, within one sentence, the IF order is IF-3 + IF-1, then it is the theme + rheme structure. Another ascending intonation structure – IF-6 – may express the rheme. But it is characteristic of fluent colloquial speech.

Thus, the communicative structure of the first phrase is as follows:

Hamovnicheskij sud Moskv (**Theme¹**)
 [Khamovnichesky court of Moscow]
segodnya rassmotrit po sushchestvu (**Theme²**)
 [today will consider the merits]
isk o torgovle v Hrame Hrista Spasitelya (**Rheme**).
 [of the claim for trade in the Cathedral of Christ the Savior].

Such a structure determines the further unfolding of the text, with the fact of the claims, and not a new court case, becoming the main fact. Note that the lexical composition and word order in the rheme of the first phrase is completely consistent with the order of developing the semantic structure in the subsequent discourses of analyzed text: the claim – (2) reports on the content of the legal claim and the claimant, on trade – (3) and (4) disclose the contents of the “trade” nomination, in the Cathedral of Christ the Savior – (5) reports on the position of the Cathedral.

It is important that the actual structure of theme + rheme (known + new), expressed by the rhythmic structure of IF-3 (incompletion with an ascending tone) + IF-1 (completion with a descending tone), does not have an inverse version. If, in a discourse, due to a specific communicative purpose, the order is reversed (rheme + theme), then the theme is no longer marked in an upward tone, which means that IF models are not fixed to the components of the communicative structure (theme and rheme), but to the positions of the theme and rheme as parts of a complete discourse. This is the way emphasis is being heard in an inverse order. Let's explain by example: Tomorrow afternoon ↑ 3 (theme) / slight cooling ↓ 1 (rheme) // – the theme is the weather for tomorrow, which is reported in the rheme part (answer to the question: “What will the weather be like tomorrow?”). Having inverted the parts, but maintaining the IF order, we will get a different actual division: A slight cooling ↑ 3 (theme) / tomorrow afternoon ↓ 1 (rheme) //. In this latter case the theme is temperature reduction, and the rheme answers the question “When will it get colder?”. If a speaker wants to report a decrease in temperature using such order of the parts (i.e. answering the question “What will the weather be like tomorrow?”) the theme would lose its upward intonation, being in the final position, while the rheme would keep the ascending tone: Slight cooling ↓ 1 (rheme) / tomorrow afternoon ↓ 1 (theme) //.

The reported ability of IF-1 to turn the syntagma into rheme in the initial position is very important when studying our case.

3.3 Rhythmic markers of humor

The further analysis is being built by comparing the standard of rhythmic and intonation organization of the news text presented above with the actual reading of this text on the air of “Ekho Moskv” radio station. The newscaster reads the news in a calm, even manner. However, in some parts of the text, his reading reveals a deviation from the standard, which is perceived as a humorous colouring of the news content. We will show in detail and pay attention to the rhythmic series in the standard and the speaker’s speech (IF models are given through a slash as a series of syntagmas in a phrase). Compare **the first phrase** of the analyzed news.

(1) [Khamovnichesky court of Moscow today will consider the merits of the claim for trade in the Cathedral of Christ the Savior]

Standard: *Hamovnicheskij sud Moskv* ↑3 / *segodnya rassmotrit po sushchestvu* ↑3 / *isk o trgovle v Hrame Hrista Spasitelya* ↓1 // 3/3/1

Newscaster: *Hamovnicheskij sud Moskv* ↓1 / *segodnya rassmotrit po sushchestvu* ↑3 / *isk o trgovle* ↑3 v *Hrame Hrista Spasitelya* ↓1 // 1/3/3/1

As it was said, the standard communicative structure – theme /rheme – is the characteristic of most sentences of the Russian language. But the newscaster implements a different, inverse (emphatic) structure and makes syntagmatic division more fractional. Thus, he gets a symmetrical rhythmic structure (1/3/3/1) and changes the ratio of theme and rheme. The presenter organizes the first syntagma using IF-1, thereby turning *the Khamovnichesky court of Moscow* into a rheme (IF-1 with a drop in tone on the accent bearer), since the rheme is always expressed by a drop in tone. But, as we have shown above, judging by the semantic structure, this text does not unfold the fact of the court’s activity, but clarifies the essence of the claim. Is such a choice of IF a presenter’s error?

Having listened to numerous news broadcasts on different radio stations, we should note that such beginning of the news – with IF-1 – is not uncommon today. It seems that in this way the journalists, guided by their professional interest, realize the “priority of the new in the news” – a kind of mechanical transfer of the news motive to the initial position of the text. At the same time, creatable rhematization designs a symmetrical rhythmic structure within the syntagma, which focuses the listener’s attention on the content and forms the contrast – as the basis of a humorous assessment – between standard content and non-standard prosodic form.

The second phrase is read by the newscaster as the standard suggests:

(2) [On its territory actually operates a business **center** with **many** violations of the law, according to **the consumer** rights protection Society]

Na ego territorii fakticheski dejstvuetsya biznes-centr ↑3 / *so mnogimi narusheniyami zakona* ↓2+contrast / *utverzhdaet obshchestvo zashchity prav potrebitel’* ↓1 //

The logical emphasis in the IF-2 syntagma (the law) and contrast (many violations) create sufficient emotional expression to convey rational content.

Compare **the third phrase** of the analyzed news.

(3) [According to his **representatives**, the Cathedral has a **car wash, tire service, car service, paid Parking, dining room, dry cleaning, stalls and pavilions**]

Standard: *Po slovam ego predstavitelej* ↓2 / *v hrame est' avtomojka* ↑3 / *shinomontazh* ↑3 / *avtoservis* ↑3 / *platnaya avtostoyanka* ↑3 / *stolovaya* ↑3 / *himchistka* ↑3 / *torgovye lar'ki* ↑3 / *i pavil'ony* ↓1 // 2/3/3/3/3/3/3/1/

Newscaster: *Po slovam ego predstavitelej* ↑3 / *v hrame est'* ↓2 / ↓ *avtomojka* ↑4 / ↓ *shinomontazh* ↑4 / ↓ *avtoservis* ↑4 / *platnaya avtostoyanka* ↑4 / *stolovaya* ↑3 / *himchistka* ↑3 / *torgovye lar'ki* ↑3 / *i pavil'ony* ↓1 // 3/2/ – 4/4/4/4/ – 3/3/3/1/

Let us pay attention to how the presenter listed the sale outlets in the Cathedral. Unlike the standard (where IF-3 is needed), the newscaster groups outlets with the help of two intonation structures that are used in the Russian language for enumeration: he pronounces the first four with IF-4, the next three – with IF-3, and completes with the standard IF-1. How can such a choice of a newscaster be explained?

IF-4 is characterized by a kind of placing the intonation center in the “fossa of tone” (we showed it with the two downward arrows enclosing the intonation center): at first a decrease – then a take-off (one can imagine this IF in such hypothetical situation: you address a man of office – *Sorry...* He raises his head from the papers and looks at you inquiringly – *Yeah?* – IF-4: ↓*Ye*-↑*ah?*). It is traditionally believed that the IF-4 serves as an indicator of incompleteness in the official style of speech. By forming a lineup of IF-4, the newscaster adds rigor to his voice. In our example, the first four sale outlets in the Cathedral are associated with car service nominations (a car wash, tire service, car service, paid Parking), and the rest with domestic services (dining room, dry cleaning, stalls and pavilions). The listener catches mocking surprise in the newscaster’s voice: the group of outlets, which denotes realities that are absolutely inappropriate on the territory of the Cathedral of Christ the Savior, the newscaster presents using a series of IF-4 syntagmas. In his choice, one can see what E. A. Bryzgunova described as an “answer with a challenge”, characteristic of IF-4: “*Is your father at home?*” – *At home!* ↓*And what?*↑? (Bryzgunova, 1980a). The respondent is waiting for objections, calls for controversy. Within IF-4 a certainty of speaker’s right to have an opinion is combined with a challenge to the dispute for those who disagree with this opinion. At the same time, household services, from the point of view of common sense, are quite common even on the territory of a church, and the newscaster lists them within IF-3, the latter being standard, neutral, not bearing additional communicative values - the most multifunctional structure in intonation of the Russian language.

Consequently, the grouping of syntagmas in series within a phrase and the choice of IF to design these syntagmas are subject to a newscaster's assessment of artifacts. For example, the usage of IF-4, which has the meaning of “answer with a challenge”, instead of neutral IF-3, supposed by the standard, forms a newscaster’s humorous assessment.

In **the fourth phrase** one can once again observe the coincidence of the standard and the newscaster’s mode of reading.

(4) [At the same time there are no cash **registers**, on many **goods** there are no **price tags**]

Pri etom otsutstvuyut kassovye apparaty ↑3 / *na mnogih tovarah net cennikov* ↓1+contrast //.

Once more we can see that the presence of contrast creates the sufficiency of expression without the presenter’s innovations.

At last, we turn to **the final phrase**, which differ from the standard.

(5) [Meanwhile, the ROC **says** that all commercial activity on the territory of **the Cathedral** is carried out by the Cathedral of Christ the Savior **Foundation**, the **Cathedral itself being not** the founder of the latter]

Standard: *Mezhdu tem v RPC govoryat* ↑3 / *chto vsyu kommercheskuyu deyatel'nost' na territorii hrama* ↑3 / *osushchestvlyayet Fond hrama Hrista Spasitelya* ↓2 / *ch'im uchreditelem sam hram ne yavlyayetsya* ↓1+contrast // 3/3/2/1C

Newscaster: *Mezhdú tem v RPC govoryat* ↑3 / *chto vsyu kommercheskuyu deyatel'nost'* ↑3 *na territorii hrama* ↑3 / *osushchestvlyayet Fond hrama Hrista Spasitelya* ↑3+ *contrast* / *ch'im uchreditel'm* ↑3 / *sam hram* ↑3 / *ne yavlyetsya* ↓1 // 3/3/3/ – 3C/ – 3/3/1

When comparing, both quantitative and qualitative differences attract attention. The newscaster's speech shows the priority of discursive meanings over illocutionary ones, that is, the priority of coherence over informing. This is evidenced by the fact that the newscaster builds the discourse exclusively on IF-3 with the meaning of incompleteness, thus admitting a monotonous, boring reading of the first three syntagmas presented by the same IFs. However, in the fourth syntagma, the presenter adds contrast on the word “fund” to IF-3, thus noting the unexpected appearance of a new organization on the territory of the Cathedral. The entire phrase is rhythmically formed around the IF-3 syntagma with contrast, the syntagma's content is being presented by the newscaster as another new and interesting fact with a general humorous assessment. We connect the ease of assessment with the fact that more analytical forms of humor (mockery, irony, ridicule) need more information to form an attitude towards what is happening. The short news within the radio issue form space only for the mild humorous reactions of the newscaster. A humorous assessment can thereby be realized by a typical phrase, which is rhythmically formed around the IF-3 syntagma with contrast (3/3/3 / – 3C / – 3/3/1). In the end of a news message such phrase allows forming an intrigue regarding new and interesting fact not yet subject to discussion in mass media.

4 CONCLUSION

In our study, we proceed from the proposition that the result of the interaction of prosodic characteristics of a statement is its rhythmic organization. The text rhythm is understood as “quasiregular repeatability of rhythmic structures constituting intonational-semantic blocks formed within syntagma and phrase – the minimal semantic units” (Potapov, 2011). Having discovered in our previous work the correlation (in conversation and declamation of prose) of rhythmic structures with a certain emotional-semantic content (Vasileva, 2018), and possessing the knowledge on the specifics of the rhythm in radio news (Prokhvatilova & Sinitsyna, 2014), we assumed that prosodic signals about the humorous content in the oral media speech should be found within the rhythm characteristics. A study of the scientific context of the problem, given in Section 2, indicates the absence of studies of Russian prosaic rhythm markers in the aspect of humor (see the review of foreign works in Gironzetti, 2017). This article is the first attempt at such an analysis.

The objective of our research was to indicate within media text the rhythm structures correlating with emotional-semantic content of those fragments in which the newscaster makes a humorous assessment.

An important concomitant purpose was to demonstrate the non-experimental auditory analysis during which the introspection “allowed” to all linguists by Wallace Chafe is fully involved. The value of the researcher himself is of great significance for the intonation analysis, which is discussed in section 3.1.

At the stage of case selection the listening by a group of students was implemented: young people were proposed to listen to the news release and note the news message in which they heard a humorous intonation in the newscaster's speech; at the same time, the auditors were not explained what was meant by humorous intonation. The majority of auditors selected a short news message, which was finally chosen as an object for analysis in the article. The author of the article basing on previously obtained data on the Russian radio news rhythm, made audio recording of the selected message in a standard reading with neutral ascertaining intonation. The material mentioned above was used in Section 3.2 to show the interaction of syntagmas in the rhythmic structure. The processing of both texts (standard and precedent) was done by the author of the article using auditory marking, which resulted in determining of syntagmas' boundaries, stressed syllables and logical and emphatic accents in the syntagma. Then, the IFs of each syntagma were determined and the syntagmatic series of the phrase were shaped in digital form, for example: 1/3/3/1, where the IF types were shown in numbers, while slashes separate the syntagmas - therefore, this is a four-syntagmas phrase with a symmetrical structure. When analyzing the semantic content of phrases, the

interpretation of IF models was corrected by the actual division. A phrasal comparative analysis of the standard and precedent is shown in section 3.3.

The results of the analysis suggest the possibility of finding correlation between rhythm and humor. The author demonstrates this possibility using speech material, which is not a humorous narrative, moreover – judging by a definition of a news message, it should be presented to listeners in the most abstract, unemotional manner. Nevertheless, despite the text itself, the listener captures the newscaster’s assessment of the information he reports.

In the absence of paralinguistic marks (laughter, the signs of smile in the voice) and paratextual elements (explaining self-referring remarks like *it’s funny*, *all the sudden*, and so on) the rhythmic organization of a message becomes a marker of humor. This could be found by comparing the standard and precedent.

In the rhythmic structure of the phrases marked by humor in the analyzed message, the following characteristic features which can generally be referred to as rhythmic markers of humor were found:

1. The creatable rhematization of the initial syntagma of a phrase has two functions: a) typically reportorial, when the initial position of the message forms a news event; b) the function of creating a symmetrical rhythmic structure within the phrase. According to our preliminary observations, it helps to focus the listener’s attention on the content and (in this case) forms the contrast between the standard content and the non-standard prosodic form. The contrast is thus the basis of a humorous assessment.

2. The grouping of syntagmas in series within a phrase and the choice of IF to design these syntagmas are subject to a newscaster’s assessment of artifacts. For example, the usage of IF-4, which has the meaning of “answer with a challenge”, instead of neutral IF-3, supposed by the standard, forms a newscaster’s humorous assessment.

3. A humorous assessment can be realized by a rhythmic phrase type, which is symmetrically formed around “IF-3+contrast” syntagma type (3/3/3 / – 3C / – 3/3/1). In the end of a news message such phrase allows creating an intrigue regarding new and interesting fact not yet subject to discussion in mass media.

We believe that further empirical analysis will help, firstly, to deepen our ideas about humor as a communicative resource in a digital news environment, secondly, to discover new mechanisms for the rhythmic organization of media texts, and thirdly, to advance in the field of understanding the communicative content of modern Russian media speech.

ACKNOWLEDGMENT

The study was carried out with the financial support of the RSF: grant 19-18-00530 “Humor as a communicative resource in the digital news environment”. I also thank the colleagues with whom I had useful conversations after my report in the International Conference at the Institute for Experimental Phonetics and Speech Pathology “Djordje Kostic”. Those conversations are reflected in this article.

REFERENCES

- Abercrombie, D. (1967). *Elements of General Phonetics*. Edinburg.
- Antipova, A.M. (1984). *Ritmicheskaya sistema angliyskoy rechi* [The rhythmic system of English speech]. Moscow. In Russian.
- Archakis, A., Giakoumelou, M., Papazachariou, D., & Tsakona, V. (2010). The prosodic framing of humor in conversational narratives: Evidence from Greek data. *Journal of Greek Linguistics*, 10, 187–212.
- Attardo, S. & Pickering, L. (2011). Timing in the performance of jokes. *Humor: International Journal of Humor Research*, 24 (2), 233–250.
- Attardo, S., Eisterhold, J., Hay, J., & Poggi, I. (2003). Multimodal markers of irony and sarcasm. *Humor: International Journal of Humor Research*, 16 (2), 243–260.
- Bauman, R. (1986). *Story, performance, and event: Contextual studies of oral narrative*. Cambridge.
- Bryzgunova, E.A. (1980a). Formy prostogo predlozheniya [Form a simple sentence]. In N. Shvedova (Ed.), *Russkaya grammatika [Russian grammar]*, vol. II (pp. 98–119). Moscow. In Russian.

- Bryzgunova, E.A. (1980b). Intonatsiya [Intonation]. In N. Shvedova (Ed.), *Russkaya grammatika [Russian grammar]*, vol. I (pp. 96–122). Moscow. In Russian.
- Chafe, W. (1994) (ed.). *Discourse, consciousness, and time: The flow and displacement of conscious experience in speaking and writing*. Chicago.
- Chafe, W. (2008). Rol' introspektsii, nablyudeniya i eksperimenta v ponimani myshleniya [The role of introspection, observation, and experiment in understanding thinking]. Transl. from English by E.V. Prozorova. *Voprosy yazykoznaniya [Questions of linguistics]*, 4, 78–88. In Russian.
- Chemerilov, V.V., Fadeyev A.S. & Mishunin, O.B. (2016). Algoritm vydeleniya intonatsii poyasneniya, protivopostavleniya i perechisleniya v tekste pri avtomaticheskoy sinteze rechi [Algorithm for highlighting intonation of explanation, contrasting and enumeration in the text with automatic speech synthesis]. *Fundamental Research*, 10, 354–358. In Russian.
- Cheremisina, N.V. (1982). *Russkaya intonatsiya: poeziya, proza, razgovornaya rech [Russian intonation: poetry, prose, colloquial speech]*. Moscow. In Russian.
- Demina, M.A. (2013). Prosodicheskiye sredstva vozdeystviya v rechi diktirov informatsionnykh programm [Prosodic means of influence in the speech of speakers of information programs]. *Bulletin of MSHU*, 1(661), 41–50. In Russian.
- Deterding, D. (2001). Measurements of Rhythm: a Comparison of Singapore and British English. *Journal of Phonetics*, 29 (2), 217–230.
- Dridze, T.M. (1984). *Tekstovaya deyatel'nost' v strukture sotsial'noy kommunikatsii [Textual activity in the structure of social communication]*. Moscow. In Russian.
- Duskaeva, L.R. & Konyaeva, Yu.M. (2017). Types of information portraits in a journalistic discourse. *Rupkatha Journal on Interdisciplinary Studies in Humanities*, 9 (4), 131–143. DOI: 10.21659/rupkatha.v9n4.13.
- Flamson, T., Bryant, G.A., & Barrett, H. C. (2011). Prosody in spontaneous humor: evidence for encryption. *Pragmatics & Cognition*, 19(2), 248–267.
- Gironzetti, E. (2017). Prosodic and Multimodal Markers of Humor. In *The Routledge Handbook of Language and Humor*, ed. by S. Attardo (pp. 400–413). New York and London.
- Girshman, M.M. (1982). *Ritm khudozhestvennoy prozy [The rhythm of fiction]*. Moscow. In Russian.
- Kadooka, K. (2012). An acoustic analysis of the punch line paratone in the Japanese Kobanashi Stories. *Ryukoku Journal of Humanities and Sciences*, 33 (2), 17–37.
- Kazak, M.Yu. (2014). Sovremennyye mediateksty: problemy identifikatsii, delimitatsii, tipologii [Modern media texts: problems of identification, delimitation, typology]. *Media linguistics*, 1 (4), 65–76. URL: <https://medialing.ru/sovremennyye-mediateksty-problemy-identifikatsii-delimitatsii-tipologii/> (retrieved 17.11.2019). In Russian.
- Mathesius, V. (1967). O tak nazyvayemom aktual'nom chlenenii predlozheniya [About the so-called actual division of a sentence]. In *Prazhskiy lingvisticheskiy kruzhok [Prague Linguistic Circle]*, transl. from Czech G.V. Matveeva (pp. 239–245). Moscow. In Russian.
- Matveyeva, T.V. (1997). K voprosu o ritme kak zhanroobrazuyushchem priznake v razgovornoj rechi. In *Zhanry rechi [Genres of speech]* (pp. 44–51). Saratov. In Russian.
- Muravyeva, N.V. (1998). *Kommunikativnyye strategii zhurnalista: chto takoye "neponyatnyy" tekst i kak sdelat' yego "ponyatnym" [Communicative strategies of a journalist: what is an "incomprehensible" text and how to make it "understandable"]*. Moscow. In Russian.
- Norrick, N.R. (2001). On the conversational performance of narrative jokes: Toward an account of timing. *Humor: International Journal of Humor Research*, 14, 255–274.
- Pickering, L., Corduas, M., Eisterhold, J., Seifried, B., Eggleston, A., & Attardo, S. (2009). Prosodic markers of saliency in humorous narratives. *Discourse Processes*, 46, 517–540.
- Pike, K. L. (1945). *The Intonation of American English*. Michigan.
- Potapov, V.V. (2011). Tipologicheski relevantnyye priznaki rechevogo ritma [Typologically relevant signs of speech rhythm]. *Bulletin of MSHU*, 13(619), 183–192. In Russian.
- Prokhvatilova, O.A. & Sinitsyna, L. V. (2014). O spetsifike ritmicheskoy organizatsii sovremennoy diktorskoy rechi (na materiale rechi vedushchikh novostnykh teleprogramm) [On the specifics of the rhythmic organization of modern speaker's speech (based on the speech of leading television news programs)]. *Bulletin of the Volgograd University. Series 2: Linguistics*, 2, 7–13. In Russian.
- Prokhvatilova, O.A. (1999). *Pravoslavnaya propoved' i molitva kak fenomen sovremennoy zvuchashchey rechi [Orthodox sermon and prayer as a phenomenon of modern sounding speech]*. Volgograd. In Russian.
- Prokofeva, N.A. & Vasileva, V.V. (2016). Genre Styles of Phatics: PR Communication in Media Discourse. *The Social Sciences*, 11 (7), 1151–1156. DOI: 10.3923/sscience.2016.1151.1156.

- Prokof'yeva, O.G. (2000). *Semantika intonatsionnoy vydelennosti v tekstakh spontannoy monologicheskoy rechi. Na primere akademicheskogo i informatsionnogo stilya* [The semantics of intonational emphasis in the texts of spontaneous monological speech. On the example of academic and informational styles]. Doc. diss.... cand. of philol. sciences. Moscow. In Russian.
- Rodionova, O.S. (2014). K voprosu o sintagme i sredstvakh yeye realizatsii [On the issue of syntagma and means of its implementation]. *Bulletin of the Saratov State Law Academy*, 5(100), 171–178. In Russian.
- Shevchenko, T.I., Buraya, Ye.A., Galochkina, I.Ye., Kuz'mina, M.O., & Fedotova, M.V. (2012). *Sovremennyye metody analiza zvuchashchey rechi* [Modern methods of analysis of sounding speech]. Dubna. In Russian.
- Shevyakova, V.E. (1990). Aktual'noye chleneniye predlozheniya [Actual division of the sentence]. In *Lingvisticheskiy entsiklopedicheskiy slovar'* [Linguistic Encyclopedic Dictionary] (pp. 22–23). Moscow. In Russian.
- Svetozarova, N.D. (1982). *Intonatsionnaya sistema russkogo yazyka* [Intonation system of the Russian language]. Leningrad. In Russian.
- Torsuyeva, I.G. (2009). *Intonatsiya i smysl vyskazyvaniya* [Intonation and meaning of the statement]. 2th ed. (first ed. – 1979). Moscow. In Russian.
- Vasileva, V.V. (2018). *Russkiy prozaicheskiy ritm. Dinamicheskiy aspekt* [Russian prosaic rhythm. Dynamic aspect]. 2th ed. (first ed. – 1992). SPb. In Russian.
- Wennerstrom, A. (2011). Rich pitch: The humorous effects of deaccent and L plus H* pitch accent. *Pragmatics & Cognition*, 19 (2), 310–332.
- Yagunova, E.V. (2008). *Variativnost' strategiy vospriyatiya zvuchashchego teksta* [Variability of strategies for perceiving sounding text]. Perm. In Russian.
- Zlatoustova, L.V. (1981). *Foneticheskiye yedinitsey russkoy rechi* [Phonetic units of Russian speech]. Moscow. In Russian.

New Knowledges on Genetic Continuity and Linguistic Continuity of the Serbian Language

Drago Djordjević

Institute of Pathological Physiology, Faculty of Medicine, University of Belgrade

E-mail: dragodj@gmail.com

ABSTRACT

In the Paleolithic-Mesolithic-Neolithic period, all Danube cultures had genetic continuity (paleoethnogenetics or archeogenetics) and linguistic continuity (linguistic continuity theory of the Indo-Europeans).

Archaeological genetic research has shown that the surviving carriers of BT and CT haplogroups from the Alps and Balkans have spread worldwide after the mega-tsunami caused by the fall of a large cosmic body (asteroid) into the Pacific Ocean about 68 kya. The majority of the population in Europe in the Neolithic consisted of haplogroup IJ, and mostly were consisted of haplogroups I1/I2 after 12 kya. Much later, increased the proportion of haplogroups R1a/R1b. The genetic structure of today's population (dominant haplogroups I2 and R1a of Proto-Serbs) in the territory of the Danube Region (Old Europe) shows an uninterrupted continuity with the Mesolithic and Neolithic periods and testifies the genetic autochthony of Serbs in this area.

The linguistic continuity of the Serbs is confirmed by the list of Slavs words from the Paleolithic, Mesolithic and Neolithic periods, which practically represents the “oldest substrate of European languages“. Lexicon of Slavs from these periods was shared by other Indo-European languages. Hence, the Neolithic cultures of Old Europe constitute the “primordial linguistic culture of Europe“.

Old Europe is an area of the Balkans where an advanced Indigenous Serb civilization was developed in the pre-Indo-Neolithic period, creating the first prototype, known as the Script of Lepenski Vir, whose improvement later evolved into the Vinča script or Serbica. King Stroimir's golden broad seal, engraved in Cyrillic Serbica, is material evidence of the existence of the old Serbian states before the Nemanjić dynasty. Today's Cyrillic and Latin letters are mostly unmodified letters of the Serbica.

The creation and continuity of Vinča calendar (autochthonous Serbian calendar) is, to this day, another proof of the preserved genetic and cultural identity of Serbs and their autochthony in the territory of Old Europe.

Keywords: continuity, Vinča, script, calendar, autochthony.

In the Paleolithic-Mesolithic-Neolithic period, all Danube cultures had genetic continuity (*paleoethnogenetics* or *archeogenetics*) and linguistic continuity (*linguistic continuity theory of the Indo-Europeans*) [16, 84, 85].

1 GENETICS OF SERBIAN LANGUAGE

Anatomically modern humans (AMHs) are thought to have evolved in sub-Saharan Africa about 200–150 kya [k (“kilo or thousand”) + ya (“years ago”)] and from there to have eventually colonized the rest of the world [94]. It is unclear, though, how and when modern humans first left Africa and whether there was one major migration out of Africa or more than one. Although the origin of speech is still debated, it is one of the unique characteristics of humans and the most likely arose in humans about 100 kya [64].

When AMHs left Africa about 40–50 kya and arrived in Europe about 45 kya [32], gathering food or foraging (the collecting of wild plants, fishing, and hunting) dominated their culture and lasted until the end of the last glacial period (LGP), about 12 kya [32, 50]. Development of the agriculture marked the last of the Stone Age period and began the Neolithic period, starting in Southeastern Europe about 9 kya years ago and spreading to Northern Europe by about 5 kya [32].

Early farmers from all over the Europe are directly originated from the Neolithic Balkans [52] or the Aegean [8, 33]. There is a direct genetic link between Mediterranean and Central European early farmers and those from the Balkans and Anatolia, extending the European Neolithic migration chain as far as Southwest Asia [21, 33]. Thus, with the development of agriculture indigenously or through migration [33], about 8,6–8,5 kya [25, 33], Europe experiences a *second wave* of colonization during the Neolithic period [6].

1.1. Y-DNA haplogroups

The ancestors of present humankind did not develop in Africa about 50–100 kya, but elsewhere, apparently in Eurasia or in Europe [44, 47] (Figure 1) [96, 97]. However, Proto-Eurasians evolved about 130 kya or even earlier [62].

All non-Africans have common ancestors from which has splitted Denisovans about 800 kya [24] and Neanderthals about 400 kya [37, 60].

About 68 kya (71,000–57,000) by paleoclimatology or about 64 ± 6 kya by the deoxyribonucleic acid (DNA) genealogy, a big cosmic body (probably massive asteroid) fell into the Pacific Ocean causing a mega-tsunami with wave of many kilometers high [97, 98]. The mega-tsunami flooded the most of the continents, except the East African Highlands and region in the Alps and the Balkans in Europe [97, 98].

On the East African Highlands survived the males which have a paternal-specific marker, the Y chromosome (Y-DNA) haplogroups A00, A0, A1b1 and B [40] together with their females were spread to the most of Africa [37].

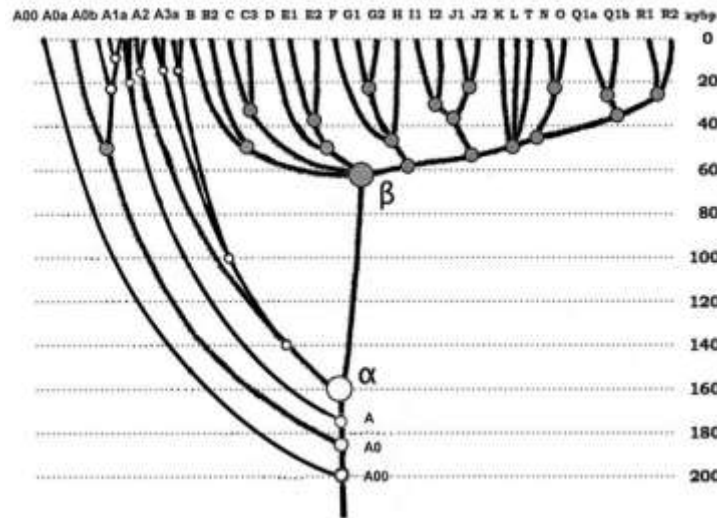


Figure 1: Haplogroup tree of the *H. sapiens* Y-chromosome derived from haplotypes and subclades that in its oldest part includes a series of nodes-haplogroups, that in the current classification are called A0-T, A1, and A1b (which is not correct, though haplogroups A0-T and A00 were formed 235,9 kybp [Yfull (2019)], where the African branch of the alpha (α) tree (on the left) arose about 160 kya, and the non-African branch of beta (β) tree (on the right) arose about 64 kya [Юрковец, В.П. (2015); modified]. Timescale on the vertical axis shows thousands (kilo) of years before present (kybp) from the common ancestors of the haplogroups and subclades.

In the region in Alps and Balkans in Europe survived the males having Y-DNA haplogroups BT and CT (Figure 2) [40] with their females having a maternal-specific marker, the mitochondrial DNA (mtDNA) haplogroup U [37]. These European survivors expanded subsequently across Eurasia, entered Americas, Australia, and the males having the Y-DNA haplogroup E entered Africa, where it is now the main haplogroup [60].

The time splitting (in parentheses is the approximate time of its formation in years ago) of the Y-DNA haplogroup DE (69,0 kya) [10] on to haplogroup D (65,2 kya) and haplogroup E (65,2 kya) [60] is very similar to the age of Eurasian mtDNA L3 (71,0 kya) [10]. Inside Africa, frequency distributions of maternal L3 and paternal E lineages incomers are positively correlated [10]. Back migration of Eurasian populations into Africa is a critical contributor to the genetic diversity [12].

All Y-DNA lineages outside Africa descend from three founder lineages: C (65,9 kya), F (65,9 kya), and D (65,2 kya) [60]. The descendants of the mtDNA haplogroup L3 outside Africa are the oldest three major mtDNA haplogroups: M (65,5 kya), N (64,1 kya), and R (61,3 kya) and have very similar age to above mentioned Y-DNA lineages [32].

In skeletons of about 30 kya and older people across Europe (in the Czechia, Romania, Russia, Germany, Belgium, Italy, Spain) were discovered the Y-DNA haplogroups BT, CT, C, F, I and the haplogroups HIJK and IJK, which derived from the haplogroup F and which are ancestors of haplogroup I [60]. Cro-Magnon Y-DNA haplogroups are thought to belong to C, F, and I [32]. Haplogroups F, I1, and I2, along with I2 lines, were also found among early farmers in Siberia and southern France [32].

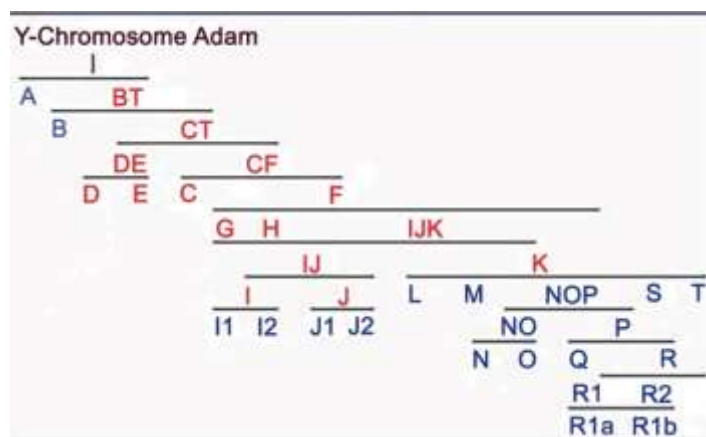


Figure 2: Human Y-DNA haplogroup tree (Y-DNA haplogroup across nations), where haplogroup descendants in red are designated survivors of BT haplogroups from the Alps and Balkans that have spread worldwide after the fall of the great cosmic body (probably massive asteroid) about 64 kya [Клёсов, A.A. (2014в); modified].

Native Europeans men are primarily carriers of Y-DNA haplogroup I, and women are carriers of mtDNA haplogroup U [37]. In our Danube region, the “nest of civilization“ [18], the development of the haplogroup I occurred about 42,9 kya [39, 60, 96]. Their more intense spread occurred after the last ice age about 12 kya [48].

Haplogroup F (65,9 kya) from the Danube region is distant ancestor of haplogroup R developed about 31,9 kya between southern Siberia and the Altai region [39, 60, 96]. At same territory formed haplogroup R1 (28,2 kya), and from it the haplogroup R1a (22,8 kya) and the haplogroup R1b (22,8 kya) [39, 60, 96]. Haplogroup R1a arrived in Europe about 9 kya [45, 46], and haplogroup R1b much later, around 4,8 kya [41]. Today, the most represented haplogroups in Europe are R1a (dominant in Eastern and Central Europe) and R1b (dominant in Western and Southern Europe); haplogroup I1 is dominant in Scandinavia and I2 haplogroup is dominant in the Balkans [48].

The Y-DNA haplogroups of Serbs is particularly typical of our (Balkans) territory [48], especially haplogroup I2 and haplogroups R1 [31]. Proto-Serbs or Serbo-Rasian (“Slavs”) are a mixture of Y-DNA haplogroups R1a and I, which lived mainly as “genetically” mixed villagers, “not clans or tribes” [62]. Haplogroups I2a and R1a played a decisive role in the ethnogenesis of the Proto-Serbs, Serbo-Rasian or Serbo-Slavs (“Slavs”) [90]. About 58% of Serbian Y-chromosomes [I1-M253 (7,8%), I2a-P37.2 (29,1%), and R1a1a-M198 (20,4%)] belong to lineages believed to be pre-Neolithic [67]. Today, this amount is only slightly increased (63,92%), as well as for haplogroups, but the haplogroup relationship is almost the same [90]. The most frequently observed haplogroups in Serbs are I-M258 (38%), R1a1a-M198 (20%), and E1b1b1-M35 (18%) [67].

Haplogroup I is the oldest large Y-DNA haplogroup in Europe, developed in the Balkans about 42,9 kya (I-M170), after separation from the superhaplogroup IJ (IJ-M429) [67], which is a derivative of the even larger haplogroup IJK from the common ancestor of BT haplogroups [39, 60, 96]. Haplogroup I is thought to have played a central role in the process of human recolonization of Europe from “isolated glacial refugia” after the last glacial maximum (LGM) [67], that lasted about 27–19 kya [89].

Haplogroup I1 and haplogroup I2 was originated in the Balkans during the Late Palaeolithic when they were formed about 27,5 thousand (kilo) of years before present (kybp) [96]. The three male skeletons found in the common tomb of Dolni Vestonice date back to about 26,640±110 kya [54].

Haplogroup I2 was dominant in European hunter-gatherers during Late Paleolithic and Mesolithic period, which displaced after the LGM throughout Europe [69]. Haplogroup I2a is typical primarily of European peoples, although it is also found in traces in the Middle East and Central Asia [42, 67].

The most represented haplogroup I2a with its single nucleotide polymorphisms (SNPs) mutations I-M423 was formed about 18,3 kybp [96]. Haplogroup I2a1b-M423 (I2a1b L178/S328, M423) is so called the “Dinaric”, “Balkanic”, “Danubian”, “East European” or “Serbian” branch of I2a and its descendent subclades [42, 48, 90].

Haplogroup I2a and its subclade I2a1 appears together as the great victor of the Neolithic period [31, 36] (Figure 3) [31]. Haplogroup I2a1 (P37.2) is by far the largest branch of I2 and one of the most strongly linked to Neolithic cultures in south-east, south-west and north-west Europe [31]. Haplogroup I2a1, the largest branch of I2, appears to have progressed especially in the Starčevo - Körös - Criş culture in Southeast Europe (Early Neolithic, 6,200–4,500 B.C.) [20, 27].

Haplogroup I2a2 (I2a2a-M223) or I-M223 formed about 17,1 kybp [96] and its samples are found in Spain during the early or middle Neolithic [20, 27]. Haplogroup I2a2 subclade I-L621, sometimes called I2a-Din (for Dinaric) [31], were formed about 11,2 kybp [96]. Subclade I-L621 were dominated in Cucuteni-Trypillian culture (4,800-3,000 B.C.) which evolved as an offshoot from the Starčevo - Körös - Criş culture [31].

In southeastern Europe, the haplogroup I2a2 is still one of the major male lines today [31]. Haplogroup I2a2 subclade I-Y3120 formed about 3,8 kybp nowadays more widespread in Europe, especially in the Balkans, among all nations [96]. This is confirmed by the current close haplotype relationship between the Basques and Sardinians (I2a1a), indicating that they had a common Neolithic ancestor [11, 32].

In ancient Serbs, “indigenous” markers (M) are special haplogroups I1b* (xM26) and R1a and R1b, present in the Balkans in the Pre-Neolithic period [63, 69]. Majority invasions of the Balkans by haplogroup R1a occurred in two “waves” (about 9 kya and 7,5 kya) [45, 46], as well as by haplogroups R1b (about 6 kya and 4,2 kya) [41, 43].

The age of the local dominant sub-branch I2a1b-M423 is estimated at about 7,500-5,000 years, corresponding to the adoption of agriculture in the Balkans and the consequent population growth [87]. During this period, the Neolithic replaced the Bronze Age, beginning in the Balkans at about 5 kya, followed by the Iron Age at about 3 kya, spreading to northern Europe over the next 500 years [32]. The Neolithic period and all three metallic ages (copper, bronze and iron) had their migrations, invasions, trading and trade routes, which led to the spread of genes, crossbreeding and the emergence of a genetic mixture.

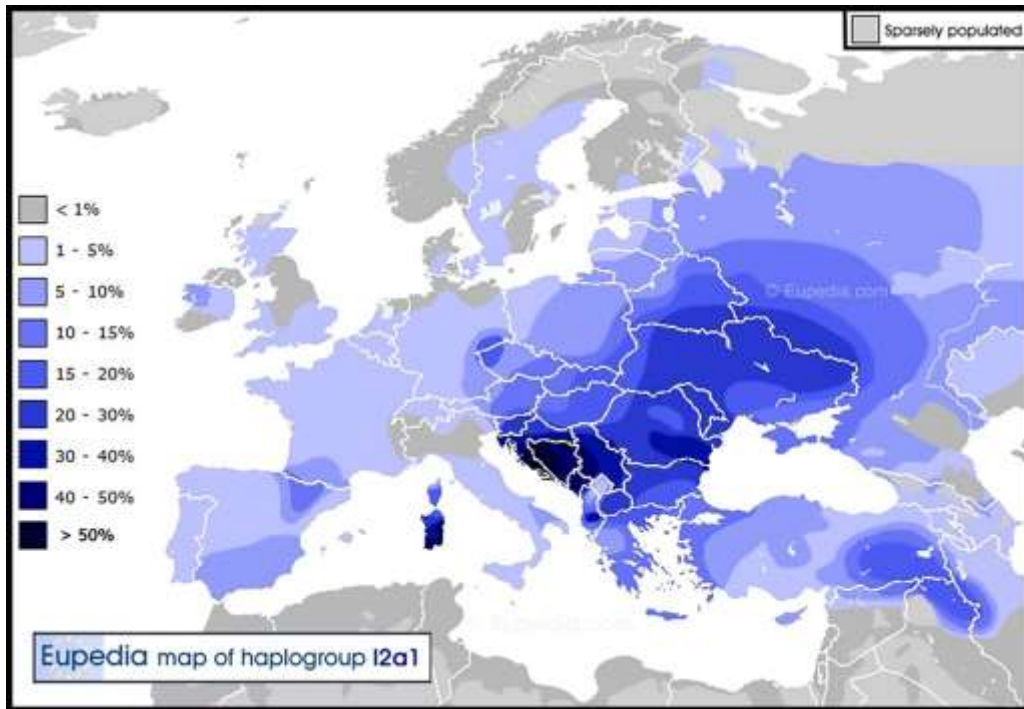


Figure 3: Distribution of haplogroup I2a1 (formerly I2a) in Europe [Hay, M. (2018)].

Haplogroup with SNP name – I-M170 • PF3715 is the oldest haplogroup I2 formed about 27,5 kybp [96] or simple I-M170, and it is one of the most numerous haplogroups among men in Europe [69]. The connection between I-M170 and the Upper Paleolithic hunter-gatherer Gravettian culture is based on the fact that the Balkans served as a “glacial refugium” for the Central European Gravettian population of about 29-28 kya [28]. The oldest specimen I-M170 documented in Europe belongs to a Gravettian man from Paglicia (lat. *Paglicci*) in Apulia, Italy (34,580–31,120 calibrated years ago) [28]. In Europe, the regional incidence of haplogroup I-M170 (responsible for high growth) is the highest in the Dinaric Mountains, in Herzegovina and Montenegro [28]. Common SNPs explain a large proportion of the heritability for human height [95]. Heritability of SNP is a fundamental quantity in the study of complex traits including association between intelligence and physical health, illness, and mortality [13].

Haplogroups in the Western Balkans today contain mostly specific sub-branch I2a1-P37.2 or I-P37 (20,9 kybp) and more specific sub-branch I2a1b-M423 (18,3 kybp) [28, 96].

The finding that the five major haplogroups (E3b1, I1b* (xM26), J2, R1a and R1b) make for more than 70% of the total genetic variation of Southeastern Europe, in which dominated R1a and I1b* (xM26), is consistent with the typical European genetic reserve Y-DNA [63].

The dating of the three major lines (I1, R1a, and R1b), which make 64% of the sampled Y-DNA, have very recent coalescing time, ranging from 3,500 to 7,300 years, with a minimum of spreading time of the effective population about 2,100–4,200 years from the Balkans to the British and Irish Isles [5].

The current genetic map of Europe is at least 7,000 years old and in Romania includes about 68% of Old Europe DNA (I1/I2–33% and J1/E1/G–35%) and 29.5% of Kurgan, Celtic and Slavs DNA (R1a–17,5% and R1b–12%) [36]. The most of the population in Europe from 12,000–6,000 B.C. constituted haplogroup I1/2 [36]. At the time of the Genesis of the World according to the Bible tradition of 5508 B.C., that is, the “beginning of the era of the Ancient Europe“, the population of Old Europe consisted of a mix of hunters I1/2 (50%) and farmers J1/2 + E1b1 + G (50%) [36].

The Y-chromosome haplogroups that represent the genetic signal of “Slavs”: **I2a-CTS10228** or I-CTS10228 (5,1 kybp), also known as **I2a-Dinaric**; **R1a-Z280 (4,8 kybp)** and **R1a-M458 (4,7 kybp)** [66, 96]. They are bearers haplogroups over half of the Serbs [I2a-CTS10228 ~ 34%, R1a (Z280+M458) ~ 17%] [66]. Dinaric branch I2a1b2-L621>CTS10228>Y3120 [66] or I-Y3120 formed 3,8 kybp [96].

1.2. mtDNA haplogroups

The carriers of female mtDNA haplogroups are of three major classes of haplogroups: 1. (H, V); 2. (U3, U4, U5, K); and 3. (J, T); they are, together with haplogroup H, the most widespread in Europe and southwest Asia, with a frequency in Europe of 40-60% [32].

The most widespread European branch of the mtDNA haplogroups is haplogroup H which represents over 40% of total mtDNA variability [55] and emerged about 25–20 kya [32, 36]. In the Balkans, the majority of Thracian women in the Bronze Age belonged to the haplogroup H subgenus, reaching 33% of the total frequency [55]. Otherwise, the European Bronze Age began about 5 kya in Southeast Europe, and is characterized by early forms of writing and the using of bronze (an alloy of copper and tin) for developing of art, tools, and weapons [32].

Haplogroup H was found in 44.3% of total samples in Serbia and Montenegro, haplogroup U in 17.7%, and haplogroup J in 8.8% [86]. This is consistent with representation of the prevalent subclade of haplogroup H of 40.34% in Serbia and 48.20% in Montenegro with an estimated coalescence time of about 20 kya corresponding to the time of its age [86]. It seems that this clade was involved in a post-glacial re-expansion of populations from southwestern Europe to the rest of the continent [86]. There is abundant internal diversification with over 60% representation of H*, H1, H2, and H5 subhaplogroups in Serbia and Montenegro [86].

Haplogroup U2 is one of the oldest haplogroups in Europe and dates from about 36 kya [24]. The U5 haplogroup mtDNA is the most abundant ancient U subhaplogroup among the first early modern humans in Europe and dates from about 30 kya, that is, from the time before the LGM [24].

It has been found that genetic diversity was shaped over time by predominantly local processes, with different sources and proportions of hunting-gatherer ancestors between Neolithic and Chalcolithic regions of Europe such as Serbia, Croatia, Hungary, Germany, and Spain [51], inhabited by Proto-Serbs or Serbo-Rasian. Admixture between groups of different ancestral profiles was often happened and resulted in a marked population transformation through almost all cultural transitions [51].

2. LINGUISTICS OF SERBIAN LANGUAGE

Signs of literacy have appeared in many parts of the world at different times in the ancient human past. There is a great similarity between the signs on the territory of the Danube region (sr. *Podunavlje*), known as *the Danube civilization*, that include the Vinča script, the Runic signs in Hungary, and the signs found inside the Bosnian Pyramids [23, 34], which are much older than the Egyptian Pyramids [23, 34, 56]. Similar writings also have been found on the *Mas d'Azil* stones in France and on islands in the Aegean Sea, Tepe-Yahya in Iran, writings from Troy and Egypt [34]. All these findings signify the actions of representatives of the same culture, as evidenced by the same or similar written characters [23, 34].

The Lower Danube region is the cradle of civilization. The Danube civilization includes a large number of cultures of the *Serbo-Rasian Prehistory* in the period that can be divided into: (1) *the period of the Proto-Lepenski Vir* (10,000 – 8,000 B.C.), which represents the “beginning of historical sources for the Serbo-Rasian”; (2) *the period of the stability or without the moving* (sr. *doba stajstva*) (8,000 – 4,000 B.C.); (3) *the period of acquiring and increasing possession* (sr. *doba imetstva*) (4,000 – 2,000 B.C.) [16]; and (4) *the period of the splitting* (sr. *doba cepanja*) of Serbo-Rasian with the forming of other nations and scripts from the Serbo-Rasian script - *Serbica* (2,000 – 100 B.C.) [65].

2.1. Serbian script

Thanks to stable climatic and social conditions, over a long period of time, a high level of economic development was achieved, primarily agriculture and animal husbandry, which conditioned a persistent way of life in the Danube region during this period, called *the period of the stability or without the moving* (8,000-4,000 B.C.) [16]. This development is expressed by the appearance of the first literacy in the world,

just in the Lower Danube region [1, 2, 3, 16], in the “nest of civilization“ [18], about 8,000 B.C., in the Lepenski Vir [16, 65].

Lepenski Vir script evolved from 8,000-6,000 B.C. [65].

The Starčevo culture inherited The Lepenski Vir culture, then the *Vinča-Turdaş* culture from the Copper Age, which is at least 200 years older than the early Sumerian culture, and literacy is incomparably older [35, 53]. All these are evidences that Serbian literacy is the oldest in the world [14, 19, 53, 75, 76]!!!

The Vinča script developed from 5,500-3,200 B.C. [16, 65]. The founder of Serbian archeology, Professor Miloje M. Vasić, first pointed to the existence of the Vinča script in 1908 [65], while his system was discovered and promoted by prof. Radivoje Pešić only in 1980, 1985 and 1987 in Milano, Italy, when its phonetic values were also identified [65]. Even today, unfortunately, is still ruling incomprehensible the shameful opinion that it is not a script, but “property or workshop signs“ or ideogram and symbolic drawings on ritual objects [65].

The invention of writing is usually attributed to Sumer and Egypt (the first alphabet of Egyptian hieroglyphics), and the earliest evidence of both language dates from the late fourth millennium B.C. [70]. Supposedly, “the first world script“ [65], “the oldest of all“, the Proto-Sumeric pictographic script (picture writing), developed in Mesopotamia, about 3,100 B.C. [65, 75, 76] and lasted until about 75 B.C. [65]. If the youngest dating data by ¹⁴C is accepted for the archeological location at Banjica (Serbia) from 3,473 B.C., which belongs to the youngest phase of Vinča culture, the Vinča script is older than the Proto-Sumerian pictographic script (picture writing) for 373 years [65].

The Proto-Elamian cuneiform script was developed about 3,000 B.C. [16, 65], as well as the Sumerian cuneiform script and the Egyptian pictographic script (picture writing), and the Acadic cuneiform script about 2,500 B.C. [65]. The Egyptian script lasted from 3,000 B.C. to about 400 B.C. [65].

The oldest writing on Serbian language dates from about 5,700 B.C. and is located on a clay tablets from Tartaria [14, 53], a archeological location in the Romanian Banat on the bank of the Mureş River (sr. *Mureş*), tributaries of the Tisa, near Tordoş (*Vinča-Turdaş* culture from Copper age), in the so-called Old Europe [35]. The writing on the Tartaria tablets belong to the early Vinča culture, which means that the earliest confirmation of the first European script comes from Transylvania [53]. Analysis by ¹⁴C was determined the age of human bones from 6,310 ± 65 yr BP (calibrated 5,370-5,140 B.C.) which were found with the tablets in the ritual grave [53]. Found bones, dated by ¹⁴C, at one discovery (Vlassa), belong to the Tartaria complex from the Vinča period, could belong to the older time, to the period of the Starčevo-Criş culture [53] or Starčevo – Koros – Cris (*Starčevo – Körös – Criş*) culture (Early Neolithic, 6,200–4,500 B.C.) [27]. At that time, the climate was drier and a little colder [20].

Old Europe is the name given by Maria Gimbutas by describing the relatively homogeneous so-called *Pre-Indo-European neolithic culture* in Southeastern Europe found in the Danube valley [9, 26]. Old Europe was an area in the Balkans and around the Balkans which was quite advanced Pre-Indo-European Neolithic civilization [29]. The culture of Old Europe is often referred to the Vinča culture, taking its name from one of the oldest archaeological location [29], which is considered to be the earliest known example of copper metallurgy in history [38].

Vinča culture was the most technologically advanced prehistoric culture in the world and also known as *Vinča-Turdaş* culture or *Vinča civilization*, *Danube culture* or *Danube civilization* [4, 16, 17, 53].

Based on multitude studies and papers [Alinei M., 1996, 1998, 2000ab, 2001, 2002, 2003], it was published the *Paleolithic Continuity Theory of the Indo-European languages* [1, 2, 3]. The “Indo-Europeans” (per definition of linguists) or more accurately Euro-Hindus carriers of the R1a haplogroup (Aryans or Proto-Slavs) [45, 46] and R1b haplogroup (Arbins or Proto-Celts) [41, 43], invaded the Balkan Peninsula [60], and spread later to all across Europe, Asia and Africa. “Proto-Indo-European is synonymous with Proto-Slavic” [62]. One of the main criteria for the definition of Proto-Slavs (more accurately Proto-Serbs or Serbo-Rasian) are primarily language and the (additional) genetic component of Y-Chromosome haplogroup I and/or R1a [62].

Only after 4 kya, due to geographical separation, people gradually began to change parts of the Proto-Slavic language, so that it converted into future Celtic, and further later into other non-Slavic languages [60].

A list of “Slavs“ words from the Paleolithic, Mesolithic and Neolithic periods formed, which practically represents the „oldest substrate of European languages“ [1, 2, 3]. Otherwise, the name “Slavians“ first appeared in the 1st century A.D. (by prince Slavian the builder of Novgorod) [18], and “Slavs“ were given by historians only in the 5th and 6th centuries A.D. [1].

The Paleolithic, Mesolithic and Neolithic Lexicon of Slavs is shared by other Indo-European languages [1]. From this “Slavs substrate“, the Germanic languages and the most other languages were separated and formed relatively later [84, 85]. This explains not only the ethnogenesis of Indo-European languages but also the origin of the people who speak those languages [1, 2, 3]. Hence, the Neolithic cultures of the Danube Region constitute the “primordial linguistic culture of Europe“ [1, 2, 3].

Subsequently to this “Slovenian“ literacy, after a long time, literacy appeared on the banks of the Tigris and Euphrates rivers, in Sumer, and on the bank of the Nile, in Misir (Egypt) [16].

The literacy of Lepenski Vir was at the level of the prototype of the Vinča script [16, 65]. The primer (elementary reading book) of Lepenski Vir has 48 characters [65], the most of which contain a Vinča script (Figure 4) [81, 92]. The Vinča script has an alphabet of 26 letters and 23 ligatures [65].

For five millennia B.C., the dominant language in Europe was the Serbo-Rasian language, and the Serbo-Rasian script was a letters script *Serbica* (name by nation) [16]. The first articulated version of the *Serbica* is called the *Vinča script* (name by locality) [16], *Vinča Serbica* (sr. *Vinčanska srbica*) or the best only *Serbica* (sr. *srbica*) [92].

The map of *Vinča script* is known as “Old European Literacy“ and covers a very large area around Old Europe [16]. It spread from the Mediterranean Sea to the North to the Baltic Sea, from the Tyrrhenian (Sardonic, Sarbs or Serbian) sea to the Caspian (Hirkans) sea [18], and from the Alps to the Altai Mountains. The *Vinča civilization* covered influence of the *Vinča script*, on the territory of Old Europe, Western Europe, Southern, Central and Eastern Europe, Central Asia, as well as the Near, Middle and Far East, encompassing the most of India but also part of Northern Africa (Figure 5). The ranges of the *Vinča civilization* and the *Vinča script* - *Serbica* span a period of six millennia, from about 6,000 B.C. to the beginning of a new era. The ranges include the relatively short time after the development of the youngest scripts (Coptic and Palmyra) about 100 B.C. [65], when there were still *Vinča* culture and/or *Serbica* traces.

The European ancient people, the ancient Serbo-Rasian, spread over a long period (7th-2nd millennium B.C.) and settled throughout Euro-Mediterranean and Eurasia, from Gibraltar to China [17, 18, 61]. This process has taken place peacefully, the natural process of diffusion of agricultural population into predominantly uninhabited and sparsely populated areas over several millennia [17, 18]. Thereby, cultural and linguistic unity was constantly maintained, with a slight permeation with a small number of indigenous tribes in particular areas [17, 18]. Accordingly, the ancient history of the Serbo-Rasian took place in the territories from the Atlantic Ocean to China, and only partly in the territories of the present-day countries of Serbia and Russia (rus. *Россия*, reads *Rassia*), which bear their name [17]. In the pre-ancient times, the Serbo-Rasians were extended to the entire civilized world from Gibraltar to the Pacific and from Africa and India to the far north of Europe and Asia [17].

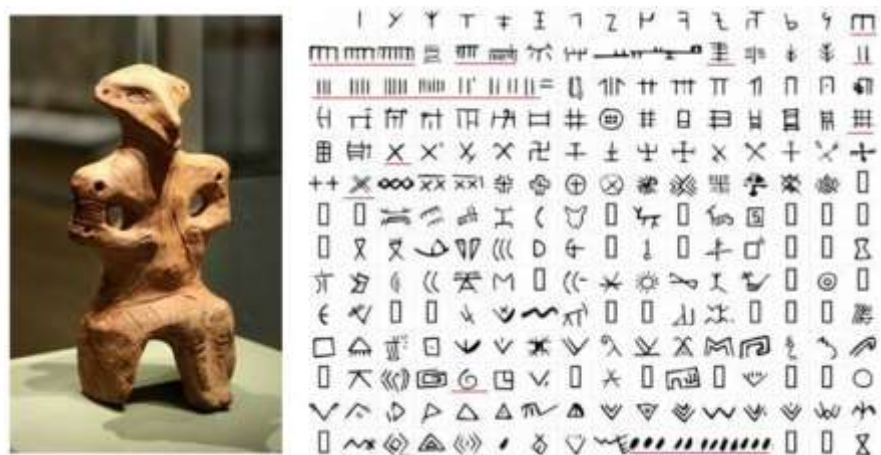


Figure 4: Neolithic terracotta figure (Vinča figurine) and script symbols [Vujić, S. (2014); modified], including the Serbian Symbol of Time [Unicode name: cyrillic thousands sign (Ѧ)] and the Serbian cross [isosceles cross with ocilla (bonfires, fires); on picture: in the sixth line, the seventh character from right], dating from the oldest period of Vinča culture (6th-5th millennia B.C.) [Стеванчевић, М.Т. (2018в)].

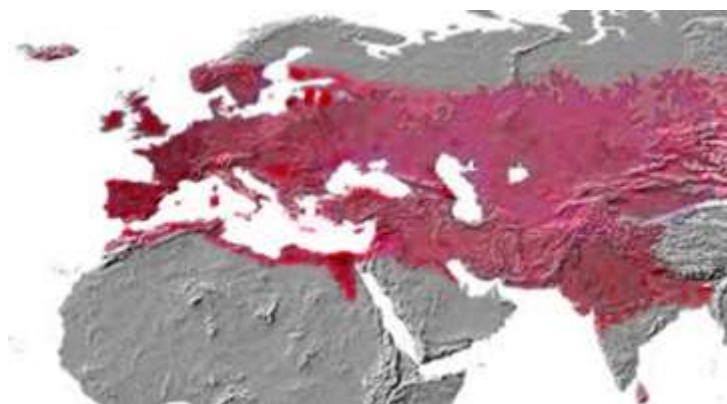


Figure 5: Genetic and linguistic reaches of the Vinča civilization, specially the Vinča script – Serbica and Serbian calendar during the six millennia of their existence, dating to around 6,000 B.C. to the beginning of a new era.

The archaeologically researched settlement Vinča is the center of the first urban European civilization, considered the highest achievement of Neolithic culture in Europe [92]. So far, over 750 archeological location of Vinča culture have been discovered [14], where many tools and other items of particular importance were found, such as the wheel and one-piece sports cars of the Neolithic period, as well as the mysterious Vinča figurine (*Vinča Idol*) [81] (Figure 4) [81, 92], which could represent an alien human being in the suit of an ancient astronaut (*theory of ancient astronauts*) [71, 72, 91].

The Vinča script, sometimes called as the Vinča-Turdaș script, the Danube script, the Old European script or just Vinča symbols and Vinča signs, is a set of symbols and letters found in the Neolithic period (6th-5th millennium B.C.) from the Vinča culture of Central Europe and Southeastern Europe [30].

Vinča script has been found in more than 54 archaeological locations, which some of them are older than the Vinča culture (Bela Voda, Tartaria, Lepenski Vir, Povlen, etc.) [16]. Until the 16th century Vinča

script was called a *Serbica*, and has 27 letters of today's Serbian alphabet (Cyrillic), then it would be appropriate to return back the old name – *Serbica* [16].

Many of historians agree that those symbols are not a writing system, but private symbols or ornaments of some kind [57]. Officially, a minority of historians claim that this is the earliest known writing system that has influenced other early writing systems [57].

The Serbs had an alphabet script at a time when the Sumerians (the Tigris and Euphrates valleys, present-day Iraq) and the Misirs (Nile valley, now Egypt) had *only* their own pictography (picture writing), when they had not moved on to the next stages of script development: pictography (picture writing) → ideography (ideoma writing) → syllography (vocalic writing) → typography (alphabet or letter writing) [14]. The final development of literacy was the transition from syllabus to alphabet, where one character indicates one syllable, that transit to one letter or one voice (one character – one voice) [14]. This led to the definition: *a script is a sign, a sign is a script*, and therefore to a writing system [65].

The signs and letters of Lepenski Vir and letters of Vinča script are the oldest sources of literacy in the world [65]. All other scripts are younger, and are mostly derived from the Vinča script – *Serbica* [16, 65, 75]. This is irrefutable evidence that the Vinča script – the *Serbica* is the oldest script of European civilization [19, 65, 75, 76].

Serbica includes letters of the alphabet (Cyrillic, including russians Ю ю, Щ щ, Ъ ъ, Я я and the other letters) [81] and abc's (Latinic, including letters W, X, Y) (Table 1) [65], but also a large number of letters of Ancient Greek and Modern Greek alphabet (Α, Ἀ, Β, Γ, Ε, Ι, Λ, Μ, Ο, Ρ, Τ, Υ, Φ, Χ, λ, Λ, Ξ, γ, π, Δ, ρ, σ, δ, ε) [65, 75, 76].

Table 1: The Vinča script is the precursor of alphabet (Cyrillic) and abc's (Latin script or Latin alphabet) [Pešić, R. (1995); modified].

	Cyrillic	Latin	Vinča
1.	A	A	A
2.	B	V	B
3.	Г	G	1
4.	Δ	D	△
5.	E	E	⌘, E, W
6.	Ж	Ž	X, H
7.	З	Z	3
8.	И, H, I'	I	I
9.	K	K	K
10.	Λ	L	Λ
11.	M	M	M
12.	O	O	O
13.	P, P'	R	4, P
14.	C	S	G, J, >, Z
15.	T	T	†, T
16.	Y	U	Y, Z, y
17.	Φ	F	Φ
18.	X	H	X
19.	Ц	C	Ц
20.	Ч	Č	Ч
21.	Џ	DŽ	Y, W
22.	Ш	Š	Ш

The Serbica was adapted by different nations in their own languages and changed the shape of the letters, but, nevertheless, the letters and their vocal value remained largely unchanged (Table 2, Table 3) [14].

The study of the Vinča script – Serbica has revealed the Basics of European literacy, especially Cyrillic, Latin and Greek scripts, including the Protocol of the Serbian calendar [75]. Protocol of Serbian calendar includes alphabet, rules of division of time units (chronometry), the manner and order of dating (Chronography) and two stronghold points, the beginning of counting years (Era) and the beginning of the calendar year (Style) [75]. Serbian protocol includes: a way of writing numbers with two dots above the letter, yearly distribution on 12 months, seven days distribution with names for each day of a week, hour as 12th part of the day or night, the beginning of counting years (5508) and the beginning of the calendar year (April) [75]. Serbian protocol includes labeling numbers: Arabs (1, 2, 3, 4, 5, 6, 7, 8); Romans (I, II, III, V, X, XX, C, D, M); Greeks (I = 1, II = 5, Δ = 10, ΠΔ = 50, H = 100, ΠH = 500, X = 1000, M = 10000); but also modern mathematical operators (=, −, +, ×, #, ≡, ((, (, >, <, ||, ((...)), ∞, Δ, ((()) [75].

Table 2: The Vinča Serbica is the ancestor of Rasen, Aramaic, ancient Greek and modern Serbica (alphabet or Cyrillic) [Деретић, Ј.И. (2008); modified].

Serbica				
Vinča	Rasen	Aramaic	Greek anc.	Modern
Δ, Δ, Δ	Δ	𐤀	Α	Α
Β, Β	Β	𐤁	Β	Β
Γ	Γ	𐤂	Γ	Γ
Δ	Δ	𐤃	Δ	Δ
Ε	Ε	𐤄	Ε	Ε
Ζ	Ζ	𐤅	Ζ	Ζ
Η	Η	𐤆	Η	Η
Θ	Θ	𐤇	Θ	Θ
Ι	Ι	𐤈	Ι	Ι
Κ	Κ	𐤉	Κ	Κ
Λ	Λ	𐤊	Λ	Λ
Μ	Μ	𐤋	Μ	Μ
Ν	Ν	𐤌	Ν	Ν
Ο	Ο	𐤍	Ο	Ο
Π	Π	𐤎	Π	Π
Ρ	Ρ	𐤏	Ρ	Ρ
Σ	Σ	𐤐	Σ	Σ
Τ	Τ	𐤑	Τ	Τ
Υ	Υ	𐤒	Υ	Υ
Φ	Φ	𐤓	Φ	Φ
Χ	Χ	𐤔	Χ	Χ
Ψ	Ψ	𐤕	Ψ	Ψ
Ω	Ω	𐤖	Ω	Ω

The ancient Serbo-Rasians, who inhabited Asia Minor and the Near East, in the period from 6th to 3rd millennia B.C., “strengthened“ the existing “ethnic mixture“ of the people of Misir and gave them script – the Serbica [16]. During this period, the ruling structures and priesthood of those areas, including Sumer and Assyria, not only Misir, had already been in contact with the Serbica [16]. It is known that at the time of the first dynasty (3,000 – 2,778 B.C.), “and perhaps earlier“, the Serbica arrived in Misir, where it was used in the palace and at the priesthood [16]. During this period, the Serbica penetrated almost all parts of the world at that time [16].

The Serbo-Rasian “superethnos“ (large related ethnic groups) was created by the expansion of the Serbo-Rasians, formed in the Danube region (the “nest of civilization“) in the Helm Peninsula and the territories around the Black Sea [18]. Thanks to the development of agriculture, metallurgy and crafts, the Serbo-Rasians have diffused for several millennia into the territories of surrounding countries, spanning the area from Gibraltar to the Far East, thus they were growing to a level of superethnos [18]. In these territories, at the end of the 4th millennium B.C., the Serbo-Rasians constitute the dominant population not only in number, but in economic-political and cultural terms [18]. Since then, on their periphery, they had started to develop their nomadic warrior tribes as well as nations of the same culture and language [18].

The development of metallurgy has helped the emergence of warrior communities and specific cultures among nomads on the outskirts of Serbo-Rasian territory in the third millennium B.C., when accelerated the cultural (gradually and linguistic) permeation and gradually changed of that periphery [17]. In these communities, farming was only possible in certain areas, and the nomadic population had limited grazing areas, which necessitated food trade [18]. Therefore, nomads often went to abduction of pasture, cattle, and food, often causing wars [18].

Table 3: The Vinča Serbica is the ancestor of Jewish, Phoenician, Misir and modern Serbica (alphabet or Cyrillic) [Деретић, Ј.И. (2008); modified].

Serbica				
Vinča	Jewish	Phoenician	Misir	Modern
А, А, А	כ	א	א	А
Б, В	ב	ב	ב	Б
Г	ג	ג	ג	Г
Д	ד	ד	ד	Д
Е	ה	ה	ה	Е
В	ו	ו	ו	В
З	ז	ז	ז	З
Т	ח	ח	ח	Т
И	ט	ט	ט	И
Ж	י	י	י	Ж
К	כ	כ	כ	К
Л	ל	ל	ל	Л
М	מ	מ	מ	М
Н	נ	נ	נ	Н
О	ס	ס	ס	СТ, ШТ
П	פ	פ	פ	О
Ш	צ	צ	צ	П
Ч	ק	ק	ק	ШЧ
Ф	ר	ר	ר	КУ
Р	ש	ש	ש	Р
С	ז	ז	ז	С
Т	ח	ח	ח	Т
У	ט	ט	ט	У
Х	י	י	י	Х
Ф	כ	כ	כ	Ф
Ч	ל	ל	ל	Ч
Ш	מ	מ	מ	Ш

Two great Aryan warfare campaigns launched from the Serbo-Rasian ancestral headquarters at Helm: (1) at the very beginning of the III millennium B.C. (under Nino Belov, 2025 – 2007 B.C.) [15, 16]; and (2) in the first half of the 2nd millennium B.C. (under Serbon Makeridov, 1330 – 1300 B.C.) [15, 16], have succeeded in slowing down the processes of population separation and restoring Serbo-Rasian unity, not only in the global cultural sense, but also in terms of better economic and any other connection [18].

With the arrival of new members of the Serbo-Rasian people during the warfare campaigns of the Aryans, again returned to the dominant influence of Serbo-Rasian culture and language and their impact in all the conquered territories [16]. Aryans reinforced their old traditions, including the Vedic tradition in India, which has continued to our time in the form of great Vedic epics [16].

Third Aryan warfare campaign (335 – 323 B.C.) was led by Alexander III Filip Karanović, known as Alexander Macedonsky or Alexander the Great, which established his authority on all the conquered territories and renewed old Serbo-Rasian culture and literacy in Serbica [16, 17] (Figure 6) [7]. His warfare campaign from Helm led to the establishment of world panempire and re-establishment of Serbo-Rasian cultural unity in a vast area that has been preserved for several centuries to come [18].

After Aryan warfare campaigns, from initial Serbo-Rasian “superethnos“ appeared numerous differentiation and massive merging with neighboring peoples of other origin which resulted the creation of new states, modification of religion, language and script [17, 18]. The Proto-Slavic preeminence has been replaced by Hellenic, Roman and Anglo-Saxon in more recent centuries.

2.2. Serbian calendar

Many nations tookover symbols of the Vinča culture for their own alphabets, which indicates that the source of European literacy is the Vinča script [75]. The oldest written records testify that the ancient Serbs started to count the time from 5508 B.C. (the Serbian era), by their own, the *Serbian calendar* or from the Beginning of the World according to biblical tradition [75]. Start of counting the time by the Serbian calendar coincides with the years of the Vinča culture 5508 B.C. (the Serbian era) [75], so the Serbian calendar is also known as the Vinča calendar.

The Serbian Vinča Calendar was in official use at the time of all Serbian dynasties until the Karadjordjević dynasty. The Serbian Vinča Calendar was abolished by Prince Milan Obrenović in order to become king [80].



Figure 6: The Xanthos Obelisk written with Lycian Serbica at 8th century B.C. from which all four sides Svetislav Bilbija read “The Code of Legal, Customary and Moral Principles of Serbs” (sr. „Zakonik pravnih, običajnih i moralnih načela Srba“) [Билбија, С.С., Ђорђевић, Р.Д. (2003); modified].

During the Serbian imperial dynasty Svevladović [ruled Serbia from 6000 to 6181 year (from 492 to 675 according to the Gregorian calendar)] wrote “The Serbian Four Gospel” (sr. „Srpsko Četvoroevangelje“), which is considered to be the Holy Serbian Manuscript [80].

During the Serbian royal dynasty Drvanović, who ruled Serbia from 6183 to 6662 (675 to 1160), a golden broad seal of the royal office of King Stroimir (Vladisav) Drvanović was preserved [81], engraved in Cyrillic Serbica, the official letter of all Serbian states [80]. King Stroimir Drvanović ruled Serbia from 6338 to 6343 (830 to 835) [78, 80]. The golden broad seal of the Serbian King Stroimir is exhibited in the National Museum in Belgrade [80] (Figure 7) [78]. At the time when the golden broad seal was engraved with Cyrillic Serbica (830 year) [77], Constantin (later monk Cyril, about 826/827–869) [68] was 3 or 4 years old, and Michael (later monk Methodius, about 815–885) [68] was 15 years old. King Stroimir's golden broad seal is material evidence of the existence of the old Serbian states before the Nemanjić dynasty.

In accordance with the dating “the founding of the World” or “Genesis dating”, 5508 B.C. was appropriated by the Second Rome (lat. *Roma Secunda*), so it is better known as Byzantine dating or “The Constantinople version” [22]. Name Byzantine calendar was invented [75].

The Serbian calendar is the oldest calendar in the world [75].

Saint Sava (Rastko Nemanjić) wrote *The Low* or *The legal rule* (sr. *Zakonopravilo*, ironically *Krmčija*; gr. *Nomokanon*), in which was Serbian calendar officially established in the 6727 year (1219) in Serbian Orthodox Church (SOC) and in Serbian country [75, 76].

The first written documents about the existence of the Serbian calendar are in *The Karyes Typikon* from 6707 (1199) years and *The Low of St. Sava* [75]. The oldest original document, which is dated according the Serbian calendar is *The Karyes Typikon* of St. Sava [76]. In *Studenic Typicon*, the first Constitution of the SOC from 6716 (1208) year, also appears a special form of straight cross from the Vinča script - Serbica [81]. The Dushan Low (sr. *Dušanov zakonik*) was also written by this Serbica, using Cyrillic and Latin letters, and dated by the Serbian calendar 6857 (1349) year, as well as an update 6862 (1354) year [76]. The youngest document, which was found in 7519 (2010) year, is *The Vujan cross of Patriarch Pavle* (Stojčević Gojko) in the Vujan monastery near Gornji Milanovac [76]. Thus, St. Sava left in testament to the Serbian people the Serbian calendar and the Serbica, alphabet script of the Vinča culture [76]. The Serbian calendar was found in Vinča in the form of a circular ceramic plate; it contains two main symbols of the Serbian people: the symbol of time (☿) and the symbol of the sun [Unicode name: white sun with rays (☼)], so it is called the Serbian Vinča Solar calendar and represents astrological solar calendar (Figure 8) [77, 78, 82]



Figure 7: The golden broad seal of the Serbian King Stroimir from 830 year [Стеванчевић, М.Т. (2016a)], engraved in Cyrillic Serbica [Стеванчевић, М.Т. (2016b); modified].

The calendar year begins in April and it is divided into two seasons: summer and winter; summer starts around St. George, and winter, about St. Mitar [75]. The Serbian calendar is a calendar of nature [76], because the year was divided into 13 months (the herbal calendar), which approximates suite to the number of rotations of the Sun during the calendar year [75].

After receiving of Christianity and influenced by the economic environment and due to easier trade, the Serbs created a calendar of 12 months [75]. Thus, *in the Serbian calendar first five months each have 31 days* [sr. *lažitrava* or *biljar* (April), *cvetanj* (May), *trešnjar* (June), *žetvar* (July), and *gumnik* (August)], *and the other seven, per 30 days* [sr. *grozdober* (September), *šumopad* or *listopad* (October), *studen* or *studen* (November), *koledar* (December), *koložeg* (January), *sečko* or *sečanj* (February), and *derikoža* or *letnik* (March)] [74, 76]. However, in the 12th century, St. Sava took the names of months from the Roman calendar, and brought them to the Serbian calendar, which is registered in *Law of St. Sava* (*St. Sava Law* transcript from 1262 year is located in the Archives of the Croatian Academy of Sciences and Arts in Zagreb) [75].

The Serbian calendar was an official calendar of the SOC and the Serbian calendar of all Serbian states until 1881 year [83]. It is known that the 28th was the Serb holy day. Just then, on June 28, 1881 was signed “The Secret Convention“ between the Austro-Hungarian Empire and the Principality of Serbia [73, 83].

Based on the “Secret Convention“, Prince Milan Obrenović becomes King Milan, and the Principality of Serbia becomes the Kingdom of Serbia [73, 83]; Serbia has pledged to introduce the Julian calendar as the official calendar of the Serbian state and the SOC [83].

By order of the signatories of the “The Secret Convention“ the entire history has been deleted (the prohibition of history until the Nemanjić dynasty etc.) and the science of the Serbian people (who had previously studied at the Grand School), and with it the Serbian calendar [80, 83]. Thus, the false history of the Serbs was formally introduced, and in the history of the SOC, the Julian (foreign) calendar was introduced as the official calendar.

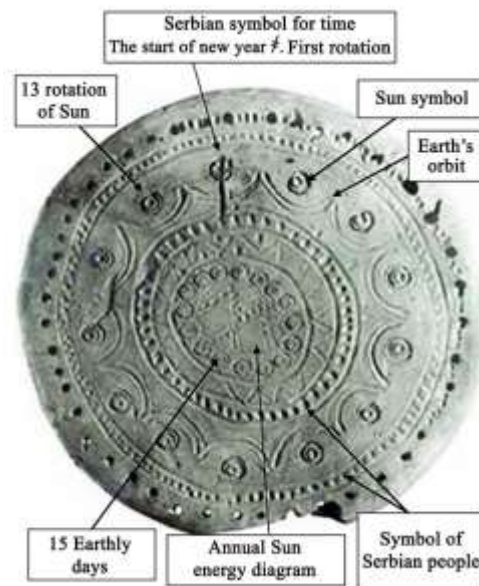


Figure 8: A snapshot of the Serbian Vinča Solar calendar. Annual Sun energy diagram is a Sun energy diagram for one calendar year. The symbol of the Serbian people are double perforated circles. Source: National Museum in Belgrade, registered under number 3053 [Стеванчевић, М.Т. (2016а, 2016б, 2019г); modified].

Based on the “The Secret Convention“, the Serbs are not indigenous people in the Balkans, but immigrants on the Balkans from their homeland. As per “The Secret Convention“ the Slavs homeland was situated between the Carpathians and the Dnieper river, on east, and the Baltic sea on the north [49, 88]. Such a view, unfortunately, still prevalent in our official history [49, 88, 93]. So, by the end of the 5th and during the 6th century, “Slavs were involved in the migration of peoples” [88]. “South Slavs were moved to the Balkans in the 6th and 7th century A.D. and occupied the territory between the Eastern Roman Empire (Byzantium) and the former Western Roman Empire, on which territory at that time were the Franks and some Germanic states“ [93].

Despite all, the Serbian script *Serbica* and the Serbian calendar have survived through all the time. The most importantly, the *Serbica*, its letters, numbers, symbols, and mathematical operators are more relevant today than ever. The Serbian calendar is the oldest scientific document of our people [75]. Besides the existing material measures, the Serbs introduced the term of immaterial measure of time into their calendar [75]. Furthermore, according to the Protocol (secular and church) dating of Serbian calendar (first year, then month and day) is carried out today's dating and computer data processing [76, 77, 82]. This protocol have not any other calendar in the world. The study of the *Vinča* script also led to the creation of computer fonts of the *Vinča* script (*GIMBUTAS.TTF*) [58, 59].

The Serbian calendar is particularly interesting from the point of view of modern science. Studies have shown that the Serbian calendar is aligned with the electromagnetic phenomena in the northern hemisphere [77, 82], which are registered by using electromagnetic modern satellite technology [76].

Intersection dates of electromagnetic energies indicate that the Serbian calendar have not fixed dates, but to be reconciled with the actual condition in the nature and the current position of the sun relative to the center of the Galaxy [76]. Each Serbian new year begins on the day of crossing of electromagnetic energies, including the new Serbian 7528 year, which began on April 3rd 2019 (on March 20th by Gregorian calendar) [77, 79, 82]. This, the 7528 year, which is ending as of the early days of April next year, when it should reach a new crossing of electromagnetic energy and starting the next, 7529 year.

With the advent of the Serbian *Vinča* solar calendar, discussion of European countries where is the cradle of the European civilization was over [77, 82]. Now it can be rightly said that *Vinča* is the cradle of European civilization and has great historical and scientific value [77, 82]. Serbian *Vinča* solar calendar and Gold Seal the Serbian king *Stroimir*, with his capital in *Raška*, is material evidence of the millennial identity of the Serbian people on these territories [77, 82]. Serbs are an ancient state-building nation, because the Serbian state, with minor interruptions, “lasts 4,000 years” [15].

3. CONCLUSION

The genetic structure of today's population in the territory of Old Europe shows an uninterrupted continuity with the Neolithic period and testifies to the genetic autochthony of Serbs in this area. The linguistic continuity of the Serbs until today is confirmed by the list of Slavs words from the Paleolithic, Mesolithic, and Neolithic periods as well as *Vinča* script - *Serbica* and autochthonous Serbian calendar. The signs and letters of *Lepenski Vir* and letters of *Vinča* script are the oldest sources of literacy in the world. King *Stroimir*'s golden broad seal, engraved in Cyrillic *Serbica*, is material evidence of the existence of the old Serbian states before the *Nemanjić* dynasty. Today's Cyrillic and Latin letters are mostly unmodified letters of the *Serbica*. All these are irrefutable evidence of the preserved genetic and cultural identity of the Serbs in the territory of Old Europe and their autochthony in this area.

REFERENCES

- Alinei, M. (2003). Interdisciplinary and linguistic evidence for Paleolithic continuity of Indo-European, Uralic and Altaic populations in Eurasia, with an excursus on Slavic ethnogenesis. Proceedings of Kobarid conference. Expanded version of a paper read at the Conference Ancient Settlers in Europe, Kobarid, 29-30 May 2003. http://www.continuitas.org/texts/alinei_interdisciplinary.pdf.
- Alinei, M. (2006). Darwinism, traditional linguistics and the new Palaeolithic Continuity Theory of language evolution. In N. Gontier., J.P. van Bendegem & D. Aerts (Eds.), *Evolutionary Epistemology, Language and Culture. A Non-Adaptationist, Systems Theoretical Approach* (pp. 121-147). Dordrecht: Springer.
- Alinei, M., & Benozzo F. (2012). The Paleolithic Continuity Paradigm for the origins of Indo-European languages: An Introduction in progress. *Paleolithic Continuity Paradigm*, May 2012. Last Updating: December 2016. <http://www.continuitas.org/intro.html>.
- Antonov, L. (2009). Bulgarian alphabet. 19 January 2015. © 2009 Lyudmil Antonov. Retrieved from lyudmilantonov.blogspot.com/2011/04/bulgarian-alphabet.html.
- Batini, C., Hallast, P., Zadik, D., Delser, P.M., Benazzo, A., Ghirotto, S., ... Jobling M.A. (2015). Large-scale recent expansion of European patrilineages shown by population resequencing. *Nat. Commun.* 6, 7152. doi:10.1038/ncomms8152.
- Battaglia, V., Fornarino, S., Al-Zahery, N., Olivieri, A., Pala, M., Myres, N.M., ... Semino, O. (2009). Y-chromosomal evidence of the cultural diffusion of agriculture in southeast Europe. *Eur. J. Hum. Genet.* 17, 820-830. doi:10.1038/ejhg.2008.249.
- Билбија, С.С. (превео ликијско писмо) & Ђорђевић Р.Д. (приредио) (2003). Обелиск из Ксантоса: Законик правних, обичајних и моралних начела Срба (пре 2600 – 2800 година), Ликија (Мала Азија). Ниш: Србона.
- Bogucki, P. & Crabtree, P.J. (2004) (Eds.), *Ancient Europe 8000 B.C.–A.D. 1000: Encyclopedia of the Barbarian World. Volume I: The Mesolithic to Copper Age (C. 8000–2000 B.C.)* (pp. 81-89, xxv-xxvii). New York: Charles Scribner's Sons/ The Gale Group, Inc./ Thomson Learning, Inc.
- Borić, D., & Price, T.D. (2013). Strontium isotopes document greater human mobility at the start of the Balkan Neolithic. *Proc. Natl. Acad. Sci. USA.* 110(9), 3298-3303. doi:10.1073/pnas.1211474110.
- Cabrera, V.M., Marrero, P., Abu-Amero, K.K., & Larruga, J.M. (2018). Carriers of mitochondrial DNA macrohaplogroup L3 basal lineages migrated back to Africa from Asia around 70,000 years ago. *BMC Evolutionary Biology* 18, 98. <https://doi.org/10.1186/s12862-018-1211-4>.
- Chiang, C.W.K., Marcus, J.H., Sidore, C., Biddanda, A., Al-Asadi, H., Zoledziewska, M., ... Novembre, J. (2018). Genomic history of the Sardinian population. *Nat. Genet.* 50(10), 1426-1434. doi:10.1038/s41588-018-0215-8.
- Choudhury, A., Aron, S., Sengupta, D., Hazelhurst, S., & Ramsay, M. (2018). African genetic diversity provides novel insights into evolutionary history and local adaptations. *Hum. Mol. Genet.* 27(R2), R209-R218. doi:10.1093/hmg/ddy161.
- Deary, I.J., Harris, S.E., & Hill, W.D. (2019). What genome-wide association studies reveal about the association between intelligence and physical health, illness, and mortality. *Current Opinion in Psychology* 27, 6-12. <https://doi.org/10.1016/j.copsyc.2018.07.005>.
- Деретић, Ј.И. (2008). Докириловска писменост. Доклад на Првом међународном конгресу «Докириловска славјанска писменост и дохристијанска славјанска култура». Ленинградски државни универзитет имени А.С. Пушкина, Санкт-Петербург, 12 – 14 маја 2008. године. Текући број - №12 [140]. *Организмика* № 5[65]. <http://www.organizmica.org/archive/505/jddp.shtml>.
- Deretić, J. (2011). Srpska država traje 4000 godina. <https://beleznica.wordpress.com/2011/07/15/srpska-drzava-traje-4-000-godina/>
- Деретић, Ј.И., Антић, Д.П. (2017а). *Древна историја Срба и Руса. Настанак и ширење цивилизације*. Прва књига. Београд: Ганеша клуб.
- Деретић, Ј.И., Антић, Д.П. (2017б). У: *Древна историја Срба и Руса. Древна царства*. Друга књига. Београд: Ганеша клуб.
- Деретић, Ј.И., Антић, Д.П. (2017в). *Древна историја Срба и Руса. Ратничке државе*. Трећа књига. Београд: Ганеша клуб.
- Димитријевић, М. (2014б). Винчанске метрополе у Параћинско – јагодинском Поморављу. У, *Из историје Срба старе и нове ере – сакривена историја Срба*. Прво издање. Београд: Мирослав, 68-86.

- El Susi, G. (2008). The comparative analyze of faunal samples from Sites dated in Starčevo-Körös-Criș Culture – phases IB-IIA from Transylvania and Banat. *Acta Terrae Septemcastrensis* Band: VII, 91-106. Lucian Blaga University of Sibiu. <http://arheologie.ulbsibiu.ro>.
- Feldman, M., Fernández-Domínguez, E., Reynolds, L., Baird, D., Pearson, J., Hershkovitz, I., ... Krause, J. (2019). Late Pleistocene human genome suggests a local origin for the first farmers of central Anatolia. *Nature Communications* 10, 1218. <https://doi.org/10.1038/s41467-019-09209-7>.
- Fomenko, A.T. (2003-2015): Scaliger, Petavius, and other clerical chronologers. The creation of contemporary chronology of the ancient times in the XVI-XVII century A.D. In: *The Issue with Chronology. Book 1 of History: Fiction or Science?* Series. Chapter 2. Paris: Delamere Resources LLC.
- Friedrich, K. (2012). Comparison between the sign-systems of the Carpathian Basin, the Bosnian Pyramids and Glozel. Retrieved 2012.01.26. <https://magyar-megmaradas.eoldal.hu/cikkek/our-language/klara-friedrich--comparison-between-the-sign-systems-of-the-carpathian-basin--the-bosnian-pyramids-and-glozel.html>.
- Fu, Q., Mittnik, A., Johnson, P.L.F., Bos, K., Lari, M., Bollongino, R., ... Krause, J. (2013). A Revised Timescale for Human Evolution Based on Ancient Mitochondrial Genomes. *Curr. Biol.* 23, 553-559. doi:10.1016/j.cub.2013.02.044.
- Fu, Q., Posth, C., Hajdinjak, M., Petr, M., Mallick, S., Fernandes, D., ... Reich, D. (2016). The genetic history of Ice Age Europe. *Nature* 479, 525-528. doi:10.1038/nature17993.
- Gimbutas, M. (1993). The Indo-Europeanization of Europe: the intrusion of steppe pastoralists from south Russia and the transformation of Old Europe. *Word* 44(2), 205-222. DOI:10.1080/00437956.1993.11435900.
- Gonzalez-Fortes, G., Jones, E.R., Lightfoot, E., Bonsall, C., Lazar, C., Grandal-d'Anglade, A., ... Hofreiter, M. (2017). Paleogenomic Evidence for Multi-generational Mixing between Neolithic Farmers and Mesolithic Hunter-Gatherers in the Lower Danube Basin. *Curr. Biol.* 27(12), 1801-1810.e10. doi:10.1016/j.cub.2017.05.023.
- Grasgruber, P., Popović, S., Bokuvka, D., Davidović, I., Hřebíčková, S., Ingrová, P., ... Stračárová, N. (2017). The mountains of giants: an anthropometric survey of male youths in Bosnia and Herzegovina. *R. Soc. Open Sci.* 4(5), 170445. doi:10.1098/rsos.161054.
- Griffen, T.D. (2007). Deciphering the Vinča Script. Revised 1 August 2007. <http://www.fanad.net/vincascript.pdf>.
- Haarmann, H. (2010). *Einführung in die Donauschrift*. Hamburg: Helmut Buske Verlag GmbH, 2010.
- Hay, M. (2018). Haplogroup I2 (Y-DNA). Eupedia Home > Genetics > Haplogroups (home) > Haplogroup I2. Last update May 2018. https://www.eupedia.com/europe/Haplogroup_I2_Y-DNA.shtml.
- Herrera, R.J., Garcia-Bertrand, R. (2018). *Ancestral DNA, Human Origins, and Migrations*. Amsterdam: Elsevier/Academic Press.
- Hofmanova, Z., Kreutzer, Z., Hellenthal, G., Sell, C., Diekmann, Y., Diez-del-Molino, D., ... Burger, J. (2016). Early farmers from across Europe directly descended from Neolithic Aegeans. *PNAS* 113(25), 6886-6891. <https://doi.org/10.1073/pnas.1523951113>.
- Imreh, A. (2011a). Symilarity between Vinca, Hungarian Runic signs and signs found inside the Bosnian Pyramids, older than Egypt pyramids. Posted on 05/01/2011. <https://aleximreh.wordpress.com/2011/01/05/similarity-between-vinca-hungarian-runic-signs-and-signs-found-inside-the-bosnian-pyramids-older-than-egypt-pyramids/>
- Imreh, A. (2014). Ethnogenesis Around the Black Sea and along the Danube. Present day Romania, the turntable of Old & New Europe. Ethnogeneses Around the Black Sea and along the Danube. Present day Romania, the turntable of Old & New Europe. <https://aleximreh.files.wordpress.com/2014/12/vinca-sumer.jpg>.
- Imreh, A. (2016). Old Europe: 7000 years of history. Ro DNA: 68% Old Europe & 29.5% Kurgan. <https://aleximreh.wordpress.com/2016/01/09/7000-years-of-history/>
- Jandaček, P., Perdih, A. (2017). Words for the Animal Elephant/Mammoth in Relation to the DNA Genealogy Data. *Advances in Anthropology* 7(4), 251-272. <https://doi.org/10.4236/aa.2017.74014>.
- Јовановић, Б. (1990). Винчанска култура и почетак коришћења метала на Балкану. (Borislav Jovanovic: Die Vinca-Kultur un der Beginn der Metallnutzung auf dem Balkan). У: Винча и њен свет: Сажети на српском. Међународни скуп “Подунавље између 6000 и 3000 г. пре нове ере“. Српска академија наука и уметности, Центар за археолошка истраживања Филозофског факултета, Београд. http://www.rastko.rs/arheologija/grupa-vinca_svet_c.html#Тoc503523178.
- Клѣсов, А.А. (2014а). Ископаемые гаплогруппы и гаплотипы. *Вестник Академии ДНК-генеалогии* 7(7), 1135-1184. https://www.anatole-klyosov.com/07_07_2014.pdf.
- Клѣсов, А.А. (2014в). У нас в гостях сайт Переформат (<http://pereformat.ru/avtory/>). Что показал геном древнего человека из Костенок. *Вестник Академии ДНК-генеалогии* 7(10), 1888-1911.

- Klyosov, A.A. (2012a). Ancient History of the Arbins, Bearers of Haplogroup R1b, from Central Asia to Europe, 16,000 to 1500 Years before Present. *Advances in Anthropology* 2, 87-105. <https://doi.org/10.4236/aa.2012.22010>.
- Klyosov, A.A. (2012b). Динарска (источно-европска) и «островне» ветви гаплогрупе I2a. *Вестник Академије ДНК-генеалогии* 5(11), 1304-1317.
- Klyosov, A.A. (2013). Миграциони профил субклада гаплогрупе R1b се слаже са северно-африканским маршрутом ербина од Ближњег Востока до Пиренеја и даље у континенталну Европу. *Вестник Академије ДНК-генеалогии* 6, 727-729.
- Klyosov, A.A. (2014). Reconsideration of the “Out of Africa” Concept as Not Having Enough Proof. *Advances in Anthropology*, 4(1), 18-37. <https://doi.org/10.4236/aa.2014.41004>.
- Klyosov, A.A. (2016a). Миграције аријева од 6000 до 3000 година назад – како их види ДНК-генеалогия, археологија и лингвистика. Част 1. *Вестник Академије ДНК-генеалогии* 9, 2-29.
- Klyosov, A.A. (2016b). Миграције аријева од 6000 до 3000 година назад – како их види ДНК-генеалогия, археологија и лингвистика. Част 2. *Вестник Академије ДНК-генеалогии* 9, 187-240.
- Klyosov, A.A., Tomezzoli, G.T. (2013). DNA Genealogy and Linguistics. Ancient Europe. *Advances in Anthropology* 3(2), 101-111. DOI:10.4236/aa.2013.32014.
- Кљосов, А.А. (2013). Одакле су се појавили Словени и “Индоевропљани” и где је њихова прапостојбина? (Откуда появились Славяне и “индоевропейцы” и где их прародина?). У: *Порекло Словена. Осврти на ДНК-генеологију* (Кљосов А.А., Происхождение Славян и других народов: очерки ДНК-генеалогии). Превод са руског језика. Прво издање. Глава 1. Београд: Мирослав, 17-68. <http://tatur.su/wp-content/uploads/2013/04/klsv-ocherk.pdf>.
- Коматина, И., Јеврић, Ј., Живковић, Е., Недовић, Љ., Поповић, Р.Ј. (2019). Стварање Европе (рани средњи век). У: *Историја 6. Уџбеник са одабраним историјским изворима за шести разред основне школе*. Прво издање. Београд: “Klett”, 22-71.
- Lee, R., Daly, R. (1999). Introduction: foragers and others. In R. Lee & R. Daly (Eds), *The Cambridge encyclopedia of hunters and gatherers* (pp. 1-22). Cambridge: Cambridge University Press.
- Lipson, M., Szécsényi-Nagy, A., Mallick, S., Pósa, A., Stégmár, B., Keerl, V., ... Reich, D. (2017). Parallel paleogenomic transects reveal complex genetic history of early European farmers. *Nature*. 2017; 551(7680), 368-372. doi:10.1038/nature24476.
- Mathieson, I., Alpaslan-Roodenberg, S., Posth, C., Szécsényi-Nagy, A., Rohland, N., Mallick, S. (2018). The Genomic History of Southeastern Europe. *Nature*. 555(7695), 197-203. doi:10.1038/nature25778.
- Merlini, M., Lazarovici, G. (2008). Settling Discovery Circumstances, Dating and Utilization of the Tărtăria Tablets. *Acta Terrae Septemcastrensis* Band: VII, 111-195. Sibiu: Lucian Blaga University of Sibiu. <http://arheologie.ulbsibiu.ro>.
- Mittnik, A., Wang, C.-C., Svoboda, J., Krause, J. (2016). A Molecular Approach to the Sexing of the Triple Burial at the Upper Paleolithic Site of Dolní Věstonice. *PLOS ONE* 11(10), e0163019. doi:10.1371/journal.pone.016301.
- Modi, A., Nesheva, D., Sarno, S., Vai, S., Karachanak-Yankova, S., Luiselli, D., ... Caramelli, D. (2019). Ancient human mitochondrial genomes from Bronze Age Bulgaria: new insights into the genetic history of Thracians. *Sci Rep*. 9, 5412. doi:10.1038/s41598-019-41945-0.
- Osmanagić, S. (2018). Ексклузивно: утврђена сензационална старост тунела ‘Равне 3’. *Задње ажурирање*, 26 новембар 2018. <http://piramidasunca.ba/bs/blogovi-3/semir-osmanagic-blog-x/item/13775-ekskluzivno-utvrdena-senzacionalna-starost-tunela-ravne-3-1.html>.
- Палавестра, А. (2018). Измишљање традиције: “Винчанско писмо”. У: Палавестра, А., Јовановић, М., Шуица, М., Џино, Д., Кузмановић, З., Михајловић, В.Д., Радић, Р.: *Боља прошлост: измишљање традиције и нови идентитети*. Београд: Evoluta, 9-30.
- Paliga, S. (2005). Vinca-Tordos symbols, 2005. <https://www.omniglot.com/writing/vinca.htm>.
- Paliga, S. (2007). Tabulae Tartarienses. The Tablets of Tartaria – an Enigma? A reconsideration and further perspectives. *Etymologica et Anthropologica Maiora*. In English. Anglice. Fundatia Evenimentul, Bucuresti, 113-150.
- Perdih, A. (2018a). Continuity of European Languages from the Point of View of DNA Genealogy. *International Journal of Social Science Studies* 6(1), 1-15. doi:10.11114/ijsss.v6i1.2809.
- Perdih, A. (2018b). Synergistic Evaluation of Data Presented by Archaeology, Anthropology, DNA Genealogy and other Disciplines Can Lead to Better Understanding of Past Events. *Glob. J. Arch. & Anthropol.* 4(5), 555646. DOI:10.19080/GJAA.2018.04.555646.
- Perdih, A., Jandaček, P. (2012). New Understanding of Western Eurasia in Prehistoric Times. *Proceedings of the Academy of DNA Genealogy* 5, 38-94. https://www.researchgate.net/publication/277234587_New_Understanding_of_Western_Eurasia_in_Prehistoric_Times.

- Peričić, M., Barać, Lauc, L., Martinović Klarić, I., Rootsi, S., Janićijević, B., Rudan, I., ... Rudan, P. (2005). High-resolution phylogenetic analysis of southeastern Europe traces major episodes of paternal gene flow among Slavic populations. *Mol. Biol. Evol.* 22(10), 1964-1975. DOI:10.1093/molbev/msi185.
- Perreault, C., Mathew, S. (2012). Dating the Origin of Language Using Phonemic Diversity. *PLoS One* 7(4), e35289. doi:10.1371/journal.pone.0035289.
- Pešić, R. (1995). *Vinčansko pismo i drugi gramatološki ogledi*. Beograd, Milano: Pešić i sinovi/ Dugan.
- Рајевац, М. (2018): Генетска слика Лепенског Вира и Винче. Објављено: јун 15, 2018. <https://www.poreklo.rs/2018/06/15/genetska-slika-lepenskog-vira-vince/>
- Regueiro, M., Rivera, L., Damjanovic, T., Lukovic, L., Milasin, J., Herrera, R.J. (2012). High levels of Paleolithic Y-chromosome lineages characterize Serbia. *Gene* 498(1), 59-67. doi:10.1016/j.gene.2012.01.030.
- Rohdewald, S. (2008). Figures of (trans-) national religious memory of the Orthodox southern Slavs before 1945: an outline on the examples of SS. Cyril and Methodius. *Trames* 12(62/57), 3, 287-298. DOI:10.3176/tr.2008.3.04.
- Rootsi, S., Magri, C., Kivisild, T., Benuzzi, G., Help, H., Bermisheva, M., ... Semino, O. (2004). Phylogeography of Y-chromosome haplogroup I reveals distinct domains of prehistoric gene flow in Europe. *Am. J. Hum. Genet.* 75(1), 128-137. doi:10.1086/422196.
- Seyfzadeh, M., Schoch, R. (2019). World's First Known Written Word at Göbekli Tepe on T-Shaped Pillar 18 Means God. *Archaeological Discovery* 7, 31-53. DOI:10.4236/ad.2019.72003.
- Sitchin, Z. (1976). *The 12th Planet (The First Book of The Earth Chronicles)*. Rochester: Bear & Company.
- Sitchin, Z. (1990). *Genesis Revisited: Is Modern Science Catching Up With Ancient Knowledge?* New York: Avon Books.
- sr.wikipedia.org. Opusteno.rs. (2014). Biografija: knez i kralj Milan Obrenovic. Ova stranica je napisana 16. februara 2014. Pristupljeno 14.09.2019. <https://opusteno.rs/biografije-poznatih-f151/biografija-knez-i-kralj-milan-obrenovic-t21546.html>.
- Стефановић, А., Какашевски, В. (2013). Годишњи циклус. *Слава* 7521/ (2013), 1, 12-23.
- Stevančević, M.T. (2010). Heliocentrična meteorologija kao put za uspostavljanje Srpskog kalendara. U: Stevančević M.T., Todorović N., Radovanović M., Ducić V., Milenković M. (ured.): *Beogradska škola meteorologije*. Sveska treća. Beograd: "LOG", 2010, 191-254.
- Стеванчевић, М.Т. (2011). Српски календар Светог Саве и Вујански Крст Патријарха Павла. У: Стеванчевић, М.Т., Тодоровић, Н., Радовановић, М., Дуцић, В., Миленковић, М. (уред.): *Београдска школа метеорологије*. Свеска IV. Београд: SOHO (NASA & ESA), 399-442.
- Стеванчевић, М.Т. (2016а). Винчански Сунчев календар и промене синодичке ротације Сунца. У: Стеванчевић, М.Т., Тодоровић, Н., Радовановић, М., Дуцић, В., Миленковић, М. (уред.): *Београдска школа метеорологије*. Свеска 9. Документ бр. 1. Београд, 7525. (2016.), 15-22.
- Стеванчевић, М.Т. (2016б). Украдена српска историја. У: Стеванчевић, М.Т., Тодоровић, Н., Радовановић, М., Дуцић, В., Миленковић, М. (уред.): *Београдска школа метеорологије*. Свеска 9. Документ бр. 27. Београд, 7525. (2016.), 383-394.
- Стеванчевић, М.Т. (2018а). Српска зима 7527. године (2018). www.carsa.rs/medju-izmedju-srpska-zima-7527-godine/
- Стеванчевић, М.Т. (2018б). Срећна српска Нова 7527. година. У: Стеванчевић, М.Т., Тодоровић, Н., Радовановић, М., Дуцић, В., Миленковић, М. (уред.): *Београдска школа метеорологије*. Документ бр. 22. Београд, 7527. (2018.), 329-332.
- Стеванчевић, М.Т. (2018в). Равнокраки Винчански крст. У: Стеванчевић, М.Т., Тодоровић, Н., Радовановић, М., Дуцић, В., Миленковић, М. (уред.): *Београдска школа метеорологије*. Документ бр. 23. Београд, 7527. (2018.), 333-353.
- Стеванчевић, М.Т. (2019г). Винчански Сунчев календар и промене синодичке ротације Сунца. У: Стеванчевић, М.Т., Тодоровић, Н., Радовановић, М., Дуцић, В., Миленковић, М. (уред.): *Београдска школа метеорологије*. Свеска 10. Документ бр. 29. Београд, 7528. (2019.), 509-516.
- Stevančević, M.T. (2019). Srećno Novo Leto 7528 (2019). <http://galaksijanova.rs/srecna-nova-7526/?script=lat>.
- Swadesh, M. (1952). Lexicostatistic dating of prehistoric ethnic contacts. *Proceedings American Philosophical Society* 96, 452-463.
- Swadesh, M. (1955). Towards greater accuracy in lexicostatistic dating. *International Journal of American Linguistics* 21, 121-137.
- Šarac, J., Havaš Auguštin, D., Metspalu, E., Novokmet, N., Missoni, S., Rudan, P. (2017). Maternal Genetic Profile of Serbian and Montenegrin Populations from Southeastern Europe. *Genetics & Applications* 1(2), 14-22. DOI:10.31383/ga.vol1iss2pp14-22.

- Šarac, J., Šarić, T., Havaš Auguštin, D., Novokmet, N., Vekarić, N., Mustać, M., ... Rudan, P. (2016). Genetic heritage of Croatians in the Southeastern European gene pool-Y chromosome analysis of the Croatian continental and Island population. *Am. J. Hum. Biol.* 28(6), 837-845. doi:10.1002/ajhb.22876.
- Шуница, М., Радић, Р., Јелић, П. (2019). Рани средњи век. У: *Историја. Уџбеник са одабраним историјским изворима за шести разред основне школе*. 1. изд. Тема П. Београд: Фреска, 19-63.
- Tallavaara, M., Luoto, M., Korhonen, N., Järvinen, H., Seppä, H. (2015). Human population dynamics in Europe over the Last Glacial Maximum. *Proc. Natl. Acad. Sci. USA.* 112(27), 8232-8237. doi:10.1073/pnas.1503784112.
- Тодоровић, И., Вучетић-Драговић, А., Марић, А. (2014). Компаративни аналитички осврт на најновија генетска истраживања порекла Срба и становништва Србије – етнолошка перспектива. *Гласник Етнографског института САНУ* LXII (2), 99-111. DOI:10.2298/GEI1402099T.
- von Däniken, E. (1968). *Chariots of the Gods? Unsolved Mysteries of the Past*. Translation from original title: *Erinnerungen an die Zukunft: Ungelöste Rätsel der Vergangenheit*. Stockholm: Econ-Verlag/ Bonier AB; New York: G.P. Putnam's Sons/ Penguin Group.
- Vujić, S. (2014). *Istorija srpskog rudarstva. U: Srpsko rudarstvo i geologija u drugoj polovini XX veka. Koreni*. Beograd: Akademija inženjerskih nauka Srbije, Matica srpska i Rudarski institut Beograd, 1-38. <http://www.serbianmedievalcoins.com/resources/Istorija%20Srpskog%20Rudarstva.pdf>
- Вујовић, Д. (2016). Порекло и развој српског језика. У: *Грамотологија: прегледна граматика српског језика*. Допуњено и измењено издање. Београд: Школа плус, 9-12.
- Wall, J.D. (2017). Inferring Human Demographic Histories of Non-African Populations from Patterns of Allele Sharing. *The American Journal of Human Genetics* 100(5), 766-772. <https://doi.org/10.1016/j.ajhg.2017.04.002>.
- Yang, J., Benyamin, B., McEvoy, B.P., Gordon, S., Henders, A.K., Nyholt, D.R., ... Visscher, P.M. (2010). Common SNPs explain a large proportion of the heritability for human height. *Nat. Genet.* 42, 565-569. <https://doi.org/10.1038/ng.608>.
- YFull. Haplogroup YTree v7.09.00 (21 October 2019). <https://www.yfull.com/tree/>
- Юрковец, В.П. (2015). Климатическая катастрофа гаплогруппы «Бета». *Вестник Академии ДНК-генеалогии* 8(3), 376-432. http://dna-academy.ru/wp-content/uploads/8_3_2015.pdf.
- Юрковец, В.П., Василенко, С.И. (2017). ДНК-генеалогия, палеоклимат и геоморфология. Гидродинамический карст. *Вестник Академии ДНК-генеалогии* 10(3), 1412-1442. http://dna-genealogy.ru/vestnik.html/_/proceedings-of-the-academy-of-dna-genealogy-vol-10-no-3-2017-r94.

Individual or Group Verbotonal Phonetic Correction – Which One Is Better?

Arnalda Dobrić

Department of Phonetics, Faculty of Humanities and
Social Sciences, University of Zagreb, adobric@ffzg.hr

Matea Haičman

mhaicman@ffzg.hr

ABSTRACT

In this pilot study main similarities and differences between individual and group sessions of phonetic correction using verbotonal methods are discussed on the basis of their outcomes. Four speakers who started to learn Croatian as foreign language participated in 10 sessions of individual (1 speaker) or group (3 speakers) phonetic correction, respectively, during the initial level language course. The main purpose of the sessions was the improvement of pronunciation of Croatian fricative /s/ that was not adequately pronounced in any of the speakers resulting therefore in misunderstanding or insufficient speech quality. Furthermore, some time in the beginning of each session was dedicated to the work on global form of speech (rhythm and intonation) since the rhythm and intonation present in each speech would easily reveal speaker's native language. The sessions were established following main principles of the verbotonal method – listening as the basis of speech acquisition, wholeness of the structure and filtering speech in order to enhance better pronunciation. The results of the phonetic correction training were compared on the basis of the perceptive test performed by 2 trained listeners. The listeners participated in the listening of selected words recorded before and after sessions of the verbotonal phonetic correction without any knowledge whether the person attended individual or group classes although they had had the information on the two possibilities before the test. The results show that the words recorded after the correction were defined as more acceptable or pronounced by a native speaker and the answers depended partly on the position of the sound /s/ in the word.

Key words: voiceless dental fricative /s/, individual and group phonetic training, the verbotonal method

1. INTRODUCTION

During rather demanding and long foreign language learning process phonetic correction sessions or phonetic training is usually considered one of the duller or demanding parts of the process. Therefore it is also rather neglected. On the other hand, teachers themselves obviously are not taught enough or well enough in that field (Billières, 2016; Rimpault, 2019). Grammar exercises and reading or writing tend to be the main part of this process so consequently many adults will estimate their oral language skills as the lowest (Dobrić, 2011). In terms of Jakobson's functions of language the final aim for most learners of foreign languages is the referential function. In practical terms this means that students are able to communicate with their peers about everyday subjects and their closest environment and therefore giving the contextual information. These utterances are usually rather poor in terms of L2 on multiple levels and the teaching of language should aim beyond this rather basic aim. Jakobson (1995) explains that it is hard to find verbal message „that would fulfill only one function.“ Furthermore it explains that the diversity and richness is not a monopoly of one of the six functions but that this is the question of their different hierarchical order. Apart from the referential function of language, he mentions other five functions: emotional, conative, phatic, metalinguistic and poetic function. Although speech comprises all those functions, it is not all it contains. Speech reveals many other information on the speaker himself/herself

such as the origin, social and economic background, emotional state, health, gender etc (Škarić, 1991; Dobrić and Mildner, 2003). Therefore entering the domain of speech in phonetic correction is a very demanding process since the procedure deals with person's most inherent characteristics. On the one hand a student is in vulnerable position since he or she is still mastering the language and phonetic correction is usually performed in the beginning of language courses. On the other hand during the correction many details of the person are revealed thorough speech are revealed. It can be seen through the voice intensity, diction, voice and language problems etc. (Lum et al., 2016; Misono et al., 2019; Park and Stepp, 2019; Pinyopodjanard et al., *in print*). This specific factors might be of great importance when it comes to the emotional function of language.

Pronunciation characteristics in foreign language speaking seem to have pretty important role when it comes to social integration in the countries where this language is official or dominantly used (McLeod et al., 2016). On segmental and suprasegmental level speech of a foreign speaker can be characterized with inadequacy of rhythm and intonation (often called global structure in the verbotonal theory and method), mispronunciation or inconsistency (due to surrounding sounds and therefore coarticulation) in certain speech sounds. The basic notion of the verbotonal method is to start from the strong point of the speaker, therefore something the student can pronounce. In this way positive feedback will enable the speaker to speak more openly without fear of making mistakes and therefore engage all his/her capability to improve pronunciation (Guberina, 2010). Although sometimes applied in the group work, the verbotonal method in practice as a part of a group phonetic training during the classes of Croatian as L2 has not been described since the practice is to work with each person respectively working on his/her weakest point in pronunciation (Dobrić and Bićanić, 2013; Bukovski and Dobrić, 2019; Kanjir et al., 2019) using basic postulates of the verbotonal method in pronunciation teaching (Mildner, 1999; Dobrić, 2013). As the possibilities and tendencies differ in different countries when it comes to phonetic training in foreign language teaching and in different L2 methods of teaching (Rezaei et al., 2015; Flores et al., 2017; Grenon et al., 2019), it can be seen that in teaching of pronunciation in FLE (French as foreign language) when verbotonal method is applied it is applied in the group sessions (Rimpault, 2019).

Even a non-trained listener will be able to differentiate native and non-native speakers of his/her mother tongue. This will be determined on the basis of performance on global structure level, therefore the conclusion will be made based on rhythm and intonation of speaker's utterances. Since vowel (or a speech sound overtaking the role of vowel) is the stress carrier in the syllable, a lot of works has been done on vowel pronunciation and perception. When it comes to segmental level of speech great prevalence of speech disorders or mispronunciation can be seen in fricatives (Varošaneć-Škarić, 2010; Gibbon and Patterson, 2006 and McLeod et al., 2006 in Liker et al., 2012) and therefore this makes them very interesting speech sound group for perceptive and articulatory investigation both in native and foreign language. The articulation of fricatives is characterized by the narrowed pipe-like passage in the articulatory tract in which the air flow produces turbulences (Kent and Read, 2002; Harrington 2013). Besides such narrowed pipe-like passage, Kent and Read (2002) as well as Shadle (2013) describe fricatives as speech sounds characterized by the development of turbulent air flow and turbulent sound generating. In Croatian, more intense part of spectrum in intervocalic /s/ was measured in frequency range between 4 and 10 kHz and has usually 8% shorter duration than postalveolar fricatives (Bakran, 1996). Noise spectrum of fricatives has a chaotic spectral composition so the quantitative analysis of such sounds is complex. Therefore both for Croatian and other languages spectral moments (center of gravity, spectrum standard deviation, skewness and kurtosis) are frequently used to precisely quantify all aspects of noise spectrum (Vujašić, 2014).

One of the main differences in application of the verbotonal method apart from the difference between the group and individual work is the question of gross motoric movement. Due to different translations and different semantic fields the term *gross motoric movement* is sometimes, especially in papers written in French, replaced by a word *la geste* and afterwards translated in English as *gesture*. Clear cut should be drawn between the two for one single reason: *la geste* (Fr.) // *gesture* (Engl.) // *gesta* (Cro.) is a body movement with specific signification, i. e. handwave differs between languages and are gestures. They belong to the domain of non-verbal communication. Some gestures are not appropriate in certain languages while they have absolutely positive meaning in other languages. Although gestures change slightly in language during time and new ones enter the language, they are rather stable and pretty much in certain period of time always the same (i. e. blowing a kiss). In the verbotonal method movement of a body part (usually hand, arm or leg) is directly connected to the purpose of correction and it changes over time as the quality of speech changes during correction sessions. Many practitioners of the verbotonal method has rather small or no knowledge of the origin of movement application in the verbotonal method so they applied the same or the similar movement in many occasions not paying attention to the characteristics of the currently pronounced speech sound or the aim. In numerous occasions the movement does not undergo any variations no matter if it is applied to obtain perceptively „higher“ sound, prolonged duration or more open vowel. In most cases it is just a sharp movement determining the stress place in the word or sentence. Therefore it is always useful to mention that the movement in the verbotonal method was applied in such form by hearing and speech therapist who were also trained dancers and worked with Petar Guberina in Polyclinic SUVAG. The applied movement analysis (LMA) was developed by Rudolph Laban, an early 20th century choreographer of Hungarian origin. He structured the system of dance movements classification on the basis of different human movements in various professions. The system of analysis has become more popular under the name of LBMA (Studd and Cox, 2013), getting a *B* from Ingmar Bartenieff, who continued Laban's work and applied in on polio patients. Both of them had to „write down“ specifics and variations in movements of the people they worked with and therefore the system has become extremely detailed. It is based on the notions of duality and wholeness which can be easily related to certain segments of articulation, as Guberina also saw it. For example, if the duality is understood as not to have and to have a sound which equals not to have and to have movement, the stops can be immediately related to it. Of four elements in LMBA, *body*, *effort*, *space* and *shape*, the first two are of greatest importance in speech correction. They give answers to the question *what* (what part of the body) and *how* (how much effort will be applied) in certain movement. *Body* also refers to the duality of part and whole. It can be therefore applied to the analysis of body posture while speaking. The movement in correction refers to the hand, arm or leg, but the whole posture changes with the movement itself. If more strenght is needed it will be immediately seen in the upright, standing body position while more relaxed body posture can be seen while demands of the correction are to obtain more relaxed pronunciation. In acoustic correlates, the first case usually refers to obtaining speech sounds characterized with higer frequencies (such as /s/), while the second case usually refers to the opposite cases. When it comes to effort, great deal of varieties can be seen in obtaining i.e. vowels of different F1, F2 and F3, fricatives and affricates (in both directions, that is whether the person pronounces an affricate instead of a fricative or vice versa). Therefore the final shape of the movement will be characterized with the final stage of correction or the aim that still has to be achieved or has already been achieved. *Effort* will enable variations in progression and control or lingering and rushing (therefore slowing the pronunciation or speeding it up) (Studd and Cox, 2013).

In this pilot study differences between individual and group correction of Croatian dental fricative /s/ are questioned on the basis of acoustic data (such as duration and spectral moments), perceptual test and descriptive analysis.

2 HYPOTHESIS

The comparison of the two possible practices of the verbotonal method in foreign language pronunciation teaching is based on the hypotheses that negative emotions or inhibition will be greater in the beginning stages of group training, that the progression will be somewhat different in the group training and that all participants of group or individual training will perform better after the training sessions.

3 MATERIALS AND METHODS

Subjects

Four subjects participated in ten sessions of training based on the verbotonal method, respectively. One male native Spanish speaking subject (in further text: person A) from Argentina participated in individual sessions while a three-member family participated in the group session. The Brazilian speaking family consisted of a daughter (in further text person B), a mother (in further text person C), a father (in further text person D). At the time of training sessions all people were adult beginners of Croatian as foreign language. Although from different language backgrounds, all four learners had the same pronunciation mistake pronouncing dental affricate /ts/ instead of dental fricative /s/.

Phonetic training sessions

The program for both types of training was the same. First part of the session was dedicated to improvement of global structure (rhythm and intonation). The sentence were pronounced by the teacher and passed through low pass filter. The student were to repeat the structure using syllables such as *ba* or *ma*. Further step was to pronounce sentences containing /s/ in initial, middle and final position. The sentences were filtered through the high band pass filter 6400- 12800 Hz using verbotonal electroacoustic devices. At first stages of correction the slope used was 60 dB per octave and later 30 dB per octave. The same filters and slopes were then used for individual words. Each session would end with work on sentences, at first stages with slopes of 60 dB per octave and later on the direct channel (with no filters). For the individual classes headphones and for the group sessions speakers were used. The students were asked to repeat each utterance as soon as they heard it using the gross motoric movement showed by the teacher in order to improve their pronunciation. The movements followed the requirements of the person or the group (based on the common errors and therefore representing the common ground) and were designed using the basis of LMA/LBMA (Studd and Cox, 2013). All subjects were recorded before the first and after the last session in the recording studio of the Department of Phonetics at the Faculty of Humanities and Social Sciences (University of Zagreb) while reading the words, sentences and text that were used during phonetic training.

Analysis

For the purpose of this paper only words were analysed. Although the corpus of approximately 50 words was used for both types of training few words proved to be equally difficult for all four participants. Therefore those words were discussed separately according to the surrounding of the target sound. Center of gravity as well as duration were measured in Praat and compared before and after the sessions for each person individually as well as between the individual participant and the participants who participated in group training. Since the number of tokens and participants is rather small no further quantitative analysis was done. Descriptive analysis was based on the perceptual test/description of two trained listeners (phoneticians) and remarks written by the teacher during the phonetic session training.

4 RESULTS

In Table 1 results of the phonetic training are given according to each person and each word (representing /s/ sound in different sound environment).

Table 1. Results of the phonetic training according to each person and /s/ sound in the initial position

word	person	CoG (Hz)	SD (Hz)	SK	KT	Duration (ms)
individual training before						
sakriti	A	1810	3678	1,95	2,422	0,1
sin	A	797	2510	3,673	12,369	0,273
sir	A	922	2725	3,311	9,716	0,254
individual training after						
sakriti	A	8427	2842	-0,332	1,519	0,137
sin	A	8894	2436	-0,663	3,417	0,245
sir	A	7507	2846	-0,585	1,677	0,179
group training before						
sakriti	B	10063	3541	-0,755	0,942	0,222
sakriti	C	8482	1515	0,788	3,549	0,211
sakriti	D	8655	2235	0,1	3,49	0,141
sin	B	9979	2319	-0,163	2,298	0,183
sin	C	8033	1513	-0,549	11,773	0,175
sin	D	9396	1767	0,243	4,225	0,235
sir	B	10527	2375	-0,695	2,545	0,135
sir	C	9592	1975	-0,474	4,357	0,216
sir	D	9441	1968	-0,02	3,039	0,253
siv	B	10257	2812	-0,06	1,227	0,193
siv	C	7876	1598	2,628	9,739	0,2
siv	D	9118	2129	0,028	2,455	0,211
group training after						
sakriti	B	9864	2897	-0,332	1,666	0,167
sakriti	C	8178	1509	1,383	3,836	0,166
sakriti	D	8426	1231	0,683	6,188	0,132
sin	B	10005	3131	0,176	0,447	0,183
sin	C	8167	1981	1,004	1,337	0,208
sin	D	8435	1350	1,932	8,313	0,273
sir	B	9865	2596	0,267	1,943	0,176
sir	C	8835	1617	0,64	1,826	0,222
sir	D	8478	1683	0,563	6,681	0,258
siv	B*	9834	2658	0,861	1,841	0,2
siv	D	7922	1549	0,916	7,186	0,252

Table 2 shows the examples of words in the middle or final position of Croatian voiceless dental fricative before and after individual or group phonetic training. The measures, as in the previous table, are spectral moments and duration.

Table 2 shows the examples of words in the middle or final position of Croatian dental fricative.

word	person	CoG (Hz)	SD (Hz)	SK	KT	Duration (ms)
middle position						
individual training						
disati	A - before	5455	4194	0,185	-0,854	0,145
disati	A - after	7343	3485	0,186	-0,15	0,193
group training						
disati	B - before	7737	4401	-0,327	-0,624	0,136
disati	D - before	6338	4686	-0,16	-1,251	0,132
disati	B - after	8076	4310	-0,44	-0,367	0,159
disati	D - after	8073	2516	-1,458	3,96	0,142
final position						
individual training						
pas	A- before	5556	3825	0,019	-0,534	0,216
pas	A - after	4202	4244	0,645	-0,51	0,303
group training						
pas	B - before	8384	3204	-0,104	0,391	0,2
pas	C - before	7267	1670	2,249	6,085	0,282
pas	D - before	8345	2874	-0,064	2,041	0,269
pas	B- after	8140	3144	0,079	1,165	0,28
pas	C - after	8625	1731	0,679	0,382	0,419
pas	D - after	7978	1584	0,037	8,066	0,316

Small differences in the center of gravity (Hz) can be seen among individual pronunciation for the dental fricative in the initial position before or after the group sessions in the Table 1. Surprisingly great differences can be seen for the speaker A. Small differences can be seen between duration of the fricative before and after correction but there is no clear consistency. In the pronunciation of the target sound in final position rather longer duration can be observed. It can be partly explained as if the speakers' attention was focused on the sound since it was the end of the utterance. The results obtained for /s/ CVCV structures in nonsense words show average duration of 157 ms, center of gravity 8641 Hz, SD 2206 Hz (Vujasić, 2014).- The greatest differences between the previous results (Vujasić, 2014) and the results in this paper can be seen in the duration of /s/ in final position whereas other results are rather similar. No further conclusions or discussion about significance of the results cannot be drawn since the number of participants is small and it can be observed as the results of two separate cases studies. Compared to the values of English, the obtained results are up to a certain degree similar to those for the same English voiceless fricatives (Jongman and Wayland, 2000) or higher up to 2000 Hz. Extremely low values can be observed in the participant A before the training and the results can be partly explained on the basis of pronunciation habits in his native

language. Every piece of discussion should be observed only within these data because they represent the results of the pilot study. Furthermore, next step in investigation would assume not only larger number of participants but also of words analysed. In that case, words should be selected not only on the basis of students needs but also on the basis of attentively chosen surrounding since coarticulation and place in the word play an important role in speech perception and speech production.

Trained phonetician who listened to the recorded words scored high 93% deciding whether the recording was made before or after the phonetic training. Both phoneticians' remarks were consistent in not being able to decide whether the speaker participated in group or individual sessions. This observation should be taken seriously enough to proceed with this type of correction since it is easier and less time and money consuming. Special attention should obviously be paid to the similar language background if possible as well as the difficulties they share. The perceptive test should preferably be repeated on the greater number of listeners, both trained and untrained.

As for the remarks of the teacher involved in the training sessions, it can be seen that the organization of the group sessions was somewhat demanding since there was no available guidelines. Individual sessions were based on the available literature (Mildner, 1999; Guberina, 2010, Dobrić and Bićanić, 2013, Bukovski and Dobrić, 2017). The most challenging part was body posture and gross motoric movement. Since person A seemed to have overall more relaxed body posture, the person tended to sit more relaxed. It performed quite a challenge to obtain required tension and height in the pronunciation of the dental fricative. Gross motoric movement such as glide upwards was suggested so the participant A was encouraged to use the movement during the first stages of the correction. Although some time was required before the automatization of the movement, the participant A finally used the movement every time when he was not sure his pronunciation was good enough. In the group session all three participants sit uprightly but did not accept movement until later sessions (4 or 5). They tended to ask more questions about the purpose of the movement trying to discuss it but they were asked to proceed with repeating and the purpose was discussed after the class. Somewhat negative relationship was established in the beginning between the teacher and elder participants which was partly due to the frustration. When the teacher managed to master the relations between the participant and established certain rhythm of the activities, the correction sessions became more pleasant and relaxed. The relations changed between the participants themselves, but also between the teacher and the participants. More positive attitude was observed and positive self assessment was obtained. Finally, the participants wanted to proceed with correction for further sessions. It can be concluded that the first and the last hypotheses were confirmed as opposed to the second one.

During the correction a question arose: whether the explanation of the movement, necessity and benefits of it should be previously explained to the students or not? This same question often arises during language courses based on the verbotonal method. Although Guberina insisted on the globality and acquisition of structures without further explanation on the procedures during the class (Guberina, 2010), it turns out that adult students require certain knowledge of the purpose and procedures. It should be tested at which point of process explanation would show benefits since human brain tends to be more analytical with age and to which extent it is possible to obtain such confidence of a student to follow the instructions of the teacher without many questions.

The remarks obtained from the teacher are extremely valuable result because it gives the insight of the emotions as one of the basic characteristics of speech and one of the 6 functions of language (Jakobson, 1995; Tribus, 2017). To obtain the utterance which predominantly fulfills the emotional function of language speaker must feel well during the speech. Therefore positive evaluation and easier starter point as one of the verbotonal principles can be once again confirmed (Guberina, 2010). Furthermore, positive attitude and motivation are basic factors that will influence which modalities will be part of the participant's language acquisition. Better acquisition of pronunciation as a part of this overall acquisition is expected if more modes of input are accepted (Tribus, 2017; Mottironi, 2019).

5 CONCLUSIONS

Although not described in terms of consistent procedures, phonetic correction in teaching Croatian as foreign language is performed. In this pilot study it is clearly seen that despite some potential initial difficulties or obstacles group phonetic training should be performed both as separate part of language teaching as well as the integral part of every language class in somewhat different way. Although not based on acoustic measures, the results of the both types of phonetic training confirmed overall positive results on foreign language pronunciation and different approaches do not exclude one another. Based on the different interactions and emotions observed during different sessions of correction, it can be once again confirmed and stressed that the role of a teacher during the process of language learning is irreplaceable on different levels.

REFERENCES

- Bakran, J. (1996). Zvučna slika hrvatskoga govora. Zagreb: IBIS grafika.
- Billières, M. (2016). La phonétique corrective est-elle soluble dans la didactique ? *Français dans le monde - Recherches et applications*, (60), 118-127.
- Bukovski, A. and Dobrić, A. (2017). Vowels in Croatian as foreign language – example of native Slavic speakers. In M. Sovilj and M. Subotić (eds.) *Proceedings of Speech and Language 2017 – 6th International Conference on Fundamental and Applied Aspects of Speech and Language*, 334-341. Belgrade: Life Activities Advancement Center and The Institute for Experimental Phonetics and Speech Pathology.
- Dobrić, A. and Mildner, V. (2003). Influence of Time on the Success of Speaker Identification. *Proceedings of the 15th International Congress of Phonetic Sciences* (Eds. M.-J. Sole, D. Recasens and J. Romero), 1615-1617.
- Dobrić, A. (2011). Funkcionalna mozgovna asimetrija triju tipova dvojezični govornika. Doktorski rad. Zagreb: Filozofski fakultet Sveučilišta u Zagrebu.
- Dobrić, A. and Bičanić, J. (2013). Verbotonal method in modern practice – phonetic correction of palatal lateral approximant /ʎ/. (Eds. S. T. Jovičić, M. Subotić and M. Sovilj). In *Verbal communication research – Interdisciplinary research II*, 303-318. Beograd: IAAC and IEPSP.
- Flores, C., Rinke, E., and Rato, A. (2017). Comparing the outcomes of early and late acquisition of European Portuguese: an analysis of morpho-syntactic and phonetic performance. *Heritage Language Journal*, 14(2). National Heritage Language Resource Center, UCLA. <http://www.heritagelanguages.org/Journal.aspx>
- Grenon, I., Kubota, M. and Shepard, C. (2019). The creation of a new vowel category by adult learners after adaptive phonetic training. *Journal of Phonetics*, 72, 17-34.
- Guberina, P. (2010). Govor i čovjek. Zagreb: ArTrezor.
- Harrington, J. (2013). Acoustic phonetics. In: W. J. Hardcastle, J. Laver, F. E. Gibbon (ur.), *The Handbook of Phonetic Sciences*. Malden: Blackwell Publishing.
- Jakobson, R. (1995). *On Language*. Cambridge: Harvard University Press.
- Kanjir, I., Dobrić, A. et Orešković Dvorski, L. (2019). Méthode verbo-tonale dans la correction phonétique des consonnes /r/ et /R/. *Inter-lignes*, 22, 51-64.
- Kent, R. D. and Read, C. (2002). *The Acoustic Analysis of Speech*. Canada: Singular.
- Liker, M., Horga, D. and Mildner, V. (2012). Electropalatographic specification of Croatian fricatives /s/ and /z/. *Clinical Linguistic and Phonetics*, 26, 3, 199-215.
- Lum, J. A. G., Powell, M. and Snow, P. C. (2016). The influence of maltreatment history and out-of-home-care on children's language and social skills. *Child Abuse & Neglect*, 76, 65-74.
- McLeod, S, Harrison, L. J., Whiteford, C. and Walker, S. (2016). Multilingualism and speech-language competence in early childhood: Impact on academic and social-emotional outcomes at school. *Early Childhood Research Quarterly*, 34, 53-66.
- Mildner, V. (1999). Odpravljanje izgovornih napak v maternem in tujem jeziku. Skripta 3: Zbornik za učitelje slovenščine kot drugega/tujega jezika. (ur. M. Bešter). 13-21.
- Misono, S., Haut, C., Meredith, L., Frazier, P. A., Stockness, A., Michael, D. D., Butcher, L, Harwood, E. M. (2019). Dysphonia, Perceived Control, and Psychosocial Distress: A Qualitative Study. *Journal of Voice*, 33, 682-690.
- Motironni, E. (2019). Techniques de correction phonétique et l'expressivité émotionnelle. *Inter-lignes*, 22, 19-32.

- Park, Y. and Stepp, C. E. (2019). The Effects of Stress Type, Vowel Identity, Baseline f_0 , and Loudness on the Relative Fundamental Frequency of Individuals With Healthy Voices. *Journal of Voice*, 33, 603-610.
- Pinyopodjanard, S., Suppakitjanusant, P., Lomprew, P., Kasemkosin, N. Chailurkit, L., Ongphiphadhanakul, B. Instrumental Acoustic Voice Characteristics in Adults with Type 2 Diabetes. *Journal of Voice*, in print.
- Rezaeia, F., Gowharya, H. and Azizifara, A. (2015). Investigating the effect of formal training of phonetic rules on intermediate Iranian EFL learners' observing assimilation. *Procedia - Social and Behavioral Sciences*, 199, 196 – 203.
- Rimpault, D. (2019). Interphonologie et correction phonétique phonétique en FLE – le cas chinois. *Intér-lignes* (22) 77-92.
- Shadle, C. H. (2013). The aerodynamics of speech. In: W. J. Hardcastle, J. Laver, F. E. Gibbon (ur.), *The Handbook of Phonetic Sciences*. Malden: Blackwell Publishing.
- Studd, K. and Cox, L. (2013). *Everybody is a body*. Indianapolis: Dog Ear Publishing.
- Škarić, I. (1991). *Povijesni pregled, glasovi i oblici hrvatskoga književnog jezika*. Zagreb: HAZU. Globus. Nakladni zavod.
- Tribus, A. C. (2017). The Communicative Functions of Language: An Exploration of Roman Jakobson's Theory in TESOL. .MA TESOL Collection. 723. https://digitalcollections.sit.edu/ipp_collection/723
- Varošanec-Škarić, G. (2010). *Timbar*. Zagreb: FF press.
- Vujasić, N. (2014). Akustička analiza spektra šuma hrvatskih lingvalnih frikativa. *Govor*, 31, 2, 109-131.
- Yongman, A. and Wayland, R. (2000). Acoustic characteristics of English fricatives. *The Journal of the Acoustical Society of America*. <https://www.researchgate.net/publication/12314438>

Error Correction in the Foreign Language Classroom: Why, When, How?

Antonio J. Díaz Toledo
Western Albemarle High School
5491 Rockfish Gap Turnpike, Crozet, Virginia, U.S.A
adiaz@k12albemarle.org

ABSTRACT

This work explores the reasons and the timeliness of error correction and the different techniques to use to provide feedback in the foreign language classroom. It also explores the teacher and students' beliefs around error correction in a public school in Virginia, and the possible correlations between students' attitudes towards corrective feedback and their academic performance in the STAMP test at the Spanish 3 level.

Keywords: corrective feedback, students' and teachers' beliefs, overcorrection, academic performance

1. INTRODUCTION

Attitudes towards error correction range from the abolition of errors before 1960s, to strong disapproval of error correction as being unjustified in the late 1970s, and to an appreciation of the value of correcting errors in the 1980s (Lee, 1997). In recent decades, many proposals have emerged that address the treatment of errors in the field of foreign language teaching, as well as a series of essential questions to which the teacher must respond when considering his error correction philosophy and how to implement it in the classroom. The different approaches to second language acquisition result in often contrastive ways of understanding errors: a negative one, since they demonstrate the student's inadequacies to use the language correctly, and a positive one, since it allows the teacher to have an idea of where the student is in the linguistic learning process (Núñez-Méndez) 2001.

As to the effectiveness of error correction in the foreign language classroom, Botha (1987) points out that many language teachers make error corrections hoping that the students will register the error and rectify it when the same structure is used again in a comparable context. According to Stokes (1975), quite often, teachers' attempts to address students' errors are ambiguous and misleading, and may be counterproductive.

Another aspect that deserves special attention is the classroom environment and the daily interactions between the language teacher and the students. According to Macfarlane (1975), students' anxiety diminishes greatly when corrections are not presented as failures but as opportunities to grow.

This paper is an attempt to explore some of the issues mentioned before and offer some concrete ideas on the why, when and how of error correction in the foreign language classroom.

2. ERRORS

2.1. Defining errors

There seems to be a consensus among language teachers, regardless of how many years of experience they have, that error correction is one of the most challenging tasks in the field of language acquisition, not only for its complexity, but also because it is one of the most inherent responsibilities that they have: to provide feedback to students on their language use. According to Catalán (1997), there are at the very minimum three distinct definitions of errors in the field of language acquisition. These definitions are linked from three related disciplines: Psycholinguistics, English Language Teaching Methodology and Theories of Second Language Learning. The word mistake in Psycholinguistics is used as a synonym of error. According to its proponents, mistakes are made in spontaneous speech and in writing, as a result of the malfunctioning of the neuromuscular commands of the brain.

The English Teaching Methodology adheres to two definitions in regards to learners' errors. On one hand, one negative but moderate definition states that errors are "unwanted forms by the teacher or course designer" (George 1972:2). On the other, errors are positive and necessary. In the words of Catalán (1997), errors are proof of learning and impossible to eliminate no matter how deliberate instructors are.

These viewpoints of errors have their foundation in opposite theories of learning. One of these is the Behaviourist Theory. Behaviourists believe that students' behaviour is shaped via stimulus and response and that is observable as well. The task of the teacher is to control and manipulate the stimulus and the learning environment to as to change the outcome or behaviour (Leahey) 2000. The other is the Creative Construction Hypothesis. This theory states that errors allow students to learn, as also serve as a point of reference to guide the teachers in addressing those parts of the second language students have more difficulty using correctly and what are the errors that truly getting in the way of establishing effective communication.

2.1.1. The importance of error correction and timeliness

Needless to say, students need to be corrected as part of their language experience. However, language instructors should not overcorrect, and on the contrary, should emphasize the use of the target language. If the instructor is trying to enhance the students' communicative skills while interrupting them every time they make a mistake, this will only bring frustration and discouragement. Krashen and Terrell (1983:177) elaborated: "Our view is that overt error correction of speech even in the best circumstances is likely to have a negative effect on the student's willingness to try to express themselves." I am a proponent of selective correction. The instructor decides to correct only certain errors, based on the objectives of the lesson, or the specific activity that is done at the moment. If students are working on the present subjunctive in Spanish, only mistakes in that mood are corrected. Other mistakes made by students are purposely not addressed.

One alternative to correcting while the students speak is to make correction an activity. It can be implemented as a follow-up to a class activity. For example, each mistake or a specific type of mistake will be corrected in groups. In my opinion, this saves time and can potentially address the same mistakes made by several students in the same class. This will allow the negotiation of meaning as well.

2.1.2. Error correction techniques

Self-correction:

Once the student recognizes what is incorrect in his/her response, s/he should be able to correct himself/herself. This is definitely the best technique because the student will remember it better. Allwright and Bailey (1991) state that only the learner can do the learning needed to improve the performance, regardless of how much error treatment is provided.

Rephrasing question:

Holley and Kink (1971) propose rephrasing the question with the intention of reducing the number of words. This technique is particularly useful when the student has difficulty understanding the question but does not make a grammatical error.

Questioning:

Burt and Kiparsky (1974) suggest that when the student uses a word that the teacher does not understand, the teacher should ask a question about it. The student should explain the meaning of the word without using his/ her mother tongue. Example:

S: I moved to Mexico to (incomprehensible word)

T: Why did you do that?

S: In order to improve my Spanish.

Repetition:

Cohen (1975), suggest teachers to ask the student to repeat the sentence containing the error. This technique may be vague, in the sense that the student may not even realize why the teacher is asking to repeat and that an error has been made in the first place. I would personally use this technique with intermediate-high to high level students who have plenty of experience with the grammar of the target language.

Peer correction:

The teacher can encourage other students in the class to provide correction when a student cannot correct himself/herself. Prior to that, the teacher must foster an environment where everyone feels safe and comfortable. According to Edge (1990), peer correction has several advantages:

- It promotes cooperation in the classroom and the students get used to learning from each other.
- Both learners, the one who made the error and the one who makes the correction, are involved in an active process of listening and thinking about the language.
- The teacher has the opportunity to gather information about the learners' abilities.

Teacher correction:

If it comes to the realization that no one is able to make a correction, the teacher can explain again the particular item of the language that poses difficulty. This technique can be very useful, especially when many students make the same error in the same class. Valid to mention, this technique has its detractors. According to Fanselow (1977), the teacher must present the proper form only after other techniques have not worked to correct the error.

3. ATTITUDES TOWARDS ERROR CORRECTION

Corrective feedback has an important role in the language acquisition process (Li, 2010; Lyster & Saito, 2010; Mackey & Goo, 2007; Russell & Spada, 2006). For this reason, it is important for the teacher to be aware of his/ her own philosophy about error correction, and also to understand the students' perceptions toward leading them to master the correct forms of the language. As Brown (2009) points out, "L2 teachers and their students may have similar or disparate notions of effective teaching" (p. 46). Therefore, it is important for teachers to know their learners' preferences for corrective feedback in order to maximize its potential positive effect the development of language skills.

3.1. Teacher beliefs towards error correction

Errors in the foreign language class are natural and necessary, and teachers should have a positive attitude toward them. When teachers embrace this philosophy, students feel more inclined to participate and react positively to teacher's corrective feedback.

There seems to be agreement on the teachers' role on error correction. However, the type of corrective feedback and time allocated in the classroom varies in different instructional situations. According to Akhter (2007), it is the teacher who determines the severity of the error and the strategies implemented to provide corrective feedback. Some of these corrective feedback strategies available are asking questions, pausing and giving another chance, or repeating the error with rising intonation. Another effective strategy is to delay the feedback.

There is evidence that suggests that promoting self-correction is effective in language acquisition (Ferris, 2006). Harmer (1991) cautions about the scope of corrective feedback, and recommends teachers not to interfere with communication by emphasizing on accuracy and asking for too much repetition. Additionally, Burt (1975) suggests focusing on what is being communicated and not on specific errors.

3.2.. Students beliefs towards error correction

Learner beliefs are defined as learner's metacognitive knowledge about learning (Wenden, 1999). These beliefs were first introduced by Horwitz, who conducted several studies on student attitudes and L2 outcomes. Using the Beliefs About Language Inventory (BALLI), which contains 34 statements that assess students' beliefs in five different areas, -(a) the complexity of language learning, (b) foreign language aptitude, (c) the nature of language learning, (d) language learning and communication strategies, and (e) motivation and expectations, Horwitz (1988) confirmed that learners of diverse cultural and linguistic backgrounds share certain beliefs about learning. Other studies conclude that learner's beliefs about the nature of learning differ from those about language learning (Mori, 1999), proposing that learners conceive learning in general differently from learning about specific concepts and subjects. According to Loewen et al. (2009), learners consider grammar instruction and corrective feedback as distinct categories.

Among the studies that have analyzed learner beliefs about corrective feedback, Schultz's stands out (1996, 2001). His questionnaire on teacher and learner attitudes in regard to the role of grammar study and corrective feedback in foreign language learning, consists of seven questions; two deal with the role of feedback in general, two with students' attitude towards feedback on written errors, and one with learners' attitudes towards oral corrective feedback. In one study conducted by Schulz (1996), he compared the results of 824 American FL students and 92 teachers, and found that both groups agreed on the relevance of feedback on written work, but differed greatly of oral feedback; 90% of the students had a positive attitude towards corrective feedback to their spoken errors, but the majority of the teachers did not consider it as important.

4. METHODOLOGY

4.1. Introduction

The purpose of this research was to find correlations between students' attitudes towards corrective feedback and the results of the STAMP test in a Spanish 3 class. For clarification purposes, the STAMP test stands for Standards-Based Measure of Proficiency and is a web-based test that assesses language proficiency. This test has four sections: Reading, Writing, Listening and Speaking. For this study, only Speaking and Writing were considered, since students need to score 5 on both sections to earn the Seal of Biliteracy at the end of their high school career. The students took the test in early April, and certified raters who used a rubric using a 1-8 scale for both sections scored it.

4.2. Participants

A questionnaire of 5 questions designed by me was administered at the beginning of the school year 2017-2018 to a total of 20 participants studying Spanish 3 at the high school level in a public school in Charlottesville, Virginia. All the participating students took this level for the first time. The students were not given a proficiency test at that time, and the only point of reference is that all students had earned an A or a B in Spanish 2. 14 of the students had earned an A, and 6 students had earned a B. Ten of the participants (50%) were females, and ten (50%) were males. Students were asked not to write their names and a random number was assigned to each and every questionnaire. The idea was to avoid personal bias towards the participants.

4.3. Data Collection and Data Analysis

The questionnaire consisted solely of 5 questions with a scale to collect quantitative data, and did not include any qualitative part to elicit students' deep beliefs about error correction.

4.3.1. The quantitative analysis

Of the students who completed a questionnaire, 80% of the females agreed that they wanted corrected feedback in the form of clue or pointing that an error was made, versus 50% of the male counterparts.

In regard to being corrected exclusively by the teacher, 90% of the female participants disagree or strongly disagree, versus 50% of males who agreed and 50% who had a neutral opinion. As to the preference of time correction, 10% of females wanted to be corrected as soon as the error is made, 80% after they have finished speaking, and 10% after the activity. 50% of their male counterparts preferred to be corrected as soon as the error is made, 50% after speaking, and 0% after the activity. Lastly, 70% of the female students indicated that they always wanted to be corrected their individual errors and 30% usually, versus males who indicated 50% always, 40% occasionally, and 10% never.

4.4. The STAMP test results

In late April 2018, the official results of the Speaking and Writing sections test became available. Out of the 20 students who filled the questionnaire at the beginning of the year and took the test in early March, 60% of the female students scored at least 5 in the Speaking section and 5 in the Writing section, therefore earning the Biliteracy Seal, versus 30% of the male students who scored at least 5 in the Speaking Section and 5 in the Writing section.

5. CONCLUSION

After comparing the official results of the STAMP test with the responses of the questionnaire, it is fair to indicate that there seems to be a correlation between the students' positive attitude towards error correction and the scores that granted the students the Biliteracy Seal. Positive attitude for this study is defined as the willingness of the students to be corrected in a way that points out or gives a hint on the error in order to attempt self-correction, high tolerance for peer correction, and correction of their individual errors. The other variable that seems to have a positive impact in the students' performance is the time of the correction. Most female students (80%) preferred to be corrected after they speak and 50 % of the male counterparts shared that opinion.

It is important that teachers and students have a common understanding of the purpose of certain correction techniques. On the contrary, "if teachers and students have mutually exclusive ideas regarding correction techniques, the result will most likely be feedback that is ineffective and, in the worst case, discouraging for students who are learning to write in their second language" (Diab, 2006, p.2).

REFERENCES

- Akhter, T. (2007). *Giving feedback and correcting errors in ESL classroom*. Department of English and Humanities. BRAC University, Dhaka, Bangladesh.
- Allwright, D. & Bailey, K. 1991. *Focus on the Language Classroom*. Cambridge: CUP.
- Botha H. L. 1987. "The role of error correction in communicative second language teaching". Retrieved from <http://perlinguam.journals.ac.za/pub/article/view/472/509>,
- Brown, A. (2009). Students' and teachers' perceptions of effective foreign language teaching: A comparison of ideals. *The Modern Language Journal*, 93, 46-60.
- Burt, M. (1975). Error analysis in the adult EFL classroom. *TESOL Quarterly*, 9 (1), 53-63.
- Burt, Marina K. and Carol Kiparsky. 1974. Global and local mistakes. In *New frontiers in second language learning*, John H. Schumann and Nancy Stenson, eds. Rowley, MA: Newbury House.
- Catalan, R. (n.d). Terms and Definitions of Error in SLA. Retrieved from www.raco.cat/index.php/bells/article/view/File/102789/163499
- Cohen, Andre. 1975. *Error correction and the training of language teachers*. *Modern Language Journal* 59 (8).
- Diab, L.L. (2006). Error correction and feedback in the EFL writing classroom. Comparing instructor and student preferences. *English Teaching Forum*, 3,3-13.
- Edge J., 1990. *Mistakes and Correction* (Longman Keys to Language Teaching). Harlow: Longman.
- Harlow, England: Pearson Education.
- Fanselow, John F. 1977. The treatment of error in oral work. *Foreign Language Annals* 10 (5).
- Ferris, D. (2006). Does error feedback help student writers? New evidence on the short-and long-term effects of written error correction. In K. Hyland & F. Hyland (Eds.), *Feedback on second language students' writing* (pp. 81-104). Cambridge, U.K: University Press.
- George, H. 1972. *Common Errors in Language Learning*. Rowley, Mass: Newbury House.
- Harmer, J. (1991). *The practice of English language teaching*. London, U.K: Longman.
- Holley, Freda M. and Janet K. King. 1971. Imitation and correction in foreign language learning. *Modern Language Journal* 55 (8).
- Horwitz, E. K. (1988). The beliefs about language learning of beginning university foreign language students. *Modern Language Journal*, 72 (3), 283-294.
- Krashen, Stephen D. and Terrell, Tracy D.1983. *The Natural Approach. Language Acquisition in the Classroom*. New York: Pergamon Press Ltd.
- Leahey,T. H. (2000). *A History of Behavioral Psychology*. New York: Freeman.
- Lee, I. 1997). ESL learners' performance in error correction in writing. Some implications for teaching. *System*, 25 (4), 465-477.
- Li, S. (2010). The effectiveness of corrective feedback in SLA: A meta-analysis. *Language Learning*, 60 (2), 309-365.
- Loewen, S., Li, S.,Fei,F., Thompson, A.,Nakatsukasa,K.,Ahn,S&Chen,X. (2009). Second language learners' beliefs about grammar instruction and error correction. *The Modern Language Journal*, 93, 91-104.

- Lyster, R. & Saito, K. (2010). Oral feedback in classroom SLA: a meta-analysis. *Studies in Second Language Acquisition*, 32 (2), 265-302.
- Macfarlane, J. M. 1975. Some types of psychological discussion that help to establish the teacher's treatment of error as a fruitful variable for investigation. In R.L. Allwright (ed.), 4-63.
- Mackey, A., & Goo, J. (2007). Interaction research in SLA: a meta-analysis and research synthesis. In A. Mackey (Ed.), *Conversational interaction in second language acquisition: A collection of empirical studies* (pp. 407-452). Oxford, England: Oxford University Press.
- Mori, Y. (1999). Epistemological beliefs and language learning beliefs: What do language learners believe about their learning? *Language Learning*, 49, 377-415.
- Núñez-Méndez, E. 2001. "Corregir o no los errores en la clase de español como LE". Proceedings of the VII Symposium of Social Communication. Ed. By Center of Applied Linguistics 2: 132-38. University of Santiago de Cuba.
- Russell, J., & Spada, N. (2006). The effectiveness of corrective feedback for second language acquisition. A meta-analysis of the research. In J. Norris & L. Ortega (Eds.), *Synthesizing research on language learning and teaching* (pp. 131-164).
- Schulz, R. A. (1996). Focus on form in the foreign language classroom: students' and teachers' view on error correction and the role of grammar. *Foreign Language Annals*, 29 (3), 343-364.
- Schulz, R. A. (2001). Cultural differences in student and teacher perceptions concerning the role of grammar instruction and corrective feedback: USA-Columbia. *The Modern Language Journal*, 85 (2), 244-258.
- Stokes, A. 1975. Error and teacher-student interaction. In R.L. Allwright (ed.), 52-63.
- Wenden, A. (1999). An introduction to metacognitive knowledge and beliefs in language learning: Beyond the basics. *System*, 27, 435-441.

The Inherited Form Of 22q11.2 Deletion Syndrome: Speech Impairment And Delay In Language Development

**Marijana Rakonjac^{1,2}, Marina Vujovic¹, Goran Cuturilo^{3,4}, Milena Stevanovic^{5,6,7},
Sovilj Mirjana^{1,2}, Danijela Drakulic⁵**
masadanicic@gmail.com

¹Institute for experimental phonetics and speech pathology, Belgrade, Serbia;

²Life activities advancement center, Belgrade, Serbia;

³Faculty of Medicine, University of Belgrade, Belgrade, Serbia;

⁴University Children's Hospital, Belgrade, Serbia;

⁵Institute of Molecular Genetics and Genetic Engineering, University of Belgrade, Belgrade, Serbia;

⁶University of Belgrade, Faculty of Biology, Belgrade, Serbia;

⁷Serbian Academy of Sciences and Arts, Belgrade, Serbia

ABSTRACT

The 22q11.2 Deletion Syndrome (22q11.2DS) is the most common microdeletion syndrome in humans. It commonly includes cardiac defect, characteristic facial appearance, thymic hypoplasia, cleft palate/velopharyngeal insufficiency, hypoparathyroidism with hypocalcemia, speech and language impairment and developmental delay. The mode of inheritance of the 22q11.2DS is autosomal dominant. In approximately 72 - 94% of the cases the deletion has occurred *de novo*, while in 6 to 28% of patients deletion was inherited from a parent.

As a part of a multidisciplinary study we examined the speech and language abilities of members of two families with inherited form of 22q11.2DS. The tests of language and motor abilities were applied in order to determine the communication profile of children monolingual native speakers of the Serbian language with 22q11.2DS. The presence of 22q11.2 microdeletion was revealed by fluorescence in situ hybridization (FISH) and/or multiplex ligation-dependent probe amplification (MLPA).

We found considerable variability in the phenotypic characteristics of 22q11.2DS and the degree of speech-language pathology not only between different families with 22q11.2 deletion, but also among members of the same family.

In addition, we detected no correlation between the phenotype and the size of 22q11.2 microdeletion.

Key words: 22q11.2 deletion syndrome; inheritance, development of speech and language;

1. INTRODUCTION

The 22q11.2 deletion syndrome (22q11.2DS), encompasses DiGeorge syndrome is the most common microdeletion syndrome (Boto, et al. 2003) and the second most common genetic syndrome associated with congenital heart malformations after Down syndrome (Wiehann G. J., 2004.; Bassett A. S., 1999) with an estimated incidence of approximately 1/4000 per live births (Fernandez L., 2005). It is caused by an autosomal dominant *heterozygous* microdeletion of the q11.2 band of chromosome 22 (Chiara Squarcione, 2013). Most patients (90%) have a deletion of 3 Mb in size (encompassing ~60 genes); less frequent (8%) is a deletion of 1.5 Mb in size (~28 genes); a few patients have atypical deletions of shorter size and in variable locations (Beaujard M. P., 2009). This syndrome is among the most clinically variable syndromes, with more than 180 features related with the deletion, but commonly includes cardiac defect, characteristic

facial appearance, thymic hypoplasia, cleft palate/velopharyngeal insufficiency (VPI), hypoparathyroidism with hypocalcaemia, feeding difficulties, speech and language impairment and developmental delay (Chiara Squarcione, 2013; McDonald-McGinn DM, 1999; Firth H. et al., 2005; Hennekam R. et al., 2010). Additionally, literature data indicate that patients with this syndrome are at high risk of developing schizophrenia and other psychiatric disorders (Bassett, et al. 2003).

One of the characteristic features of 22q11.2 DS is the presence of speech difficulties. Most children show both developmental delay and learning difficulties and often need special education. Their learning disabilities are both verbal (language, speech, articulation, reading, comprehension) and non - verbal (motor skills, maths, visuo - spatial organisation) ((Solot et al., 2000., Persson et al., 2006).

Several studies have shown that children with the deletion show delayed language onset (Scherer et al., 1999; Solot et al., 2000, Persson et al., 2006). In addition, a number of other communication disorders has been described. These include articulation, language, resonance and voice problems. Palatal abnormalities may cause hypernasal speech and nasal air emission. Secondary to palatal anomalies and velopharyngeal insufficiency (VPI), compensatory articulation errors occur. The articulatory errors observed in children with 22q11.2 DS seem not only related to a delay in speech sound achievement as they are uncharacteristic of normal speech development, although it is not yet clear if they are syndrome specific (Van Lierde et al., 2001). Aggravating these speech difficulties are language problems due to cognitive deficits, delayed motor development, and frequent hearing problems (Solot et al., 2000).

. The mode of inheritance of the 22q11.2DS is autosomal dominant. In approximately 72% - 94% of the cases the deletion has occurred *de novo*, while in 6 to 28% of patients deletion was inherited from a mildly affected or normal parent (Carelle - Calmels et al., 2009).

2. METHODOLOGY

The aim of this pilot study was to analyzed speech and language abilities of patients with inherited form of 22q11.2DS from four different families. Patient 1 was 7.66 years of age and Patient 2 and 3 was 8 years of age. Patient 4 was 1,9 years of age. All patients were Caucasian. Patients were evaluated by the medical team from the University Children's Hospital, Belgrade, Serbia and a speech and language therapist from the Institute for Experimental Phonetics and Speech pathology (IEPSP), Belgrade, Serbia. Prior to the participation in the study, the consent was obtained from their parents. The ethical committee of the University Children's Hospital approved the study protocol.

2.1. Genetic analysis

The presence of 22q11.2 microdeletion was revealed by fluorescence in situ hybridization (FISH) and/or multiplex ligation-dependent probe amplification (MLPA). FISH on metaphase spreads from cultivated lymphocytes with the probe specific for the common deletion interval (TUPLE1, 22q11.2, SpectrumOrange) and the control probe (ARSA, 22q13.3, SpectrumGreen) (Vysis/Abbott) was performed as described by Cuturilo et al. (CUTURILO et al., 2013). The MLPA was done using Kit P250-A1 DiGeorge (MRC-Holland, Amsterdam, The Netherlands). The kit was used according to the instructions of the manufacturer, with some modifications earlier described in Cuturilo et al.(CUTURILO et al., 2013).

2.2. Assessment of language abilities

The tests applied in this study belong to IEPSP Test battery and are regularly used in speech and language clinical practice in Serbia (Global articulation test, Test of oral praxis, The story generation test). In the current study, these tests have been used in order to compare the language skills of the two children and not for the purposes of diagnosis. The research was conducted according to the ethical guidelines following the Declaration of Helsinki. The Ethical committee of the University Children's Hospital in Belgrade approved the study protocol. In this study we used A story generation test (KOSTIC and VLADISAVLJEVIC, 1983), Global articulation test (KOSTIC and VLADISAVLJEVIC, 1983), Test of oral praxis (STEVANKOVIĆ et al., 1993). It should be pointed out that none of the above-mentioned language measures have been standardized on the Serbian population, however, all of them are regularly used in speech and language clinical practice in Serbia (VUKOVIC et al., 2010).

3 RESULTS AND DISCUSSION

Results from this study demonstrated that in patients from two families with 22q11.2 microdeletion of about 3 Mb was detected, while in two families a 22q11.2 microdeletion of about 1.5 Mb was detected. Mothers were carrier in all four families. Previous studies have shown that brain volume is smaller and speech and language disorders are more pronounced in patients with 22q11.2DS whose 22q11.2 microdeletion is detected on chromosome 22 originating from the mother (Eliez et al. 2001).

We also found variability in the clinical presentation and in the degree of speech-language pathology between different families with inherited form of 22q11.2DS, as well as among the members of the same family. Specifically, by analyzing families with the familial form of 22q11.2 microdeletion, it was observed that members of the second generation exhibit a more severe form of speech and language disorders. Also, congenital heart malformation was not detected in the mothers of the subjects, while congenital heart malformation was detected in the subjects. These results are in agreement with data from the literature indicating a higher manifestation of second-generation clinical manifestations (Cirillo et al., 2014).

The results of the assessment of speech and language abilities in this study showed that the patient from family no. 1 (microdeletion 22q11.2 of about 1.5Mb in size) spoke at 3 years of age, while patients from family no. 3 (patient with microdeletion about 3 Mb in size), family no. 2 (with microdeletion about 1.5 Mb in size) and family no. 4 (patient with microdeletion about 3 Mb in size) produced their first meaningful words with meaning at the age of 14 months. Our results are consistent with the literature data suggesting delayed lingual stages in patients with familial 22q11.2DS (Cirillo et al., 2014). By analyzing oral practice in patient no. 1, 2, and 3 found that their oral practice was worse when compared with these abilities in peers of orderly speech-language development. Less coordinated facial movements, poorer lip movements, and poorer imitation of logomotor models were observed in all three patients. In patients no. 4 the ability of oral practice could not be analyzed in detail considering the age of this patient (1.9 years). The literature also cites the case of a 4-year-old girl with 22q11.2 microdeletion from her father who has articulation disorder, oral and motor impairment, as well as speech and language and cognitive disorders (Vergaelen et al., 2015). Patient no. 3 with a 22q11.2 microdeletion of about 3 Mb in size had a more severe form of speech disorders compared with patients no. 1 and 2 which detected a microdeletion 22q11.2 of about 1.5 Mb in size. Fewer sentences, fewer grammatically correct sentences and fewer words when describing events in pictures were observed in patients from three families (patient no.1, 2 and 3) compared to expected for chronological ages.

Data from the literature indicate a more frequent presence of microdeletion of 22q11.2 of about 1.5 Mb in children with the familial form of 22q11.2DS (Adeyinka et al., 2004; Fernandez et al., 2005). A potential explanation for the more frequent presence of 1.5 Mb of 22q11.2 microdeletion in patients with the 22q11.2DS familial formulation is the possibility that the 3 Mb microdeletion causes haploinsufficiency of a larger number of "modifier" genes compared to 1.5 Mb microdeletion, which making a 3 Mb microparticle more burdensome for the embryos that have inherited that microparticle (Adeyinka et al., 2004). In order to determine whether in the population of Serbia with the 22q11.2DS familial forms, the

1.5 Mb of 22q11.2 microdeletion is more frequent, it is necessary to analyze the microdeletion size in more patients with the 22q11.2DS familial form.

4 CONCLUSIONS

Based from the results from this study the speech and language abilities of all four patients with familial 22q11.2 microdeletion was lower than expected for their chronological age. In patients with the 22q11.2DS familial form, inter- and intrafamilial variability in the level of speech-language development was detected. The obtained results indicate that, based on the size of the inherited form of microdeletion, it is not possible to predict the level of speech-language development. These results are consistent with the literature suggesting that the size of 22q11.2 microdeletion does not affect the clinical manifestation of this syndrome (Yamagishi et al., 2003).

ACKNOWLEDGEMENT:

This work was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia (Grant No. 178027).

REFERENCES

- Adeyinka, A., Stockero, H. C., Flynn, C. P., Lorentz, R. P., Ketterling, S. M., (2004). Familial 22q11.2 deletions in DiGeorge/velocardiofacial syndrome are predominantly smaller than the commonly observed 3Mb. *Genet Med.*, 6: 517-520.
- Bassett, A. S., Chow, E. W. (1999). 22q11 deletion syndrome: a genetic subtype of schizophrenia. *Biological Psychiatry*, 46(7), 882-891.
- Bassett, A. S., Chow, E. W., AbdelMalik, P., Gheorghiu, M., Husted, J., Weksberg, R. (2003). The schizophrenia phenotype in 22q11 deletion syndrome. *Am J Psychiatry*, 160(9), 1580-1586.
- Beaujard M P, Chantot S, Dubois M. et al. Atypical deletion of 22q11.2: detection using the FISH TBX1 probe and molecular characterization with high-density SNP arrays. *Eur J Med Genet.* 2009;52(5):321–327.
- Botto LD, et al. A population-based study of the 22q11.2 deletion: phenotype, incidence, and contribution to major birth defects in the population. *Pediatrics.* 2003;112:101–107.
- Carelle-Calmels, N., Saugier-Verber, P., Girard-Lemaire, F., Rudolf, G., Doray, B., Guérin, E., Kuhn, P., Arrivé, M., Gilch, C., Schmitt, E., Fehrenbach, S., Schnebelen, A., Frébourg, T., Flori, E. (2009). Genetic Compensation in a Human Genomic Disorder. *N Engl J Med.*;360,1211–1216.
- Cirillo, E., Giardino, G., Gallo, V., Puliafito, P., Azzari, C., Bacchetta, R., ... Pignata, C. (2014). Intergenerational and intrafamilial phenotypic variability in 22q11.2 deletion syndrome subjects. *BMC medical genetics*, 15, 1. doi:10.1186/1471-2350-15-1
- Čuturilo, G., Drakulić, D., Krstić, A., Gradinać, M., Ilišić, T., Parezanović, V., . . . Jovanović, I. (2013). The role of modern imaging techniques in the diagnosis of malposition of the branch pulmonary arteries and possible association with microdeletion 22q11.2. *Cardiology in the young*, 23(2), 181-188. doi: 10.1017/S1047951112000571.
- Eliez, S., Antonarakis, E., Morris, A., Dahoun, P., & Reiss, L. (2001). Parental origin of the deletion 22q11.2 and brain development in velocardiofacial syndrome: a preliminary study. *Archives of General Psychiatry*, 58(1), 64-68.
- Eliez, S., Schmitt, E., White, D., & Reiss, L. (2000). Children and adolescents with velocardiofacial syndrome: a volumetric MRI study. *American Journal of Psychiatry*, 157(3), 409-415.
- Fernandez, L., Lapunzina, P., Arjona, D., Lopez Pajares, I., Garcia-Guereta, L., Elorza, D., . . . Delicado, A. (2005). Comparative study of three diagnostic approaches (FISH, STRs and MLPA) in 30 patients with 22q11.2 deletion syndrome. *Clinical Genetics*, 68(4), 373-378. doi: 10.1111/j.1399-0004.2005.00493.x
- Fernandez, L., Lapunzina, P., Arjona, D., Lopez Pajares, I., Garcia-Guereta, L., Elorza, D., . . . Delicado, A. (2005). Comparative study of three diagnostic approaches (FISH, STRs and MLPA) in 30 patients with 22q11.2 deletion syndrome. *Clinical Genetics*, 68(4), 373-378. doi: 10.1111/j.1399-0004.2005.00493.x

- Firth, H., Hurst, J., & Hall, J. (2005). *Oxford desk reference: clinical genetics*. Oxford, New York: Oxford University Press.
- Hennekam, R., Allanson, J., Krantz, I., & Gorlin, R. (2010). *Gorlin's syndromes of the head and neck*. Oxford, New York: Oxford University Press.
- McDonald-McGinn, M., Kirschner, R., Goldmuntz, E., Sullivan, K., Eicher, P., Gerdes, M., . . . Zackai, E. H. (1999). The Philadelphia story: the 22q11.2 deletion: report on 250 patients. *Genetic Counseling*, 10(1), 11-24.
- McDonald-McGinn, M., Tonnesen, M. K., Laufer-Cahana, A., Finucane, B., Driscoll, D. A., Emanuel, B. S., & Zackai, E. H. (2001). Phenotype of the 22q11.2 deletion in individuals identified through an affected relative: cast a wide FISHing net! *Genetics in Medicine*, 3(1), 23-29. doi: 10.109700125817-200101000-00006
- Persson, C., Friman, V., Oskarsdottir, S., & Jonsson, R. (2012). Speech and hearing in adults with 22q11.2 deletion syndrome. *American Journal of Medical Genetics Part A*, 158A(12), 3071-3079. doi: 10.1002/ajmg.a.35589
- Persson, C., Lohmander, A., Jonsson, R., Oskarsdottir, S., & Soderpalm, E. (2003). A prospective cross-sectional study of speech in patients with the 22q11 deletion syndrome. *The Journal of Communication Disorders*, 36(1), 13-47.
- Scherer, N. J., D'Antonio, L. L., & Kalbfleisch, J. H. (1999). Early speech and language development in children with velocardiofacial syndrome. *American Journal of Medical Genetics*, 88(6), 714-723.
- Scherer, N. J., D'Antonio, L. L., & McGahey, H. (2008). Early intervention for speech impairment in children with cleft palate. *The Cleft Palate-Craniofacial Journal*, 45(1), 18-31. doi: 10.1597/06-085.1
- Solot, C. B., Gerdes, M., Kirschner, R. E., McDonald-McGinn, D. M., Moss, E., Woodin, M., . . . Wang, P. P. (2001). Communication issues in 22q11.2 deletion syndrome: children at risk. *Genetics in Medicine*, 3(1), 67-71.
- Solot, C. B., Knightly, C., Handler, S. D., Gerdes, M., McDonald-McGinn, D. M., Moss, e., Wang, P., Cohen, M., Randall, P., Larossa, D. & Driscoll, D. A. (2000). Communication disorders in the 22Q11.2 microdeletion syndrome. *J Commun Disord*. 33: 187-203; quiz 203-184.
- Solot, C., Gerdes, M., & Wang, P. . (1998). Developmental profiles of preschool patients with 22q11.2 deletion. Paper presented at the Fourth Annual Velo-Cardio-Facial Education Foundation meeting, Boston, MA.
- Squarcione, C., Torti, M. C., Di Fabio, F., & Biondi, M. (2013). 22q11 deletion syndrome: a review of the neuropsychiatric features and their neurobiological basis. *Neuropsychiatric disease and treatment*, 9, 1873–1884. doi:10.2147/NDT.S52188
- Van Lierde, K. M., Van Borse, J., Van Cauwenberge, P. (2001). Speech patterns in children with Velo-Cardio-Facial syndrome. *Folia Phoniatrica et Logopaedica*;53:213e21.
- Vergaelen E, et al. (2015). 3 generation pedigree with paternal transmission of the 22q11.2 deletion syndrome: intrafamilial phenotypic variability. *Eur. J. Med. Genet.* ;58:244–248.
- Wiehahn, G. J., Bosch, G. P., du Preez, R. R., Pretorius, H. W., Karayiorgou, M., & Roos, J. L. (2004). Assessment of the frequency of the 22q11 deletion in Afrikaner schizophrenic patients. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, 129B(1), 20-22. doi: 10.1002/ajmg.b.20168

The State of Oral Practise in Dysphasic Children

Aleksandra Veselinović^{1,2}, Maša Marisavljević^{1,2}, Jelena Nikolić¹
valdar92@gmail.com¹

¹Institute for Experimental phonetics and Speech pathology

²Life Activities Advancement Centre

ABSTRACT

Oral practice represents the activation of facial organs through complex, learned movements that involve muscles of lips, tongue and face in order to produce the speech. Well-developed oral and motoric practice is one of the requirements for proper pronunciation of speech sounds. The maturation of oral practice follows the child's physiological development. The developmental dysphasia is characterized by the appearance of specific "pathological" patterns of expression, such as the distortion and replacement of phonemes and words that take the form of parafasic (substituted) productions, which remain in the speech for a long time, and which do not occur in any stage of normal language development. The aim of this research is to examine oral practice abilities of children of different ages with the diagnosis of developmental dysphasia. A sample for the examination is made up of a total of 50 children with a diagnosis of developmental dysphasia, which are divided into two groups age-related. The ages of children of the first and second groups ranged from 4.0 to 6.0 years. The first group of children included 25 children aged from 4.0 to 4.11 years, while the second group consisted of 25 children aged 5.0 to 6.0 years. The methodology of work was based on the application of Oral Practice Test to examine the children's pronunciation. The results of the research are curtailing the degree of harmonization of the speech-based structures with the age of the child, as well as their deviation in the form of specific functions in relation to the speech-language pathology. *Keywords* : oral practice, developmental dysphasia, articulation

1 INTRODUCTION

Oral practice represents the activation of facial organs through complex, learned movements that involve muscles of lips, tongue and face in order to produce the speech. Well-developed oral and motoric practice is one of the requirements for proper pronunciation of speech sounds. The maturation of oral practice follows the child's physiological development.

Oral practice includes: coordination of movement, muscle tone, muscle strength, range of muscle movement, movement speed, ability of an independent movement.

Observed from the phylogenetic aspect, organs involved in speech production are primarily intended for the feeding function, and then for the function of speech.

The first acts that are developed are swallowing, sucking and chewing. Breakdowns in these functions during a certain stage of child's development are the first indicators of poor oral practice, resulting in articulation mistakes. Proper stimulation of these functions in the earliest age affects the good development of oral practice and, consequently, the proper development of articulation (Dobrota, 2010).

An adequate pronunciation, requires adequate state of the speech organs capable to perform precise movements that are necessary for the articulation of speech sounds (Vasić, 2000).

The process of approaching some speech sound (or speech sounds) to the good pronunciation takes place spontaneously and in accordance with the laws of neurophysiological and neurolinguistic development, which is a continuous improvement of pronunciation. A spontaneous autocorrecting happens unconsciously during the development, while the willing autocorrecting takes place consciously, with the increased listening of someone else's correct pronunciation, with the attempt to approach such a speech, the child succeeds immediately or after some time (Kostić and Vladislavljević, 1995).

The developmental dysphasia is characterized by the appearance of specific "pathological" patterns of expression, such as the distortion and replacement of phonemes and words that take the form of parafasic (substituted) productions, which remain in the speech for a long time, and which do not occur in any stage of normal language development (Kašić, 2003).

The pathological features of irregularly formed speech sounds and the wrong direction of the air current create a barrier to the formation of correct audio performances about the acoustic phoneme features (Đorđević, 2006).

2 MATERIALS AND METHODS

The aim of this study was to determine the ability of Oral Practice at different age stages in children with diagnosis of developmental dysphasia. A sample for the examination was made up of 50 children with developmental dysphasia in total, divided into two groups and compared to their age, ranged from 4.0 to 6.0 years. The first group included 25 children aged from 4.0 to 4.11 years, while the second group consisted of 25 children aged from 5.0 to 6.0.

In accordance with the defined research objectives, the following Oral practise examination Test (Radičević, Stevanković) was applied.

3 RESULTS AND DISCUSSION

Statistical parameters used in data analysis were:

- Mean value, as a measure of the central tendency, or as a representative of the group from which it was calculated
- Standard deviation, as a measure of deviation of individual values from the arithmetic mean and
- Correlation coefficient – a measure of the degree of dependency when the signs are numerical.

Analysing the age of both groups, it is examined that the average age of children of first group is ranged from 4 years and 6 months +/- 4 months; and the average age of children of second group is ranged from 5 years and 6 months +/- 4 months (Table 1.).

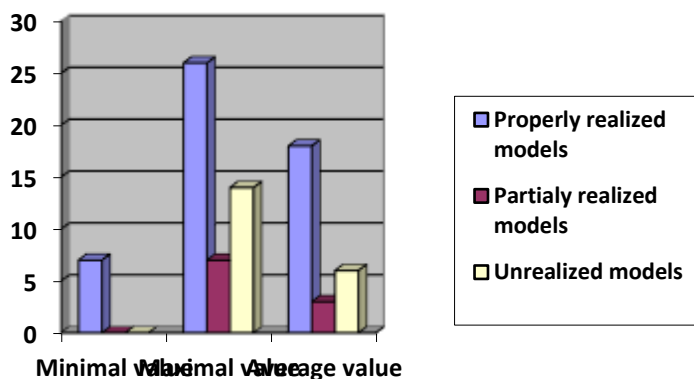


Chart 1. Results of children in the first group (4-5 years) on the oral practice test in relation to age

Regarding gender, in the first group (4-5 years), 16 boys were represented, which is 64%; and 9 girls, which is 36%. In the second group (5-6 years), 13 boys were represented, which is 52%; and 12 girls, which is 48%. Following, the total sample consisted of 29 boys (58%) and 21 girls (42%) (Chart 1).

The results presented (Chart 1) speak about the state of oral practice of children in the first group of ages from 4.0 years to 4.11 years; or from 48 to 59 months (expressed in months).

It is noted that the percentage of children with properly implemented models is leading and amounts to 69%. The percentage of children with undeveloped models is 22%, while the smallest percentage of children with partially (clumsily) modelled models is 10% (Table 1).

Table 1. The results of children of the first group (4-5 years) on the oral practice test related to age

Age	Oral Practise	Minimal value	Maximal value	Average value	Standard deviation	%
From 4.0 to 4.11 years	<i>Properly realized models</i>	7	26	18	5.92	69
	<i>Partly implemented models</i>	0	7	3	2.42	10
	<i>Unrealized models</i>	0	14	6	4.38	22

The results presented (Chart 2) represent the status of oral practice in children of the second group of ages from 5.0 years to 6.0 years; or from 60 to 72 months (expressed in months).

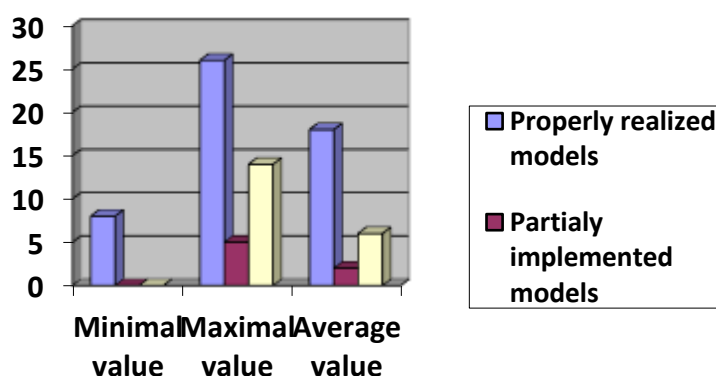


Chart 2. Results of children of the second group (5-6 years) on the oral practice test in relation to age

A group of children with correctly derived models is dominant with a percentage of 71%.

The percentage of children with unrealized models encompasses 21%, while the smallest percentage of children with partially (clumsily) derived models is 7% (Table 2).

Table 2. The results of children in second group (5-6 years) on the oral practice test related to age

Age	Oral Practice	Minimal value	Maximal value	Average value	Standard deviation	%
From 5.0 to 6.0 years	<i>Properly realized models</i>	8	26	18	6.44	71
	<i>Partly implemented models</i>	0	5	2	1.93	7
	<i>Unrealized models</i>	0	14	6	4.73	21

Observing the results of dysphasic children in the first group (4-5 years) and in the second group (5-6 years), the following comparison can be made (Chart 3):

Based on the perception of the percentage representation of correctly derived models in the first and the second group, it is concluded that there is a tendency of differentiation of oral practice with age, which corresponds to the possibilities of proper pronunciation of voices. The ratio of correctly derived models in the first group (4-5 years) and in the second group (5-6 years) is 69% versus 71%, where this difference between two age groups is not significant, but testifies to the growth of the correctly derived models oral practice, according to age.

By looking at the percentage of clumsy, i.e. partially derived models in the first group (10%) and in the second group (7%), there is a tendency of decreasing inconsistencies in the performance of the oral practice movement with the age of children.

Regarding the percentage comparison of incorrectly derived models in the first group (22%) and in the second group (21%), a slight decrease of 1% of incorrectly derived models with age was recorded; which notes that the linguistic deficit of dysphasic children nevertheless affects the achievements of the Oral Practice Test, with the minimal impact of age differences.

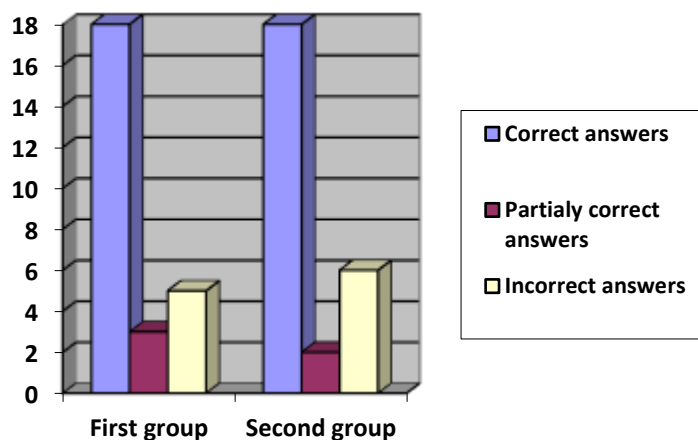


Chart 3. Results of the first and second groups in the Oral Practice Test

In Chart 3, the overall average value (from a maximum of 26 points), in children aged from 4.0 to 6.0 years, on the Oral Practice Test:

- for the evaluation + of the children of the first group (4-5 years) 18, and for the children of the second group (5-6 years) 18
- for the grade +/- in the children of the first group (4-5 years) 3, and in the children of the second group (5-6 years) 2
- for evaluation - for children of the first group (4-5 years) 6, and for children of the second group (5-6 years) 6

4 CONCLUSION

Based on the described objectives and research tasks, as well as the results obtained by research of oral practice abilities and articulation development, it can be concluded that diagnosis of dysphasia affects speech and language development and oral practice abilities.

The most common affected oral practice abilities were: coordination of movement, muscle tone, muscle strength, range of muscle movement, movement speed, ability of an independent movement.

In processed sample, the results have shown the differences between two age stages of dysphasic children. There is a tendency of slight improvement with age, but the results must be interpreted in the context of this study, which means that more comprehensive sample should be used for further investigations.

REFERENCES

- Bugarski, R.: *Introduction to general linguistics*, Belgrade, Čigoja, 1996
- Cristal, D.: *'Cambrian encyclopaedia of language'*, Belgrade: Nolit, 1996
- Čolić, G.: 'Phonological awareness of children with developmental dysphasia and children of typical language development', *Special education and rehabilitation*, 14 (2), 155-168, 2015
- Dobrota-Davidović N.: 'Early articulation – phonological disorders' *Multidisciplinary Approaches to Special Education and Rehabilitation, Proceedings and Abstracts, International Conference, Institute for Psychophysiological Disorders and Speech Pathology, Prof. Dr Cvetko Brajović*, 81-87, 2006
- Dobrota, N.: 'Articulation - phonological disorders' Belgrade: Institute for Psychophysical Disorders and Speech Pathology "Cvetko Brajović". University of Belgrade, Faculty of Special Education and Rehabilitation, 2010
- Đorđević, V., Golubović, S. (2006): Oralna praksija kod dece sa dizartrijom i verbalnom apraksijom. VII Kongres otorinolaringologa Srbije sa internacionalnim učešćem i XVI ORL nedelja, Novi Sad, Srbija
- Gec, V., Ivanuš J.: 'Phonological development in infants with perinatal brain lesions', *Speech and Language, Institute for Experimental Phonetics and Pathology of Speech, Belgrade*, 270-278, 2003.
- Golubović, S.: 'Phonological disorders' Belgrade: Society of Defectologists of Serbia, 2012.
- Kašić, Z. (2003a). Fonetika. Beograd, Defektološki fakultet.
- Keramitčievski, C.: 'General speech therapy', Belgrade: Scientific Book, 1990.
- Kostić, D., Vladislavljević, S.: 'Speech and the language of the child in development' Belgrade: Institute for Textbooks and Teaching Resources, 1995.
- Luria, A.R.: 'The basics of neuropsychology' Belgrade: Nolit, 1983.
- Punišić, S., Čabarkapa, N.: 'The state of the phonological system in pathological forms of speech and language' *Speech and Language Belgrade: Institute for Experimental Phonetics and Pathology of Speech*, 611-619, 2003.
- Vasić, S. (2000). Govor u razredu. Poslovni biro, Beograd.
- Vladislavljević, S.: *Pathologically underdeveloped speech of children*, Belgrade: Institute for Textbooks and Teaching Resources, 1997.
- Vuletić, D., *Articulation test*, Faculty of Defectology, University of Zagreb, 1990.

Attachment In Children With Autism Spectrum Disorder

Maša Marisavljević^{1,2}, Dušan Zečević^{1,2}, Aleksandra Veselinović^{1,2}

Life Activities Advancement Centre, Belgrade, Serbia¹

The Institute for Experimental Phonetics and Speech Pathology “Đorđe Kostić”, Belgrade, Serbia²

masa.marisavljevic@gmail.com

ABSTRACT

Attachment represents a specific relationship between a mother and a child which lasts for a lifetime. Children with autism spectrum disorders (ASD) have difficulties in the social interactions development, which can have an influence on the development of attachment. Studies that examined attachment in children with ASD obtained somewhat contradictory results. While certain research indicate that children with ASD develop disorganized attachment styles, others claim that in most children with ASD some evidence on the presence of secure attachment can be found. It has also been shown that the severity of autistic symptoms and the child's cognitive level can be significant predictors of the attachment style. Namely, ASD does not necessarily exclude the development of a secure attachment style, but in some way it changes the behaviors that reflect it. Authors point out that during the observation of children from this population, it is necessary to allow certain behavioral idiosyncracities. It seems that the comorbidity of autism severity and intellectual difficulties is associated with insecure attachment styles, rather than the diagnosis itself.

Keywords: attachment, attachment styles, autism spectrum disorder, parent-child relationship

1. INTRODUCTION

Autism spectrum disorder (in following text ASD) is described as a complex neurodevelopmental disorder that covers a wide range of symptoms and includes impairments in social interaction and communication skills, with the presence of rigid and repetitive behaviors. ASD can vary in the severity of impairments, ranging from minor disabilities that somewhat limit a normal life, to severe disabilities that significantly impede daily functioning (Ponaman, 2015), so the newest Diagnostic and Statistic Manual (DSM-V, 2013) adopted the term “spectrum”, which refers to various clinical manifestations. Different diagnostic manuals and empirical studies suggest that in ASD socio-emotional reciprocity (DSM-V, 2013), prosocial referencing (Bacon, Fein, Morris, Waterhouse, & Allen, 1998), positive feelings during episodes of shared attention, as well as expressing empathy (Nenadović & Stokić, 2015) are impaired. Experts warn that such severely impaired development of social interactions can affect the development of relationships with parents (Rutgers, et al., 2007).

This topic aroused considerable interest in experts and researchers, and focused their research on examining the development of attachment of children with ASD to their parents. However, despite the keen interest in this issue and the significant insights they have received, some questions have not yet been answered by the researchers, and the topic remains somewhat open. For these reasons, we felt it necessary to reopen and deepen the topic of attachment in children with ASD in this paper. First, we will describe the concept of attachment, and then focus on attachment in children with ASD and its specificities in this population. Also, we will present findings of studies indicating the presence of different mediator variables, located between ASD and attachment. Finally, we will point out the deficiencies and shortcomings of

previous studies, in the end to make suggestions for further studies and to outline the implications for scientific and clinical practice.

2. ATTACHMENT IN CHILDREN WITH AUTISM SPECTRUM DISORDER

2.1. Attachment as a psychological concept

Attachment refers to the specific affective relationship that is formed between mother and child during infancy (Bowlby, 1969). The first signs of attachment occur in the first year of life, and during the second and third year, due to the increase of the child's awareness of maternal departures and returns, as well as the progression of motor skills, ways of expressing attachment change, while the intensity and frequency of occurrence of its components remains unchanged. After the age of three, the strength of separation protesting begins to decline, and behavior stabilizes (Stefanović Stanojević, 2011). Stages of attachment and their descriptions are more precisely shown in Table 1. Although children may also develop attachment to several different individuals (Toter, 2011) in this paper we will focus solely on the attachment of the child to the mother, as they are the most common primary affective attachment figures.

Table 1. Attachment phases

Phase	Age	Description
Pre-attachment	0-2m	Infants do not discriminate one person from another-no fear of strangers
Indiscriminate	2-6m	Infant begins to show preference for primary caregivers
Discriminate	7-10m	Infant shows strong attachment to one specific caregiver
Multiple	10m-3y	Growing bonds with several people
Goal-oriented partnership	>3y	Child understands caregiver's schedule. Separation protests decline

Bowlby claimed that almost all children develop attachment to their mothers, with certain individual differences (Bowlby, 1956, according to Cassidy, 2008), but his work remained open and unfinished, especially in the absence of methods to examine mentioned differences. Empirical studies, which began in the 1980s, have created the Foreign Situation Method and have continued to use it in numerous studies to this day. The standard procedure for this method was devised by Mary Ainsworth and her colleagues. It is consisted of eight pre-planned episodes, whereby the level of anxiety to which the child is exposed changes: the mother and the child first stay in the room with toys, after which a foreign female person enters the room; the mother then leaves the child only with the foreign person, returns after a specified period and calms the child while the female leaves the room; the mother then leaves again and leaves the child only with toys, after which a foreign female person enters again, trying to calm the child, so that after a certain time the mother enters again. In the described episodes, the examiners monitor and observe the child's behavior, his or her attitude towards toys, reactions to separation and re-encounter with the mother, as well as reactions to the foreign female person. By analyzing the patterns of behavior in detail, the researchers identified three attachment styles: secure (66% of children exhibit this pattern), insecure-avoidant (22% of children), and insecure-ambivalent (12% of children) (Stefanović Stanojević, 2011). Later researchers (Main & Solomon, 1990) added a fourth category to this classification-disorganized attachment. Four types of attachment are shown in Graph 1, with presented intensity of avoidance and anxiety.

		Anxiety	
		Low	High
Avoidance	Low	Secure	Ambivalent
	High	Avoidant	Disorganized

Graph 1. Attachment styles

Securely attached children in the mother see the provider of a safe haven, a secure base for environment exploration, and a source of comfort when they feel disturbed or stressed (Sroufe, Egeland, Carlson, & Collins, 2005). They are curious, confident and enthusiastic and successfully deal with disappointments. They perceive their mothers as safe and caring, and the world as a benign place. In insecure patterns of attachment other than love, fear of abandonment and anger occur at the same time. In a state of anxiety, avoidant children are less likely to exchange emotions with their mothers-they avoid them and rarely use them as a safe base for exploring the environment. These children do not show great signs of distress and anxiety at separation. When they feel pain, they withdraw from themselves, showing no positive emotions during physical contact with their mothers, and occasionally expressing anger. Ambivalent children in difficult situations find it difficult to calm down, they are crying and anxious, often preoccupied with their mother's movements, and are not overly interested in exploring the environment. Children who have experienced abuse or neglect do not have a clearly organized attachment. In different situations, they may show signs typical of different attachment patterns, exhibit rapid changes in affectivity, appear lost and confused. These children have learned to inhibit the expression of emotions, especially those that provoke maternal anger and other negative reactions, and may develop asocial and generally maladaptive behaviors in adulthood (Bowlby, 1973, according to Bretherton, 2005).

2.2. Attachment in children with autism spectrum disorder

As noted before, ASD is a complex neurodevelopmental disorder that covers a wide range of symptoms and includes impairments in social interaction and communication skills, with the presence of rigid and repetitive behaviors. Experts warn that such severely impaired development of social interactions can affect the development of relationships with mothers (Rutgers, et al., 2007). Specifically, it has been believed for many years that children with ASD are incapable of forming attachment to their caregivers. They were described as reserved, distant, independent, and more interested in objects than people. This opinion has been widely adopted and has even been a part of earlier editions of the Diagnostic and Statistical Manual of Mental Disorders. The inability to create attachment to parents was described as one of the symptoms (DSM-III, American Psychiatric Association, 1980, according to Oppenheim, Koren-Karie, Dolev, & Yirmiya, 2008), which has sparked interest in examining attachment in children with ASD, and a series of observational studies that began in the 1980s continues to this day. Certain researchers have reported that children with ASD exhibit less secure attachment styles compared to other clinical groups or to typically developing children (Rutgers et al., 2007; Van Ijzendoorn, et al., 2007), and research findings that have examined parents' perceptions of their children with ASD patterns (Hoppes & Harris, 1990) have affirmed these findings.

On the other hand, a number of studies have tested this view, showing that children with ASD can develop attachment to their mothers and even a secure type of attachment (e.g., Rogers, Ozonoff, & Maslin-Cole, 1993; Sigman & Ungerer, 1984). That is, in most children with ASD at least some evidence of behaviors that confirm the presence of attachment has been found, and noted that these manifestations are not significantly different from those observed in children of typical development: children with ASD show behavioral changes during separation and reunion with mother, prefer interaction, contact and closeness to mother rather than strangers (Dissanayake & Crossley, 1996, 1997; Dissanayake & Sigman, 2000; Rutgers, Bakermans-Kranenburg, van Ijzendoorn, & van Berckelaer-Onnes, 2004; Shapiro, Sherman, Calamari, & Koch, 1987; Sigman & Ungerer, 1984).

When it comes to what percentage of children with ASD exhibit a secure pattern of attachment, the percentages vary from 40% to 64%, depending on the research (Capps, Sigman, & Mundy, 1994; Rogers, et al., 1993; Rutgers, et al., 2004; Shapiro, et al., 1987; Teague, Gray, Tonge, & Newman, 2017). When these results are compared with the findings of the original study (that about 66% of children in the typical population exhibit a secure attachment style), it can be said that a secure attachment style is somewhat or almost the same represented in the group of children with ASD compared to the group of children of typical development. That is, the impression is that impairments in social mechanisms can coexist with secure attachment (Vivanti & Nuske, 2017).

Reviewing the above data raises the question of why these discrepancies in research occur. The answer may be provided by researchers who claim that certain factors can explain these differences, about which will be spoken in the following text.

2.3. Factors which mediate attachment in children with ASD

In the following section, we will look at factors that have been shown in previous studies to affect attachment in children with ASD. First, we will present the child factors, then later on to consider the parental and family factors.

2.3.1. Child factors

Child factors which contribute to the attachment in children with ASD can be various, but we will highlight the most explored ones, and also those which we consider the need to be explored in following studies.

Namely, the severity of symptoms, especially those in the social domain, is associated with more present insecure attachment styles (Naber, et al. 2007; Van Ijzendoorn, et al., 2007; Rutgers, et al., 2004). Specifically, low-functioning children with ASD are less emotionally available (Dolev, Oppenheim, Koren-Karie, & Yirmiya, 2009) and show a general responsiveness deficit (Bacon, et al., 1998). Correlation analyzes also show negative associations between the severity of ASD symptoms and maternal perceptions of a child's attachment. As the severity of a child's symptoms increases, mothers report less secure attachment, and research findings also confirm that symptom severity is a good predictor of maternal perceptions of a child's lower attachment (Ponaman, 2015). This could be explained in terms that children with more functional forms of ASD are more aware of the environment and therefore more able to respond to its specific requirements (Bacon, et al., 1998).

On the other hand, some authors have argued that intellectual disabilities influence the manifestation of more ASD symptoms (Naber et al., 2007). More precisely, they suggest that developmental level, rather than the severity of ASD symptoms, is the strongest predictor of secure attachment (Rogers, Ozonoff, & Maslin-Cole, 1993), that is, lower developmental levels increase the chances of having disorganized attachment (Naber, et al., 2007; Willemsen-Swinkels, Bakermans-Kranenburg, Buitelaar, & van Ijzendoorn, 2000), and the differences almost disappear in the samples of children with better cognitive development (Rutgers, et al., 2004). Such findings could be explained by Bowlby's claims that the

organization of attachment behavior systems involves cognitive components, especially the mental representation of attachment figures, self and environment, which are largely based on experience (Bowlby, 1969/1982, according to Cassidy, 2008). Namely, in this case we can assume that attachment can be impaired by cognitive impairment, that is, by the inability to learn through experience that occurs in children with intellectual disabilities. Certain researchers (Dissanayake & Crossley, 1997, according to Naber et al., 2007) add that the developmental level affects the consistency of behavioral patterns, and that children who do not really understand what happens during separations and reuniting with their mothers do not experience stress or they become too confused, which generally applies to children with intellectual disabilities, regardless of the fact that whether the cognitive deficit is comorbid with another diagnosis. That is, intellectual disability seems to influence attachment or at least its evaluation. As children with ASD are most commonly intellectually impaired (Bujas Petković, 2000), this is the possible reason that they may sometimes seem disengaged (Rutgers et al., 2004, according to Naber et al., 2007), because they cannot adequately develop working models of themselves and their parents, i.e. to interpret emotional cues and inner states (Rogers et al., 1993, according to Naber et al., 2007). On the other hand, findings which suggest that attachment has its biological basis (Dosković, 2011), indicate that the need for attachment is independent of higher levels of learning, i.e. it can be developed through basic forms, which suggests that children with intellectual disabilities may also develop some degree of attachment to their mothers. From the findings listed above, one can get the impression that the comorbidity of the severity of ASD and intellectual disabilities is potentially related to the manifestation of insecure attachment patterns (Rutgers, et al., 2004).

When it comes to gender differences, research shows that the prevalence of ASD is almost four times higher in boys than in girls (Thomas, et al., 2011), however, there are differences between the sexes in how the clinical picture is expressed. Specifically, girls with ASD exhibit more prosocial behavior (Bacon, et al., 1998), socioemotional reciprocity (Backer van Ommeren, Koot, Scheeren, & Begeer, 2016), as well as less repetitive stereotypical behavior, while boys exhibit more externalizing and social problems (Mandy, et al., 2012). However, although there are gender differences in the clinical picture, differences in attachment are hardly mentioned in previous studies, although we can assume that they are also present. For these reasons, we believe that future research should pay attention to examining gender differences in attachment in children with ASD. Specifically, the obtained data may contribute to the better understanding of the differences in the clinical picture of ASD in relation to gender, but may also indicate cultural differences in the treatment of children of different sexes. Specifically, boys are generally disciplined more strictly (Sanapo & Nakamura, 2011), they are more active and restless (Milojković, Srna & Mićović, 1997), and it has also been shown that boys with ASD have more externalizing and social problems (Mandy, et al., 2012), which can make affective exchanges with mothers more difficult and can affect upbringing style. On the other hand, these gender differences may draw experts' attention to the need for more informed and improved diagnostic assessments of ASD in girls, as some authors warn that females use masking and imitation methods more often than boys do (Tierney, Burns, & Kilbey, 2016), to prevent girls from going undetected due to their compensatory mechanisms and to be deprived for timely treatment and support.

Most studies regarding testing of attachment in children of typical development are conducted with children around the age of first year. However, although symptoms may be noted earlier, the diagnosis of ASD is generally not posted before the third year of the child's life (Goin-Kochel & Myers, 2004), and it is felt that attachment in children with ASD can only be tested after the age of three. In support of this claim, findings suggest that the development of attachment in children with ASD may be delayed, and around the second or third year of life, these children begin to show attachment to their mothers (Toter, 2011). Although a little is known about the period of occurrence of the attachment, data on age differences and specificities of expression in children with ASD are significantly lacking in the literature. For these reasons, we believe that it is also necessary to introduce this factor into the study of attachment in children with ASD, in order to obtain additional, meaningful data on age specificities in the development of attachment in children with ASD, and for parents to clarify potential developmental delays that they notice in their children with ASD.

As noted above, attachment plays a significant role in later life adjustment and the creation of different types of relationships, and in children with ASD its role is even greater. Specifically, a number of studies has shown that children with ASD with organized attachment score better on symbolic play with their parents (Marcu, Oppenheim, Koren-Karie, Dolev, & Yirmiya, 2009), that secure attachment in combination with a stimulating environment at home influences the development of language skills (Murray & Yingling, 2000), and that a child's attachment during preschool is a good predictor of its later positioning in educational inclusive programs (Dolev, Oppenheim, Koren-Karie, & Yirmiya, 2014). On the other hand, research shows that the development of secure attachment can be influenced by different types of parent-mediated interventions (Siller, Swanson, Gerber, Hutman, & Sigman, 2014). It is the expert's premise that, within the constraints imposed by this disorder, secure attachment styles can help children with ASD maximize their developmental potential (Oppenheim, et al., 2008). However, although attachment has been shown to play a large role in the later cognitive and socio-emotional adjustment of the child, the inverse effect has not been examined yet. That is, we did not find any studies that examined the impact of different types of treatments aimed either directly on the development of attachment or on other spheres which could indirectly affect the development of attachment. Specifically, the obtained data would indicate the multiple importance of the child's involvement in intensive care, as well as the connectedness, intertwining and inseparability of cognitive and socio-emotional development, i.e. the possibility of indirect influence on one developmental domain through another one.

2.3.2. Parental and family factors

When it comes to parental and family factors, studies conducted on a typical population of children show that children who are exposed to the cumulative effects of socioeconomic risks such as low income and low parental education are more often disorganized due to parental non-responsiveness and insensitivity to their needs (Cyr, et al., 2010, according to Gedaly & Leerkes, 2016). On the other hand, studies examining the association between SES and parental education with ASD show that parental education is not associated with an increased incidence of ASD (King & Bearman, 2011; Rai, et al., 2012), but that community-level resources (King & Bearman, 2011) and lower-income family environments (Rai, et al., 2012) may influence the higher prevalence of ASD. Namely, although parents of both lower and higher socioeconomic status are aware of the specific needs of their child with ASD, parents of lower SES often report that they do not receive sufficient information about support services and professional staff (Pickard & Ingersoll, 2016), and children with ASD from higher-income families are more screened by professionals and diagnosed at a younger age (Thomas, et al., 2011). These structural barriers may slow down the diagnostic process and deprive the child of adequate treatment and parents to provide timely care, but how these factors affect the attachment of children with ASD in studies to date has not been examined, but one would expect to find, as this category of children is already vulnerable.

2.4. Examining attachment in children with ASD

Children with ASD exhibit less consistent behaviors, in the sense that these children have individual variations in response patterns (Dissanayake & Crossley, 1997). For these reasons, some researchers argue that when examining attachment in children with ASD, certain behavioral idiosyncratic should be allowed, as the clinical picture of ASD may somewhat alter patterns of behavior that reflect attachment (Rogers, et al., 1993), and that drawing conclusions on the quality of social relationships should not end with an assessment of attachment security/insecurity, due to the significant heterogeneity of behavioral markers (Rutter, Kreppner, & Sonuga-Barke, 2009). Specifically, some experts believe that it is more appropriate to use the Attachment Q-Sort (AQS) technique for the examination of children with ASD compared to the Strange Situation method, since testing with this technique is performed in natural rather than laboratory conditions, and chances are that it is easier to children from this specific population to express behaviors that indicate the presence of attachment when they are within their secure base (Rutgers, Van Ijzendoorn, & Bakermans-Kranenburg, 2007).

3. DISCUSSION

A review of the literature gives the impression that the topic of attachment in children with ASD is still under-explored. Namely, although science has come a long way from the deeply held view that children with ASD are incapable of developing attachment to examine what determines its intensity and which factors affect its development, certain contradictions and disagreement still exists. First, no consensus has yet been reached as to which method will be used for attachment examination, or whether certain behavioral idiosyncracics of children with ASD will be tolerated or not. Also, earlier studies that identified differences between children with ASD and typical development children viewed attachment as a categorical concept (has/doesn't have attachment; secure/insecure attachment styles), thus potentially overlooking nuanced differences between groups. Namely, due to the nature of the difficulties, that is, idiosyncratic behavior, by using categorical measures, there is a risk that children with ASD may end up being characterized as disengaged. On the other hand, the use of a continuous measure can indicate the presence or absence of some type of attachment, and indicate the extent to which it is present or not, but it cannot classify a child's behavior into one of the categories, giving the impression that a decision is made about the application of particular methods or instruments depending on the purpose of the research, but it may also be necessary to possibly make tests or measurement scales of attachments that are specific to this diagnostic category.

Furthermore, it can be said that studies to date have focused mainly on examining the impact of developmental/cognitive level and severity of ASD symptoms on attachment, while insufficient attention has been paid to other, potentially important factors. Namely, there is a wealth of information available regarding the development of attachment in children from typical population, while age specificities regarding attachment in children with ASD are cast in the shadow. Also, while experts are aware of gender differences when it comes to the clinical picture of ASD, not enough information is available to indicate how these differences affect the development of attachment. Certain characteristics of parents, such as educational level and socioeconomic status, have also been mentioned exclusively in studies concerning the prevalence of ASD. Also, although it has been shown that attachment can be promoted and its development stimulated, there are very few papers aimed at examining the effects of different types of treatment on the development of attachment in children with ASD.

Summarizing, it seems that the original expansion of paper on the factors that affect attachment in children with ASD has slowly begun to wane, although this concept is still under-explored, and we must say, very significant for the child's socio-emotional development and general well-being. For these reasons, we believe that further research is needed that will contribute to an even more accurate and comprehensive understanding of attachment in children with ASD. Also, in our country and region there are no studies on this topic, so any research would contribute to a better understanding of the attachment of children with ASD in our area, and could also complement some findings that previous researchers did not pay sufficient attention to.

If it turns out that any of the factors is a mediator between ASD and attachment, these findings are in addition to the scientific importance, in terms of better understanding of the clinical picture of children with ASD had significant practical implications. Specifically, this may indicate that additional, targeted interventions are needed targeting parents of a particular age, level of education, or children with more or less severe symptoms, of a certain age, gender, intellectual level. And all with the aim of raising awareness and showing assistance in the early diagnosis and timely provision of necessary treatments, which through different interventions and in different ways, can directly or indirectly influence the increase of attachment.

4. CONCLUSION

Initially high interest in the topic of attachment in children with ASD slowly began to decline, despite the fact that this topic remained under-researched. The scarce number of papers, contradictions in results and incompleteness in knowledge indicate the need for additional studies in this area and the expansion of the number of factors that are in the research focus. Any additional study focused on this very important topic would further contribute to understanding the specificity of attachment in a population of children with ASD. We believe that in future research, the focus should be on certain individual and family factors, and on the effects of various interventions aimed at improving the attachment of this population of children. In addition to the scientific contribution, i.e. the deepening of knowledge about the clinical picture of ASD and the specificity of attachment, the results of additional studies may have some practical implications. Specifically, we believe that the findings of the studies could be of relevance to clinicians and therapists, for the purpose of establishing targeted interventions aimed at the individual, family, and social levels, that is, when creating treatment programs and interventions aimed at a child with ASD, but also at the parents themselves, in terms of providing a variety of advice and guidance, which would greatly enhance parent-child dyad interaction, and thus enhance the quality of life for both children with ASD and their parents.

REFERENCES

- Backer van Ommeren, T., Koot, H.M., Scheeren, A.M., & Begeer, S. (2016). Sex differences in the reciprocal behaviour of children with autism. *Autism*, 21(6), 795-803. DOI: 10.1177/1362361316669622
- Bacon, A.L., Fein, D., Morris, R., Waterhouse, L., & Allen, D. (1998). The Responses of Autistic Children to the Distress of Others. *Journal of Autism and Developmental Disorders*, 28(2), 129-142.
- Bowlby, J. (1969). *Attachment and loss: Vol. 1. Attachment*. New York: Basic Books.
- Bretherton, I. (2005). In Pursuit of the Internal Working Model Construct and Its Relevance to Attachment Relationships. In K.E. Grossman, K. Grossman, & E. Waters (Eds.), *Attachment From Infancy to Adulthood: The major longitudinal studies* (pp. 13-47). New York: The Guilford Press.
- Bujas Petković, Z. (2000). Autizam i autizmu slična stanja (pervazivni razvojni poremećaji). *Paediatrica Croatica*, 44(1), 217-222.
- Capps, L., Sigman, M., & Mundy, P. (1994). Attachment security in children with autism. *Development and Psychopathology*, 6(02), 249-261.
- Cassidy, J. (2008). The Nature of the Child's Ties. In J. Cassidy, & P.R. Shaver (Eds.), *Handbook of attachment: Theory, Research, and Clinical Applications*, Second edition. New York: The Guilford Press.
- Dissanayake, C., & Crossley, S.A. (1996). Proximity and Sociable Behaviours in Autism: Evidence for Attachment. *The Journal of Child Psychology and Psychiatry*, 37(2), 149-156. DOI: 10.1111/j.1469-7610.1996.tb01386.x
- Dissanayake, C., & Crossley, S.A. (1997). Autistic Children's Responses to Separation and Reunion with Their Mothers. *Journal of Autism and Developmental Disorders*, 27(3), 295-312.
- Dissanayake, C., & Sigman, M. (2000). Attachment and emotional responsiveness in children with autism. *International Review of Research in Mental Retardation*, 23, 239-266. DOI: 10.1016/S0074-7750(00)80013-0
- Dolev, S., Oppenheim, D., Koren-Karie, N., & Yirmiya, N. (2009). Emotional Availability in Mother-Child Interaction: The Case of Children with Autism Spectrum Disorders. *Parenting, Science and Practice*, 9(3-4), 183-197. DOI: 10.1080/15295190902844332
- Dolev, S., Oppenheim, D., Koren-Karie, N., & Yirmiya, N. (2014). Early attachment and maternal insightfulness predict educational placement of children with autism. *Research in Autism Spectrum Disorders*, 8, 958-967.
- Dosković, M. (2011). Kombinacije obrazacaafektivne vezanosti u partnerskim odnosima. *Godišnjak za psihologiju*, 8(10), 169-182.
- Gedaly, L.R., & Leerkes, E.M. (2016). The Role of Sociodemographic Risk and Maternal Behavior in the Prediction of Infant Attachment Disorganization. *Attachment & Human Development*, 18(6), 554-569. DOI: 10.1080/14616734.2016.1213306
- Goin-Kochel, R.P. & Myers, B.J. (2004). Parental Report of Early Autistic Symptoms: Differences in Ages of Detection and Frequencies of Characteristics Among Three Autism-Spectrum Disorders. *Journal On*

- Developmental Disabilities, 11(2), 21-39.
- Hoppes, K., & Harris, S.L. (1990). Perceptions of Child Attachment and Maternal Gratification in Mothers of Children With Autism and Down Syndrome. *Journal of Clinical Child Psychology*, 19(4), 365-370. DOI: 10.1207/s15374424jccp1904_8
- King, M.D. & Bearman, P.S. (2011). Socioeconomic Status and the Increased Prevalence of Autism in California. *American Sociological Review*, 76(2), 320–346. DOI: 10.1177/0003122411399389
- Main, M., & Solomon, J. (1990). Procedures for identifying infants as disorganized/disoriented during the Ainsworth Strange Situation. In M. T. Greenberg, D. Cicchetti, & E. M. Cummings (Eds.), *The John D. and Catherine T. MacArthur Foundation series on mental health and development. Attachment in the preschool years: Theory, research, and intervention* (pp. 121-160). Chicago, IL, US: University of Chicago Press.
- Mandy, W., Joy Chilvers, R., Chowdhury, U., Salter, G.C., Seigal, A., & Skuse, D. (2012). Sex Differences in Autism Spectrum Disorder: Evidence from a Large Sample of Children and Adolescents. *Journal of autism and developmental disorders*, 42(7), 1304-13. DOI: 10.1007/s10803-011-1356-0.
- Marcu, I., Oppenheim, D., Koren-Karie, N., Dolev, S., & Yirmiya, N. (2009). Attachment and Symbolic Play in Preschoolers with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, 39(9), 1321–1328.
- Miljković, M., Srna, J., & Mićović, R. (1997). *Porodična terapija*. Beograd: Centar za brak i porodicu.
- Murray, A.D., & Yingling, J.L. (2000). Competence in language at 24 months: Relations with attachment security and home stimulation. *The Journal of Genetic Psychology*, 161(2), 133-140.
- Naber, F.B.A., Swinkels, S.H.N., Buitelaar, J.K., Bakermans-Kranenburg, M.J., van IJzendoorn, M.H., Dietz, C., ... & van Engeland, H. (2007). Attachment in Toddlers with Autism and Other Developmental Disorders. *Journal of Autism and Developmental Disorders*, 37(6), 1123–1138. DOI: 10.1007/s10803-006-0255-2
- Nenadović, V. & Stokić, M. (2015). Specifičnosti komunikacijskih profila roditelja i dece sa autističkim spektrom poremećaja. *Specijalna edukacija i rehabilitacija*, 14(1), 77-100. DOI: 10.5937/specedreh1-7281
- Oppenheim, D., Koren-Karie, N., Dolev, S., & Yirmiya, N. (2008). Secure Attachment in Children With Autistic Spectrum Disorder: The Role of Maternal Insightfulness. *Zero to Three*, 28(4), 25-30.
- Pickard, K.E. & Ingersoll, B.R. (2016). Quality versus quantity: The role of socioeconomic status on parent-reported service knowledge, service use, unmet service needs, and barriers to service use. *Autism*, 20(1), 106-15. DOI: 10.1177/1362361315569745.
- Ponaman, E. (2015). *The influence of autism severity on maternal perceptions of attachment* (Master thesis). Northridge: California State University.
- Rai, D., Lewis, G., Lundberg, M., Araya, R., Svensson, A., Dalman, C., ... & Magnusson, C. (2012). Parental Socioeconomic Status and Risk of Offspring Autism Spectrum Disorders in a Swedish Population-Based Study. *Journal of the American Academy of Child and Adolescent Psychiatry*, 51(5), 467– 476.
- Rogers, S.J., Ozonoff, S., & Maslin-Cole, C. (1993). Developmental Aspects of Attachment Behavior in Young Children with Pervasive Developmental Disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, 32(6), 1274-1282. DOI: 10.1097/00004583-199311000-00023
- Rutgers, A.H., Bakermans-Kranenburg, M.J., van IJzendoorn, M.H., & van Berckelaer-Onnes, I.A. (2004). Autism and attachment: a meta-analytic review. *The Journal of Child Psychology and Psychiatry*, 45(6), 1123-1134. DOI: 10.1111/j.1469-7610.2004.t01-1-00305.x
- Rutgers, A.H., Van IJzendoorn, M.H., & Bakermans-Kranenburg, M.J. (2007). Autism and attachment: The Attachment Q-Sort. *Autism*, 11(2), 187-200. DOI: 10.1177/1362361307075713
- Rutgers, A. H., van IJzendoorn, M.H., Bakermans-Kranenburg, M.J., Swinkels, S.H.N., van Daalen, E., Dietz, C., ... & van Engeland, H. (2007). Autism, Attachment and Parenting: A Comparison of Children with Autism Spectrum Disorder, Mental Retardation, Language Disorder, and Non-clinical Children. *Journal of Abnormal Child Psychology*, 35(5), 859–870.
- Rutter, M., Kreppner, J., & Sonuga-Barke, E. (2009). Emanuel Miller Lecture: Attachment insecurity, disinhibited attachment, and attachment disorders: where do research findings leave the concepts? *The Journal of Child Psychology and Psychiatry*, 50(5), 529-43. DOI: 10.1111/j.1469-7610.2009.02042.x
- Sanapo, M.S., Nakamura, Y. (2011). Gender and Physical Punishment: The Filipino Children's Experience. *Child Abuse Review*, 20(1), 39–56.
- Shapiro, T., Sherman, M., Calamari, G., & Koch, D. (1987). Attachment in autism and other developmental disorders. *Journal of American Academy of Child Adolescent Psychiatry*, 26(4), 480-484. DOI: 10.1097/00004583-198707000-00003

- Sigman, M., & Ungerer, J.A. (1984). Attachment behaviors in autistic children. *Journal of Autism and Developmental Disorders*, 14(3), 231–244.
- Siller, M., Swanson, M., Gerber, A., Hutman, T., & Sigman, M. (2014). A Parent-Mediated Intervention That Targets Responsive Parental Behaviors Increases Attachment Behaviors in Children with ASD: Results from a Randomized Clinical Trial. *Journal of Autism and Developmental Disorders*, 44(7), 1720-1732.
- Sroufe, L.A., Egeland, B., Carlson, E., & Collins, W.A. (2005). Placing Early Attachment Experiences in Developmental Context: The Minnesota Longitudinal Study. In K.E. Grossman, K. Grossman, & E. Waters (Eds.), *Attachment From Infancy to Adulthood: The major longitudinal studies* (pp. 48-70). New York: The Guilford Press.
- Stefanović Stanojević, T.Z. (2011). *Afektivna vezanost: razvoj, modaliteti i procena*. Niš: Scero print.
- Teague, S.J., Gray, K.M., Tonge, B.J., & Newman, L.K. (2017). Attachment in children with autism spectrum disorder: A systematic review. *Research in Autism Spectrum Disorders*, 35, 35-50. DOI: 10.1016/j.rasd.2016.12.002
- Thomas, P., Zahorodny, W., Peng, B., Kim, S., Jani, N., Halperin, W., Brimacombe, M. (2011). The association of autism diagnosis with socioeconomic status. *Autism*, 16(2), 201–213. DOI: 10.1177/1362361311413397
- Tierney, S., Burns, J. & Kilbey, E. (2016). Looking behind the mask: social coping strategies of girls on the autistic spectrum. *Research in Autism Spectrum Disorders*, 23, 73-83.
- Toter, K. (2011). *Deficiti i osnaživanje komunikacijskih vještina autističnih osoba*. Osijek: Sveučilište J.J.Strossmayera u Osijeku, Filozofski fakultet, Preddiplomski studij psihologije.
- Van Ijzendoorn, M.H., Rutgers, A.H., Bakermans-Kranenburg, M.J., Swinkels, S.H.N., Van Daalen, E., Dietz, C., ... & van Engeland, H. (2007). Parental sensitivity and attachment in children with autism spectrum disorder: comparison with children with mental retardation, with language delays, and with typical development. *Child Development*, 78(2), 597-608. DOI:10.1111/j.1467-8624.2007.01016.x
- Vivanti, G., & Nuske, H.J. (2017). Autism, attachment, and social learning: Three challenges and a way forward. *Behavioural Brain Research*, 325(Pt B), 251-259. DOI: 10.1016/j.bbr.2016.10.025
- Willemsen-Swinkels, S.H.N., Bakermans-Kranenburg, M.J., Buitelaar, J.K., & van Ijzendoorn, M.H. (2000). Insecure and Disorganised Attachment in Children with a Pervasive Developmental Disorder: Relationship with Social Interaction and Heart Rate. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, 41(6), 759-767.

Attitudes and Opinions of Students in the Subject Knowledge of Nature

Ivana Pavković¹, Ivana Ristić², Ivana Stanković³

¹Life Activities Advancement Center, Belgrade

²College of Social Work, Belgrade

³Institute for Experimental Phonetics and Speech Pathology, Belgrade

ABSTRACT

In recent years, there have been an increasing number of children with problems at school. Reasons for failure should be sought in different and complex relationships as to causes. Often, failure in school work is related to change: in physical, emotional, social and intellectual development. A hearing impaired child may also have problems at school. The aim of the research was to examine the attitudes of the hearing impaired child towards: material, teacher, learning, learning conditions, family relationships and assistance that the hearing impaired child expects in order to master the subject matter knowledge of nature. The sample consisted of children attending the fourth grade of a regular elementary school. The analysis of the obtained results indicates that the attitudes of the hearing impaired child do not differ from the attitudes of children with orderly hearing. Equally, they have / have no problem mastering school material in the subject of knowledge of nature. Both groups of respondents have identical attitudes towards the school and the teachers. There is no statistically significant difference in the conditions in which the hearing impaired child and the hearing-impaired child master the school material, and there is no difference in learning aid as well.

Key words: attitudes, students, problems in school, teaching

1 INTRODUCTION

In recent years, there have been an increasing number of children with problems at school ... The reasons for failure should be sought in different and complex relationships as to causes. Often, school work failure is linked to change: in physical, emotional, social and intellectual development. A hearing impaired child may also have problems at school. The aim of the study was to examine attitudes of the hearing impaired child towards: material, teacher, learning, learning conditions, family relationships and assistance that the hearing impaired child expects in order to master the subject matter knowledge of nature. The sample consisted of children attending the fourth grade of a regular elementary school. The analysis of the obtained results indicates that the attitudes of the hearing impaired child do not differ from the attitudes of children with orderly hearing. Equally, they have / have no mastery in mastering school materials.

The word "Attitude" appears in many different sciences. He first appears in social psychology, sociology, anthropology, ... and in defectology. In literature, the word "attitude" always refers to tendencies to react to the environment, people, objects and situations outside of us. Alport (according to Radoman 2003) defines attitude as the mental and nervous state of the organism's readiness, organized through experience, which is reflected in the directional or dynamic influence of an individual's reactions to all objects or situations with which he is associated. One can have multiple views e.g. attitudes towards oneself, then attitudes toward some of their own traits but also towards their actions and actions. And the tendency to react to the environment, people, objects and situations outside of us is always emphasized.

Value systems do not refer to individual objects and relations are emphasized by Katz and Kampfeld (1994). Changing attitudes is possible. Attitude change is one of the factors that greatly influences personality characteristics (Pavković, 2012; Pavković, Kovačević, 2013, 2017). Intelligence,

persuasiveness and the need for cognitive clarity are some of the relevant personality traits. Higher levels of intelligence make it easier to change attitudes, Roth points out, while others authorize dissenting opinions. Attitudes of utmost importance when it comes to children, parents, teachers at school.

In this paper, we first look at the attitudes of teachers towards the integration of children with special needs. Many research papers discuss the readiness of teachers to accept people with disabilities - persons with special needs, knowing the analysis of their views and the desire to actively participate in finding the most appropriate forms of education and integration in the integration process (Kovacevic, 2007). Research indicates different results. Special teachers had different views, while a regular teacher had an identical attitude to a special education teacher with whom he directly interacted. Empirical studies of mainstream teachers indicate favorable opinions about the inclusion of children with special needs. There is a large number of authors who have researched attitudes towards students with special needs and their integration and education in our country. And for the most part, research has shown unfavorable attitudes towards students with special needs and their educational integration. The problem with this attitude is certainly poor awareness. Therefore, awareness is one of the important factors for the integration and inclusion of children in mainstream schools. Being well informed means taking into account the intelligence coefficient of a child with special needs as well as the attitude of peers. Children with special needs most often withdraw into themselves and into some kind of isolation. Children with special needs need additional education. As education is needed for children with special needs, so is the need for teachers. Igrić (2007) talks about this and points out that education is needed to encourage the development of positive attitudes towards the integration of children with special needs in mainstream school.

Research conducted in Australia on professional attitudes towards integration education has provided a wealth of information in this area. Studies conducted between 1985 and 1989 included teachers' attitudes toward integration / inclusion, attitudes of principals (Center et al., 1985), teachers (Center and Ward, 1987), psychologists (Center and Ward, 1989), and preschool administrators (Bochneri Pieterse, 1989) and showed that professional groups differ significantly. The difference is in their perception, ie, which children and with which problem these children are most likely to be successfully integrated (Summary data from these studies were presented by Ward, Center and Bochner, 1994). These studies suggested that attitudes toward integration were strongly based on the nature of disability. and / or educational problems. Studies in Australia have included promising teachers (Ward and Le Dean, 1996) in their research, and have had a positive integration result. Other studies have shown that school district staff are far from understanding the importance of inclusion and have no affinity for inclusion. In contrast, students expressed more positive attitudes. Positive attitudes towards inclusion were also observed in classroom teachers. The same results were obtained by Forlin (1995). The author points out that educators from educational support centers (special centers that address educational needs and provide limited or extended support) are more inclined and more accepting of children with intellectual and physical disabilities than educators from regular mainstream schools that existed in the same location. The author concludes that teachers of special education resources tend to have a more positive attitude towards inclusion in the mainstream school system than their counterparts in mainstream school. Opinions on integration in other countries such as Egypt, Jordan, Colombia, Mexico, Venezuela, Botswana, Senegal, Zambia, Australia, Thailand, Czech Republic and Slovakia, Italy, Norway and Portugal are research-based and support teachers' support for integration children with different types of disabilities in mainstream school. Bawman comes to the interesting fact that teachers from countries where integration was regulated by law had more positive attitudes about integration (ranging from 47 to 93 percent). Teachers from countries that offered mostly sophisticated segregated education had a lower percentage of integration (ranging from 0 to 28 percent). The authors Leiser, Kapperman, and Keller (1994) conducted a study on faculty members and attitudes toward integration in the US, Germany, Israel, Ghana, Taiwan, and the Philippines. The results showed that there are differences in terms of integration between particular countries in terms of integration. Teachers in the US and Germany had the most positive attitudes towards integration. Positive attitudes in the US are attributed to broader integration and the law that regulates it. Interestingly, German teachers had positive attitudes, given that there was no specific education law at the time. For a much smaller percentage of positive attitudes in Ghana, the Philippines, Israel and Taiwan, the authors explained that this could

probably be due to limited or nonexistent training for teachers. Another factor is the problem of gaining competency for integration.

Some studies (Berriman, 1989; Horne and Ricciardo, 1988), from the USA, have suggested that there are educators who have not developed an empathetic understanding of disability conditions or appear to support the recognition of students' special needs in their regular classrooms (Bacon and Schulz, 1991; Barton, 1992). This can be explained by the fact that integration is often done in an ad hoc manner, without systematic modifications at school, organization, taking into account the expertise of teachers or any guarantee of continuous provision of resources. Center and Ward's (1987) Australian study indicates that their mainstream teachers have again had a problem integrating children. As the main reason, they point out the lack of conception in both their own teaching skills and the quality of support staff. Positive attitudes toward integration were only found in those children who were unlikely to require additional learning skills. A UK study by Clough and Lindsai (1991), which examined 584 teachers' attitudes towards integration and different types of support, revealed a broader positive view of integration. This research has provided some evidence, so attitudes towards child integration have changed over the past ten years. This result is partly attributable to the teacher's experience when the Warnock Report (1978) was published.

Finally, Scruggs and Mastropieri (1996), in their meta-analysis of the American judge's position, which includes 28 research reports conducted from at least 1958 to 1995, concluded that although two-thirds (65%) of the teachers surveyed (10,560 in total) In agreement with the general concept of integration, only 40% believed that this was a realistic goal for most children. One of the more important issues was the correlation between positive attitudes towards inclusion and the date of publication of inclusion. This attitude towards inclusion indicates that teachers' attitudes have not changed significantly over the years.

A study by Coates (1989; Pavkovic, 2017) indicates that teachers did not have a negative attitude but also did not support "full inclusion". Approximate results were obtained by Semmel et al. (1991, Pavkovic, 2017) who, after interviewing 381 educators in Illinois and California, were disappointed with the special education system and how it functioned. That's why they worked to raise special education programs. Also an American study by Vaughn et al. (1996) examined teachers' particular perceptions of inclusion using focus group interviews on teachers' attitudes toward integration / inclusion. Most of these teachers were not currently involved in inclusive programs. These teachers had negative attitude about inclusion, but they also felt when they had to make decisions about the inclusive program because they had never had experience before. Teachers identified several factors that would affect the success of mainstream students. The most important factor is the inadequacy of resources, then the degree of problems or impairments (how much a child could join the school system). Another factor is the unpreparedness of teachers. Teachers should have some preparation. In other studies (Villa et al., 1996) where teachers have had an active experience of inclusion, views on inclusion are contradictory. These teachers favored inclusion. The results of this research support the commitment of teachers. At the end of the implementation cycle, teachers have acquired the professional expertise required to implement exclusive programs. Buckner's (1998) case study of a Washington high school and high school that interviewed 20 inclusion teachers at the beginning and end of the school year. These teachers had positive attitudes, ie. that inclusion is good, although greater support is needed, which poses a challenge for further plans for inclusion.

A three-year study by Simpson and Myles (1996) in Michigan showed that as teachers' experience with children increased, their conception was to educate children as much as possible. At the beginning of this study, teachers had negative attitudes about inclusion and the introduction of innovation into work. Over time, this attitude has changed and the function of experience and expertise has contributed to a positive attitude towards inclusion. Many studies have suggested that teachers with negative attitudes about inclusion have changed their minds and attitudes over time. At the end of the implementation process, they took a positive attitude towards inclusion. A number of studies also note the interrelation of factors. So e.g. the factor of nature and degree of disability of the child significantly influenced the conditions of training of the child. And the personality factor of the child (and the teacher) also has an influence on the attitude towards inclusion. Generally, teachers' perceptions may differ. Children are assessed on three dimensions: physical and sensory, cognitive, and emotional behavior. Forlin (1995) found that educators cautiously accepted the inclusion of a child with cognitive disability. He also noted that children with physical disabilities were more accepted.

Children with mild physical disabilities should be integrated part-time. And only a small number of educators (6%) find it acceptable to integrate these children full-time. Most educators (86%) believed that only children with mild intellectual disabilities should be integrated into regular classes. What is relevant and what are the best educational needs for these children are most relevant to teachers because they are in practice. However, teachers do not have identical views

There are personality factors such as gender that can affect acceptance of inclusion. According to some authors and gender educators are one of these factors, although the evidence for this is inconsistent. Aksamit, Morris and Leunberger, 1987; Eichinger, Rizzo and Sirotnik, 1991; Thomas, 1985 noted that teachers have a greater degree of tolerance for integration and for the special needs of the person than teachers. For example, Harvey (1985) concludes that there is a marginal tendency for a teacher to express more positive attitudes toward the idea of integrating children with behavioral problems than a teacher. ”(Pavkovic, Kovacevic, 2017).

Deaf and hard of hearing students can successfully engage in regular school work. Success will be conditioned by the degree of linguistic development, the ability to communicate with the teacher and other students through speech, intellectual status, emotional maturity, the ability to adapt to the environment, the attitude of the environment towards his problems and the degree of support of the school and the teacher. The implementation of direct and indirect support measures, regulated by the Law on the Basics of Education, as well as the Rulebook on Additional Educational, Health and Social Support to the Child and the Student and the Rulebook on Detailed Directions for Determining the Right to an Individual Educational Plan, its Implementation and Evaluation Deaf and hard of hearing students for quality education in an inclusive environment.

In this study, the attitudes of hearing impaired and neat hearing students were examined.

2 AIM

The aim of the research was to examine the attitudes and opinions of the hearing impaired child according to: material, teacher, learning, learning conditions, family relationships and assistance that the hearing impaired child expects in order to master the material in the subject knowledge of society.

3 METHODOLOGY

The sample consisted of children attending the fourth grade of a regular elementary school (six fourth-grade students). The survey method was a survey that included questions to look at student attitudes about the material (eight questions), student attitudes about the teacher (ten questions), student attitudes about themselves (six questions), student attitudes about learning conditions (four questions) and attitudes about the assistance teachers could provide to a hearing impaired student (seven questions). The survey was taken from the Institute for Educational Research in Belgrade. The data obtained are correlated with the student's achievement, achievement on the knowledge test (which the students did) from knowledge of nature, and with the grade from the subject on which the student expresses views. Survey responses were processed by Pearson Chi-Square statistical analysis.

4 RESEARCH RESULTS

The first group of questions about attitudes to the subject of Knowledge of Nature had eight questions. The following results were obtained in the correlation of test success and response. Correlation of grades and answers to the questions shows that only one student answered in the negative, while the other students gave the identical answer to the first question about previously learned (old) material. Asked if the student does not understand some of the words the teacher uses, does not understand some of the words in the textbook, it is difficult for him to learn from the textbook, the material is uninteresting, the

material is overblown and that when learning the student does not notice important facts, the students gave negative answers. The results obtained on these answers show that there is no statistical significance. On the claim that the student does not understand some parts of the material, the students gave positive answers $p > 0.05$

Hearing impaired students show no differences in attitudes about the material from students with orderly hearing. All students agree that the material is difficult and overwhelming.

The second group of questions was about students' attitudes about the teacher. Teacher: quickly goes over the material, does not explain the difficult parts of the material, does not teach the textbook, seeks textbook knowledge that has not been processed, unfairly evaluates, does not like the student, does not speak interestingly, does not pay attention to the student's problems, disinterested in the student's success, gives bad grades due to behavior. Students answered all these questions for which statistical analysis showed that there was no statistical significance $p > 0.05$.

Hearing-impaired students show no difference in attitudes toward the teacher from students with orderly hearing.

The third group of questions concerned the personal condition of the students. Student: he has no will to learn, he is insecure about himself, has personal problems that burden him, he is lonely, scattered, thinks that his classmates do not like him. In this part, the students provided answers whose inspection did not establish statistical significance for the questions asked $p > 0.05$.

Hearing-impaired students show no difference in attitudes about personal status from students with orderly hearing.

The fourth group of results related to the learning conditions of the students. Responses to home-based learning conditions, poor family relationships, lack of accessories and textbooks (or something else for students to write) were positive so that there was no statistical significance of $p > 0.05$.

Hearing impaired students show no differences in attitude from students with orderly hearing. Both groups of students have the necessary didactic resources to work

Fifth group of questions related to additional learning aid in school work. Answers to questions about the special preparation of assignments for the student by the teacher that the student will work at home, about the possibility of the student to ask at any time (all that is unclear) to the teacher, about the additional help of the teacher and other students (when the student does not understand the material), teaching in small groups, questions about attending classes outside regular classes, and helping teachers to explain after hours what was unclear also did not have statistical significance $p > 0.05$.

Hearing impaired students show no differences in attitude from students with orderly hearing. Both groups of students need extra classes outside of class. In the correlation of achievement scores on the knowledge test of knowledge of nature and answers to the questions asked, we also have no statistical significance $p > 0.05$. There is also no statistically significant $p > 0.05$ correlation between school success and the answers to the questions asked for the subject Knowledge Society and the answers in the survey.

5. CONCLUSION

Based on the results of the research it can be concluded that:

1) Hearing impaired students have as little / no difficulty in mastering school materials as they do with hearing impaired students.

2) School success is not crucial to the attitudes of hearing impaired students and students with orderly hearing. All students, regardless of school achievement, have the same attitude about the material, the teacher, the personal condition, the learning conditions and the help they expect from the teacher.

3) Assessment of hearing impaired and hearing impaired students does not play a significant role in students' attitudes about the material, the teacher, the personal condition, the learning conditions and the help they expect from the teacher.

ACKNOWLEDGMENT

– The research was financed in part by the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the projects No. 178027 and No.32032.

REFERENCES

- Aksamit, D., Morris, M. and Leunberger, J. (1987). 'Preparation of student services, professionals and faculty for serving learning disabled college students', *Journal of College Student Personnel*, 28, 53–59
- Alport, G., V, Attitudes in the history of social psychology“ U Warren, N. i Jahoda, m (eds): *attitudes* Cox-Wyman,, London 1973
- Bacon, E. H. and Schulz, J. B. (1991). 'A survey of mainstreaming practices', *Teacher Education and Sp* Barton M. L. (1992). *Teachers' opinions on the implementation and effects of mainstreaming*; ERIC Document No. ED 350 802. *ecial Education*, 14, 144–149.
- Barton, L. (1997). Inclusive education: Romantic, subversive or realistic? *International Journal of Inclusive Education*, 1(3), 231–242.
- Berryman, J. D. (1989). 'Attitudes of the public toward educational mainstreaming', *Remedial and Special Education*, 10, 44–49.
- Bochner, S. and Pieterse M. (1989). 'Preschool directors' attitudes towards the integration of children with disabilities into regular preschools in New South Wales', *International Journal of Disability, Development and Education*, 36, 133–150.
- Center, Y., & Ward, J., Parmenter, T. and NASH, R. (1985). 'Principals' attitudes toward the integration of disabled children into regular schools', *Exceptional Child*, 32, 149–161
- Center, Y., & Ward, J. (1987). Teachers' attitudes towards the integration of disabled children into regular schools. *The Exceptional Child*, 34(1), 41–56.
- Clough, P. and Lindsay, G. (1991). *Integration and the Support Service*. Slough: NFER
- Hannah, M. E. (1988). Teacher attitudes toward children with disabilities an ecological analysis in Yuker, H, E, (Ed) *Attitudes toward children with disabilities*, New York-Springer, pp. 154–171
- Harvey, D. H. (1985). 'Mainstreaming: teachers' attitudes when they have no choice about the matter', *Exceptional Child*, 32, 163–173.
- Horne M. D. and Riccardo, J. L. (1988). 'Hierarchy of responses to handicaps', *Psychological Reports*, 62, 83–86
- Eicinger, J., Rizzo, T. and Sirotnik, B. (1991). 'Changing attitudes toward people with disabilities', *Teacher Education and Special Education*, 14, 121–126.
- Jamieson, J. D. (1984). 'Attitudes of educators toward the handicapped'. In: JONES, R. L. (Ed.) *Attitude and Attitude Change in Special Education: Theory and Practice*. Reston, Va.: The Council for Exceptional Children, pp. 206–222
- Forlin C. (1995). 'Educators' beliefs about inclusive practices in Western Australia',
- Igrić, L. J. (2007). The right to education for children with special needs in Croatian national strategies and plans. www.erf.hr
- Katz, J. (1994). Ambivalence over emotional expression and well-being.
- Nomothetic and Idiographic Test of the Stress-Buffering.
- Kovačević, J. (2007). Special needs child in mainstream school, Faculty of Teacher Education in Belgrade, Belgrade, Serbia
- Lindsay, L. (2007). The impact of placing pupils with special educational needs in mainstream schools on the achievement of their peers, *Educational research*, volume 49, Issue 4.
- Leyser, Y., Kappelman, G. and Keller, R. (1994). 'Teacher attitudes toward mainstreaming: a cross-cult
- Pavković I., Kovačević J. (2017). *From Integration to Inclusion - Perspectives and Challenges*, Ministry of Education, Science and Technological Development of the Republic of Serbia, CUŽA, IEFPG, Belgrade p. 160. ISBN 978-86-89431-27-8
- Pavković I. (2013). Attitudes of parents and the environment towards the deaf child, *Belgrade Defectology School*, vol 19 (1), 67–81, Belgrade: Alliance of Defectologists Serbia and Faculty of Special Education and Rehabilitation, ISSN 0354-8759
- Pavković, I., Kovačević, J. (2012). Inclusive education, attitudes, teachers and parents in inclusive education. *Belgrade Defectology School*, vol. 18, (3) 467–485, Belgrade: Association of Defectologists of Serbia and Faculty of Special Education and Rehabilitation, ISSN 0354-8759

- Salvia J. and Munson S. (1986). 'Attitudes of regular education teachers toward mainstreaming mildly handicapped students'. In: MEISEL, C. J. (Ed.) *Mainstreaming Handicapped Children: Outcomes, Controversies, and New Directions*. London: Lawrence Erlbaum, pp. 111–128.
- Radoman, V. (2003). Students with developmental disabilities in a new child-friendly school
- Scruggs, T. E. and Mastropieri, M. A. (1996). 'Teacher perceptions of mainstreaming inclusion, 1958–1995: a research synthesis', *Exceptional Children*, 63, 59–74.
- Simpson, R.L. & Myles, B.S. (1996). The general education collaboration model: A model for successful mainstreaming. *Focus on Exceptional Children*, 23(4), 1–10.
- Thomas, G. (1997). Inclusive schools for an inclusive society. *British Journal of Special Education*, 24(3), 103-107.
- Thomas, D. (1985). 'The determinants of teachers' attitudes to integrating the intellectually handicapped', *British Journal of Educational Psychology*, 55, 251–263.
- Thomas, G, Vaughan, M. (2005). Review: Inclusive Education Research Journal Vol 31, No 2, Apr, 2005
- Ward J., Center, Y. and Bochner, S. (1994). 'A question of attitudes: integrating children with disabilities into regular classrooms?', *British Journal of Special Education*, 21, 34–39. WARNOCK REPORT.
- Vaughn, S., Gersten, R., and Chard, D. J. (2000). The underlying message in LD intervention research: findings from research synthesis. *Exceptional Children*, 67 (1), 99-114.
- Vaughn, J. S., Schumm, J., Jallad, B., Slusher, J. and Saumell, L. (1996). Teachers' views of inclusion',

Graphomotor Abilities In Children With Specific Language Impairment

Marija Đorđević^{1,2}, Jelena Nikolić¹, Sunčica Đorđević¹

¹Institute for Experimental Phonetics and Speech Pathology "Djordje Kostic", Belgrade, Serbia

² Institute for Reserch and Development- Life Acitivities Advancement Center, Belgarde, Serbia
Gospodar Jovanova Street, 35, 11000 Belgrade
marijadj.pi90@gmail.com

ABSTRACT

Development of graphomotor abilities represents a precondition for mastering writing skills. Hindrances in the development of graphomotor abilities, lateralization and visual-motor coordination can have an impact on developing and mastering writing skills in children.

The aim of this research was to enquire into the development of graphomotor abilities and visual-motor coordination in children of typical and atypical development. The experiment was performed on 40 children of both genders between the ages 6-7. The examinees were divided into 4 groups: group K - 10 children of typical development; E1 - children with articulation disorders; E2 - children with specific language impairment; E3 - children with autism spectrum disorder. The research took place in May, 2019. in the Institute for experimental phonetics and speech pathology "Đorđe Krstić" and in a preschool institution called "Ljolja" in Voždovac.

The results obtained in this research were considered in relation to the clinical picture of children and children of typical development.

Key words: graphomotor abilities, children of typical and atypical development

1 INTRODUCTION

Graphomotor skill, visual perception and differentiated usability of laterality, are essential for mastering the skill of writing (Ćalasan, Vuković, M., Pavlovic, Vuković, B., Zečević 2015)

Graphomotor skills start to develop in early childhood. In order to master graphomotor, a child at a certain stage of its development must go through the entire motor development that begins with the development of rough motor skills, and continues with the development of fine motor skills. In the beginning, children express through drawing which is in the form of scribbles until the age of two. At the age of three to six years, children begin to copy circles, squares and triangles. Children try to draw the human figure, first in the form of a tadpole, and later in the form of geometric shapes. Before primary school they start with distinctive drawing. At the age of four, a child can copy a diagonal line and a few printed letters, and at the age of six knows how to write its name and surname (Nikolić, 2012; Nikolić, Ilić-Stošović, Ilic & Pesic, 2012).

Dyslaly (a developmental disorder of voice articulation, functional disorder of articulation, lisp) is a disorder in the speech production of the child / persons with normal physiological hearing, normal innervation of speech organs, normal intellectual abilities and normal level of development of the rest of language skills. According to the ICD-10 classification, specific speech articulation disorder (F80.0) is a specific developmental disorder in which use of the child's speech sounds below the expected level of his or her mental age, with a normal level of speech ability. Nonverbal intelligence of a child with dyslaly is normally developed, expressive and receptive language skills are within normal / typical development, abnormalities of articulation cannot be directly attributed to sensory, structural or neurological

abnormalities, wrong pronunciation have clearly been changed in the context of speech language use within the subculture to which the child belongs (Golubović, 2012)

Specific language disorder is characterized by a delay or an atypical form of the development of expressive and / or receptive language abilities, in the absence of general cognitive deficit, autism, hearing impairment, social and emotional disorders and severe environment deprivation (Drljan, Vuković, 2017). Specific language impairment is a disorder of speech and language in which the child's ability to speak or understand speech is below what is expected for his mental or chronological age (Sovilj, 2013).

Autism is a neurodevelopmental disorder characterized by significant impairments in reciprocal social interaction and communication patterns, as well as limited, stereotyped and repetitive repertoire of behavior, interests and activities. These clinical features can be observed in varying degrees in almost all pervasive developmental disorders (Glumbić, 2009).

2 METHOD

2.1 Time and place of the research

The research was conducted in May 2019 at the Institute for Experimental Phonetics and Speech Pathology " Djordje Kostić " and preschool " Ljolja ", municipality of Vozdovac in Belgrade.

2.2 Sample of the research

The study included 40 pre-school children 6 -7 years old, divided into four groups: K group children of typical development from kindergarten Ljolja, E1 group of children with articulation disorders, E2 children with specific language impairment (SLI), E3 children with autism spectrum disorder (ASD). The criterion for entering the research was that all of the children had a dominant right hand.

2.3 Instruments

Ring Test - The child sits at a table, in front of him/her the examiner places a stand with a 30-35cm long bat, on one of the stand he sets 10 rings. The child has the task to (as quickly as possible), at a given signal, put the rings on the bat with one hand. Every miss of the bat or drop of the ring on the table is noted as a minus and the entire time is recorded in seconds. The test is repeated with the other hand. The results are used to determine the initial state, ie. vasomotor skills and hand dexterity.

OZ Rehearsal - Material required to perform this test are two panels whose upper edges are connected so that they can be folded. The upper panel is thinner and has 100 holes which are drilled through the entire panel. The lower panel is thicker and also has 100 holes of the same layout, except that the holes are not drilled through the entire board, but only halfway. A piece of white paper is placed and fixated between the two boards. Two auxiliary nails are used on the side. The examinee is given a piercer which matches the dimensions of the holes and the task is to, as quickly as possible, punch holes in the paper with the right hand and then with the left one. The duration of this test is 1 minute. After completion of the task, the paper with the holes is taken out. The examiner counts the holes which the child made with its right and left hand. The manner in which the examinee executed the task is recorded, i.e whether the child went according to the order of the holes, skipped some holes, or repeatedly returned to the same hole. Motor ability separately of the left and the right hand is estimated by giving points to the child, according to the number of holes it made with its right and left hand, as follows:

Up to 49 holes - 0 points (very reduced motor ability of the arm r/l)

From 50 to 59 holes - 1 point (reduced motor ability of the arm r/l)

From 60 to 69 holes - 2 points (functionally preserved motor ability of the arm r/l)

From 70 to 79 holes - 3 points (good motor ability of the arm r/l)

From 80 to 89 holes - 4 points (very good motor ability of the arm r/)

From 90 to 100 holes – 5 points (extremely good motor ability of the arm r/) (L.Stošljević, M. Stošljević, Odović, 2006)

Acadia test is made of a successful combination of precisely those skills required for success in school. In Canada, where this test was designed, the need was shown for such a measuring instrument that in a fast and economical way could serve to diagnose the reason of failure in children's learning. Each subtest is designed to measure some aspects of development abilities of children, which they need to cope with the school curriculum. A lot of tasks in subtests are given in non-verbal form, and there are some subtests that test verbal and psychomotor abilities. Acadia test can be used individually and in groups. Most subtests have twenty items or tasks, while fewer of them have ten or fifteen tasks. Subtests are: auditory discrimination, visual-motor coordination and the following capability, visual discrimination, drawing shapes, visual memory, audio-visual associations, tracing and encryption, auditory memory, ability to form concepts, acquired vocabulary, automatic vocabulary, visual associations, drawing. All thirteen subtests of the Acadia test are independent and can be administered in any order depending on the needs of the examiner. Time is not limited. Total number of points on the subtest 2 is 20 and the maximum number of points on the subtest 4 is also 20 (for each correct answer the subject receives one point, is scored only the best copied shape in each task gets points). Subtest 2 subtest 4 were used for the purposes of this study (Novosel, 1978).

3 RESULTS

Table 1: Ring test right hand

DG	N	M	SD
Typical development	10	14,1	1,66
Articulation disorder	10	15,9	2,07
SLI	10	20,60	4,11
ASD	10	37,70	20,67

Results of the t-test showed that there was no statistically significant difference between children of typical development and children with a articulation disorder on the ring test ($t = -2, 128$, $df = 18$, $p > .36$), while in children with a specific language disorder and children with an autism spectrum disorder there was a statistically significant difference on the ring test ($t = -2.565$, $df = 9.71$, $p < .003$).

Table 2: Oz rehearsal right hand

DG	N	M	SD
Typical development	10	55	7,95
Articulation disorder	10	56	11,51
SLI	10	44,2	13,91
ASD	10	31,7	20,79

Results of the t-test showed that there was no statistically significant difference between children of typical development and children with a articulation disorder on the OZ samples ($t = - 203$, $df = 15$, 99 , $p < .304$), whereas in children with a specific language disorder and those with an autism spectrum disorder was, also, no statistically significant difference ($t = 1.58$, $df = 15,71$, $p < .205$).

Table 3: Acadia sub test 2

DG	N	M	SD
Typical development	10	18,8	2,09
Articulation disorder	10	15,8	4,10
SLI	10	10	4,10
ASD	10	1,6	2,22

Results of the t-test showed that there was no statistically significant difference on the sub test 2 (Acadia) between children of typical development and children with a articulation disorder ($t = 2,058$, $df = 18$, $p < .022$), whereas in children with a specific language disorder and children with an autism spectrum disorder there was a statistically significant difference on the sub test 2 (Acadia) ($t = 5.686$, $df = 18$, $p > .000$)

Table 4: Test 4 Acadia sub test 4

DG	N	M	SD
Typical development	10	12,9	3,81
Articulation disorder	10	16	2,53
SLI	10	7,3	4,57
ASD	10	4,4	5,5

Results of the t-test showed that there was no statistically significant difference on the sub test 4 (Acadia) between children of typical development and those with articulation disorders ($t = 2.14$, $df = 15,66$, $p < .336$), whereas in children with a specific language disorder and children with an autism spectrum disorder was also no statistically significant difference in the sub test 4 (Acadia) ($t = 1.28$, $df = 17,41$, $p < .89$)

4 DISCUSSION

The results of this study showed that there was no statistically significant difference between children of typical development and children with a articulation disorder in tests of manipulative dexterity (Ring test and OZ trial) and the test for evaluation of graphomotoric ability Acadia (sub test 2 and sub test 4) . In children with specific language disorders and children with autism spectrum disorder there is a statistically significant difference on the Ring test and the Acadia sub test 2, while the OZ sampling and the Acadia sub test 4 showed that there was no statistically significant difference between these two groups of children.

Research suggests that fine motor skills are related to cognitive ability. In this study three types of fine motor skills were measured: dexterity, grapho-motor skills and speed, on a sample of preschool children (a sample of 78 children) and their connections with non-verbal reasoning were analyzed. The results support the notion that fine motor skills are involved in the development of cognitive abilities (Martzog, Stoeger, Suggate 2019).

REFERENCES

- Glumbić, N. (2009): *Odrasle osobe sa autizmom*. Fakultet za specijalnu edukaciju i rehabilitaciju. Univerzitet u Beogradu
- Golubović, S.(2012): *Fonološki poremećaji, drugo dopunjeno i izmenjeno izdanje*. Društvo defektologa Srbije
- Drljan, B., Vuković, M. (2017): Leksička raznovrsnost u narativnom diskursu dece sa specifičnim jezičkim poremećajem. *Specijalna edukacija i rehabilitacija*, 16(3), 261-287
- Martzog, P., Stoeger, H., Suggate, S. (2019): Relations between preschool children's fine motor skills and general cognitive abilities. *Journal of Cognition and Development*, volume 20, 443-465
- Nikolić, S. (2012). *Senzorni i motorički razvoj*. U A. Baucal (Ur.), Standardi za razvoj i učenje dece ranih uzrasta u Srbiji (str. 67-80). Beograd: Institut za psihologiju Filozofskog fakulteta Univerziteta u Beogradu
- Nikolić, S., Ilić- Stošović, D, Ilić, S., & Pešić, S. (2012): Zrelost hvata i sposobnost pisanja kod dece predškolskog uzrasta, *Beogradska defektološka škola*, 18(3), 583-595
- Novosel, M. (1978): Acadia test razvojnih sposobnosti, Defektologija, vol.14, No.1-2
- Stošljević, L., Stošljević, M., Odović, G. (2006): *Procena sposobnosti osoba sa motoričkim poremećajima*, praktikum, Fakultet za specijalnu edukaciju i rehabilitaciju, Beograd
- Sovilj, M. (2013): Protokol za optimizacijudečijih potencijala za učenje, Beograd, CUŽA- IEFPG
- Čalasan, S., Vuković, M., Pavlović, A., Vuković, B. Zečević, I. (2015): Povezanost grafomotornih sposobnosti i lateralizovanosti kod dece predškolskog uzrasta, *Beogradska defektološka škola*, vol 21, no2, str.25-37

Application of Neurofeedback Treatment in Children with Specific Language Impairment

Milica Tešić, Ivana Stanković, Selena Todorović
Institute for Experimental Phonetics and Speech Pathology
milica.tesic93@gmail.com

ABSTRACT

Neurofeedback is a kind of biofeedback, which teaches self-control of brain functions to subjects by measuring brain waves and providing a feedback signal. It is known as a complementary and alternative treatment of many brain dysfunctions including developmental disorders in children. During neurofeedback sessions, patients learn to produce desirable brain wave patterns displayed on a computer screen by controlling the activity of a computerized game or task seen on a screen. The subject becomes aware of the changes occurring during training and will be able to assess his/her progress in order to achieve optimum performance. Specific language impairment (SLI) describes a condition of delayed language development in children without intellectual disability, hearing impairment, visible neural damage. This study included 20 children from Institute for experimental phonetics and speech pathology „Djordje Kostić” with specific language impairment who were divided in two groups. The groups were consisted of 5 girls and 5 boys aged 5-8 years. Neurofeedback treatment consisted of twenty 30-min sessions given twice a week (plus one resting state measures of 2 min each before training). One group received neurofeedback training to reduce their abnormally high power of theta/beta ratio and the second group to reduce the amplitude of slow theta waves (4–7 Hz) in Cz position. The results were analyzed by methods of descriptive statistics. Results show that children in this study successfully achieved the goal of neurofeedback treatment respectively, they had statistically significant lower values of theta amplitude and power of theta/beta ratio at the end of treatment.

Key words: neurofeedback treatment, specific language impairment

1 INTRODUCTION

1.1 Neurofeedback

Neurofeedback (NFB) is an operant conditioning procedure, by which the subject learns to control their EEG activity. NFB is based on monitoring electrical brain activity and providing feedback. Neurofeedback guide individuals to regulate their brain activity.

Neurofeedback is based on two basic assumptions:

1. The brain's electrical activities (brain waves) reflect certain mental states.
2. Brainwaves can be trained (Marzbani, et al., 2016).

Electroencephalography (EEG) oscillations are conventionally divided into five characteristic types with respect to the amplitude and frequency (wave speed) of the basic activity, each of which is related to a particular state of mind or state of consciousness: delta waves (0.5-3Hz), theta (4-8Hz), alpha (8-13 Hz), beta (13-36 Hz) and gamma waves. Whether certain EEG waves will be amplified or suppressed depends on the condition of the trainee. Training consists of placing sensors or “electrodes” in specific places on the surface of the head (depending on the symptom we are working on). This procedure is painless and non-invasive. The subject tries to improve the brain patterns based on the changes that occur in the sound or movie. Neurofeedback treatment protocols mainly focus on the alpha, beta, delta, theta, and gamma waves or a combination of them such as alpha/theta ratio, beta/theta ratio, etc. (Dempster, 2012; Vernon, 2005). However, the most commonly used protocols are alpha, beta, theta, alpha/theta ratio beta/theta ratio (Marzbani et al., 2016).

The neurofeedback device captures the brainwaves of a child through a sensor. These biological signals are transmitted to a computer where they are processed using a special program and the monitor displays results that give us an objective picture of brain and physiological functions in the form of graphs and other visual representations or video animations. In addition, the practitioner may receive beeps as feedback.

The field of application of biofeedback is very wide. It is used in the treatment of many problems. Some of these are: behavioral disorder (ADHD), attention and concentration (ADD), learning disorders, reading and writing, stuttering, chronic fatigue, insomnia, stress, anxiety, depression, addiction diseases, tension headaches, migraines, muscle tension, irregular breathing. Different studies show good results of neurofeedback training in a wide range of application (Marzbani et al., 2016).

NFB brain training may be substantial support of speech and language treatment or may be self-administrated in children with verbal communication disorders, behavioural and attention deficit disorders. On the other hand, extremely significant advantage of NFB brain training is its application in children with typical development when it is used for the optimization of their specific skills. A positive reaction to neurofeedback is usually expected after the first 20 training sessions (Rasey et al, 1996).

Problems of concentration and disorder of attention in children occur very often. In children with these problems, it has been found that they have difficulty "producing" beta brainwaves and that they are dominated by theta waves. John and co-workers compared EEG children with specific learning disorders (SLD) and children with typical development. Abnormal EEGs were found in 32.7% of SLD. Irregularities were in view of increased delta and or theta and decreased alpha relative power (Fernández et al., 2002).

Delta waves are observed in the EEG signal when a person is asleep, theta waves when a person is sleepy, alpha waves when a person is relaxed and his/her muscles are loose but he/she is awake, beta waves when a person is alert and when a person is trying to solve a problem (Table 1) (Marzbani et al., 2016).

Table 1. Specific brainwaves with their characteristics

Common brainwave frequency	Frequency range (Hz)	General characteristics
Delta	1-4	Sleep, repair, complex problem solving, unawareness, deep-unconsciousness
Theta	4-8	Creativity, insight, deep states, unconsciousness, optimal meditative state, depression, anxiety, distractibility
Alpha	8-13	Alertness and peacefulness, readiness, meditation, deeply-relaxed
Lower alpha	8-10	Recalling
Upper alpha	10-13	Optimize cognitive performance
SMR (sensorimotor rhythm)	13-15	Mental alertness, physical relaxation
Beta	15-20	Thinking, focusing, sustained attention, tension, alertness, excitement
High beta	20-32	Intensity, hyperalertness, anxiety
Gamma	32-100 or 40	Learning, cognitive processing, problem solving tasks, mental sharpness, brain activity, organize the brain

Theta brain waves are related to a number of brain activities such as memory, emotion, creativity, sleep, meditation, and hypnosis. These waves are also associated with the first phase of sleep when the sleep is light and the person easily wakes up. Theta treatment reduces anxiety, depression, day dreaming, distractibility, emotional disorders, and ADHD (Vernon, 2005).

Beta activity is a good indicator for mental performance and inappropriate beta activity represents mental and physical disorders like depression, ADHD, and insomnia (Egner & Gruzelier, 2004). Beta brain waves are associated with conscious precision, strong focus, and ability to solve problems. Beta training is used to improve focus and attention (simulation of increased beta 12-14 Hz), improve the reading ability (simulation of 7–9 Hz), and introduce positive changes in school performance (Marzbani et al., 2016).

Basically, there are two classical directions in neurofeedback training. It is either focusing on low frequencies (alpha or theta) to strengthen relaxation and focus (Gruzelier, 2009) or emphasizing on high frequencies (low beta, beta, and theta) for reinforcing activation, organizing, and inhibiting distractibility (Ros et al., 2009).

1.2 Specific language impairment and attention

Specific language impairment (SLI) is a developmental language disorder which hinders the mastery of language skills in children who have no obvious sensory, mental, physical or emotional deficits. It represents one of the most common childhood learning disabilities, with prevalence of approximately 7% of preschool children (Tomblin et al. 1997). SLI encompasses a heterogeneous group of speech deficits. Children with SLI have problems with receptive language (understanding), expressive language, or speech (articulation). Most individuals have deficits in structural aspects of language (lexical knowledge, syntax, phonology), others show difficulties in pragmatic aspects of language and communication (i.e. using language appropriately in social situations). Subjects with SLI have significant communication problems which may persist into adulthood (Vydrova et al., 2015). Neurobiological mechanisms underlying SLI have not been fully elucidated.

Information-processing limitations have been associated with language problems in children with specific language impairment (SLI). These processing limitations may be associated with limitations in attentional capacity even in the absence of clinically significant attention deficits (Finneran et al. 2009).

Although these children have normal nonverbal IQ scores, researchers have found robust evidence of information processing deficits which may be attributed to limited working memory capacity (Bavin, et al., 2005; Hoffman & Gillam, 2004). Leonard et al. (2007) reported that the verbal working memory deficits exhibited by children with SLI.

Given that attention is considered to be a system that is deeply involved in information processing, and working memory is critical to language learning (Baddeley, 2003), it is not surprising, then, that attention is considered to play an important role in language processing. In the literature on child development, the relationship between attention and language is usually addressed by examining the comorbidity of language impairments and attention deficits. There is robust evidence to suggest that children with language impairments have a higher incidence of attention deficits (Willinger et al., 2003), and children with clinical attention deficits have a higher incidence of language impairments (Tannock & Schachar, 1996) than their peers. Some have proposed that clinical attention deficits and developmental language impairments are both a result of an underlying neurodevelopmental deficit, while others have proposed that deficits in one area may contribute to deficits in the other. More explicit support for a possible relationship between SLI and deficits in basic attentional capacities may be found in a study by Im-Bolter, Johnson, and Pascual-Leone (2006). This study examined information processing and the role of executive function (i.e., the control of focused attention) in children with SLI as compared to age-matched typical developing peers. The authors reported significant group differences in attentional capacity, response inhibition and working memory updating (an attentionally demanding process) as well as on visual and verbal processing tasks. The authors concluded that executive control of attention during information processing is an important factor in the relationship between information processing and language ability in SLI.

Children with specific language impairment (SLI) appear to demonstrate deficits in attention and its control. Selective attention involves the cognitive control of attention directed toward a relevant stimulus and simultaneous inhibition of attention toward irrelevant stimuli (Victorino et al., 2015). Sustained attention (SA) is the ability to direct attention and focus on specific stimuli for a continuous amount of time without being distracted (Oken et al. 2006).

Attention control is a critical component of many information and language processing models (Cowan et al., 2005). Comorbid deficits in attention are often observed in children with SLI (Cantwell & Baker, 1991; Cohen et al., 2000; Snowling et al., 2006), and limitations in sustained and selective attention have been identified in children with SLI (Finneran et al., 2009; Hanson & Montgomery, 2002). Both language-specific deficits and hypothesized underlying processing deficits have been investigated in children with SLI. Although impairments in morphosyntactic, phonological, or auditory processing might be explained by domain-specific theories, limited processing capacity and generally slower processing speed also contribute to the heterogeneous nature and range of impairments in children with SLI. Limited attention in children with SLI is a possible cause of performance deficits on linguistic tasks (Bishop et al., 1999). There is a high comorbidity of SLI and attention-deficit/hyperactivity disorder (ADHD) diagnoses (Cantwell & Baker, 1991; Snowling et al., 2006).

Deficits in attention control and working memory may be closely related and appear to be implicated in the language limitations in this population (Victorino et al., 2015).

1.3 Specific language impairment and learning disabilities

Specific language impairment (SLI) and specific learning disability (SLD) are developmental disorders whereby children have difficulties in acquiring and using oral language, attaining reading and writing skills. Specific learning deficits refer to three specific learning disorders – impairment in reading, impairment in the written expression, and impairment in mathematics (Eisenmajer et al., 2005).

Learning disabilities (LD) can occur along with the problems of attention performance and be complicated by them (Sterr et al., 2004). There is evidence that children with specific reading disorders have SA deficits (Duncan et al. 1994).

Partly as a result of this specificity criterion, the bodies of literature focusing on SLI and SRD have, for the most part, developed with little overlap. In recent years, however, researchers have been becoming more aware of many similarities between the two syndromes (Snowling et al., 2000). Moreover, it is becoming increasingly apparent that when screened thoroughly, children initially identified as having SLD are often found to have oral language impairments, and many children with early SLI develop reading and writing difficulties once formal instruction begins (Tomblin et al., 2000).

Despite previous claims of specificity, there may be a large amount of overlap in the deficits of children with SLD and SLI. McArthur and collaborators (2000) were found that 55% of children initially classified as reading disabled also had impaired oral language skills. Similarly, 51% of children who were initially identified as SLI had a reading disability. Thus 53% of the 212 children met the criteria for both SLI and SRD. The results of the current study indicate that many children presenting with learning disabilities demonstrate both reading and oral language impairments. The results of 151 children assessed for learning disabilities were categorised based on reading, oral language, and IQ scores, and it was revealed that 55% of the sample had both reading and oral language difficulties in the presence of nonverbal IQ above 80 (McArthur et al., 2000).

Oral language problems place children at risk for literacy problems, both in reading comprehension and accuracy (Bishop et al., 2004). On the other hand, children at risk of dyslexia often experience early language difficulties, even before they start to read. Language problems are of significant concern in both SLI and dyslexia because poor language learning has been linked to negative consequences for academic achievement, self-esteem, social and emotional development, and employment (Conti-Ramsden et al., 2013).

1.4 EEG characteristics of children with learning disabilities

EEG of learning disabled (LD) children, the most commonly reported pattern is an excess of slow activity, mainly in the theta frequency range, and an alpha activity deficit when compared to typical children (Roca-Stappung et al., 2017). The few that have been published demonstrate greater theta power and less alpha and beta power than normal for the child's age during relaxed rest (Gasser et al., 2003; Chabot et al., 2001). Increased theta activity is associated with underarousal and is indicative of decreased cortical activity. In the context of LD, this predominance of slow oscillations is generally taken as evidence of the so-called "maturational delay hypothesis," suggesting postponed cortical maturation in children with LD (Jäncke et al., 2016). The most frequent EEG abnormality observed in LD children is an excess of theta activity when compared with the EEG of normal children of the same age (Alvarez et al. 1992; Chabot et al. 2001; Fernández et al. 2002; Gasser et al. 2003).

Multiple studies about EEG characteristics of children with ADHD (Clarke et al., 2001; Clarke et al., 2007) have determined that compared to gender- and age-matched controls, children with ADHD have greater theta activity (Bary et al., 2003; Bary et al., 2009). Other studies showed an increase in delta activity, coupled with decreased alpha and beta activities (Clarke et al., 1998). Additionally, abnormalities in the theta/beta ratio are one of the most significant measures of EEG alterations in ADHD (Hillard et al., 2013).

The training of slow cortical potentials - SCP (delta and theta waves) improves the self-regulating capabilities of SCP, which consequently increases the ability to regulate cortical excitability to some extent. It has been used mainly for people with attention deficit hyperactivity disorder (ADHD) to increase cortical negativity and subsequently improve their attentional abilities (Omejc et al., 2019)

Considering all the potential, mentioned above, difficulties of children with the specific language disorders, it would make sense to try to prevent, alleviate or completely eliminate them, by using neurofeedback. So far, the researchers have not applied the neurofeedback treatment in this population of children, so there is non standardised neurofeedback protocol. The most often used frequency training today is EEG theta/beta ratio NFB training used for ADHD. Consequently, in our study we apply this protocol of decreasing the power of theta/beta ratio and decreasing the value of theta amplitude. Theta/beta (4–7 Hz/12–21 Hz) ratio (TBR) neurofeedback strives to decrease theta and/or increase beta power in central and frontal locations. This protocol directly targets important electrophysiological characteristics such as high theta/beta ratios, high theta power, and/or low beta power commonly observed in children with ADHD (Enriquez-Geppert et al., 2019). As we can see the most common children with mentioned developmental disorders have increased values of theta amplitude and decreased values of beta amplitude. By this study we wanted to show whether these children can learn how to manage their brain rhythms in order to alleviate and prevent attention deficits and prevent reading and writing disorders.

2 METHODS

The research aims to answer whether patients were able to demonstrate learning of cortical self-regulation by using neurofeedback treatment.

This study included 20 children from Institute for experimental phonetics and speech pathology „Djordje Kostic” with specific language impairment between 5 and 8 years. They were divided in two experimental groups by the neurofeedback protocol which they received. In each group were 10 subjects, 5 boys and 5 girls. Groups are balanced in age. The first experimental group E1 consisted of subjects who were diagnosed with a specific language impairment and who received neurofeedback training to reduce their abnormally high power of theta/beta ratio, while the second experimental group E2 consisted of subjects with specific language impairment who had to reduce the amplitude of slow theta waves (4–7 Hz) in Cz position. Neurofeedback treatment consisted of twenty 30-min sessions given twice a week (plus one resting state measures of 2 min each before training).

An assessment of language skills was made for each child by speech and language therapist. A test battery of the Institute for speech pathology „Djordje Kostic” was used for this purpose. It was found that the level of language development in these children was not in line with the chronological age. Hearing

impairment, intellectual disability, visual and neural impairment were excluded for each child. Average IQ were above 85. In addition, all subjects underwent an electroencephalographic assessment of resting state, where were found increased values of theta and alpha amplitude values and decreased beta amplitude values.

ince NFB is a learning procedure, the aim of this study is to evaluate whether, in the treatment of NFB that reinforces the reduction of the theta/beta ratio, and theta amplitude, children succeed to learn to consciously regulate their brain activity. In this study, we monitored the progress of the respondents every 5 sessions and compared the results between them and those at the beginning. In fact, we have compared the values of theta amplitude and theta/beta ratio of resting states between first and fifth session, first and tenth, first and fifteenth, first and twentieth sessions. Moreover, we compared achievement between boys and girls.

3 RESULTS

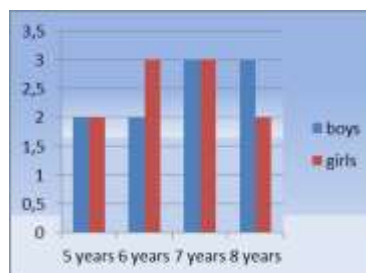
The results were analyzed by methods of descriptive statistics. Student`s T- test was used to compare two groups of subjects. In this study, statistically significance value is p-value less than 0.05.

The data in Table 1. shows that the subjects of E1 and E2 groups are balanced according to age ($p=0,36$, $p>0,05$). Average age of boys in E1 group is 6,8 years, while average age of girls was 6,4. In E2 group, average age of both boys and girls were 6,6.

Table 2. Age of subjects of both experimental groups

	E1	E2
N	10	10
N girls	5	5
N boys	5	5
Average age boys	6,8	6,6
average age girls	6,4	6,6
Student's T-test	0,36, $p>0,05$	

The data in Graph 1. shows that in this study were included 2 five years old girls and boys, 2 six years old boys and 3 six years old girls, 3 boys and girls age of seven, 3 boys and 2 girls 8 years old.



Graph 1. Age distribution of subjects

The data in Table 3. and Table 4. show that girls have decreased the power of theta/beta ratio at the end of treatment in order to first session, but the value of Student`s T test shows that the difference is not statistically significant ($p=0,05$, $p\geq 0,05$).

Table 3. Data values of theta/beta ratio power at resting state in girls

Data values of theta/beta ratio power at resting state in girls					
Session	1	5	10	15	20
Mean	4,95	4,24	4,88	4,73	4,09
Standard deviation	2,50	2,14	2,53	2,69	2,14

Table 4. Comparing theta/beta ratio power values between sessions in girls

Comparing theta/beta ratio power values between sessions in girls				
Sessions	1-5	1-10	1-15	1-20
Student`s T Test	0,088	0,407	0,385	0,055

The data in Table 5. and Table 6. show that girls have successfully achieved the goal of neurofeedback protocol of reducing theta wave amplitude. At the end of training they have significantly lower values of theta amplitude relative to beginning of treatment ($p=0,003$, $p<0,05$). Already, after five NFB sessions they reduced the theta amplitude.

Table 5. Data values of theta amplitude at resting state in girls

Data values of theta amplitude at resting state in girls					
Session	1	5	10	15	20
Mean	27,01	21,98	24,65	23,07	22,29
Standard deviation	2,67	2,9	4,61	3,18	2,29

Table 6. Comparing theta amplitude values between sessions in girls

Comparing theta amplitude values between sessions in girls				
Sessions	1-5	1-10	1-15	1-20
Student`s T Test	0,008	0,118	0,022	0,003

When it comes to the boys the data in Table 7. and Table 8. show that boys have successfully decreased the power of theta/beta ratio. It is shown that mean value of this ratio is significantly lower at the last session in order to first session ($p=0,003$, $p<0,05$). Comparing to the girls they have achieved a better result.

Table 7. Data values of theta/beta ratio at resting state in boys

Data values of theta/beta ratio power at resting state in boys					
Session	1	5	10	15	20
Mean	7,38	7,12	6,78	6,84	5,85
Standard deviation	1.98	2.38	1.98	1.70	1.65

Table 8. Comparing theta/beta ratio power values between sessions in boys

Comparing theta/beta ratio power values between sessions in boys				
Sessions	1-5	1-10	1-15	1-20
Student's T Test	0.330	0,165	0,215	0,003

The data in Table 9. and Table 10. show that boys have successfully achieved the goal of neurofeedback protocol of reducing theta wave amplitude. At the end of training they have significantly lower values of theta amplitude relative to beginning of treatment ($p=0,002$, $p<0,05$). There is no difference between boys and girls.

Table 9. Data values of theta amplitude at resting state in boys

Data values of theta amplitude at resting state in boys					
Session	1	5	10	15	20
Mean	29,26	26,84	24,7	25,2	23,03
Standard deviation	3,15	3,58	3,67	3,05	1,42

Table 10. Comparing theta amplitude values between sessions in boys

Comparing theta amplitude values between sessions in boys				
Sessions	1-5	1-10	1-15	1-20
Student's T Test	0,055	0,021	0,001	0,002

4 DISCUSSION

The value of Student's T-test shows that there is no statistically significant difference in the age of these two groups of children, what gives the possibility of comparing these two groups by achievement in neurofeedback treatment.

After 20 neurofeedback treatments children with specific language impairment achieved the goal of neurofeedback treatment and show the ability for learning of cortical self-regulation by using neurofeedback treatment. Although, girls did not show statistically significant improvements in decreasing theta amplitude, but at the end the value of theta amplitude was lower than at the beginning.

Results did not show the difference between girls and boys in achievement. They were equally successful in both neurofeedback protocols.

Our results coincide with the results of previous studies which show significant improvements in intellectual functioning and attentive behaviors. This might be explained as a result of the attentional enhancement affected by neurofeedback training (Lindeln et al., 1997).

The results of our study suggest that improving theta amplitude and power of theta/beta ratio may lead to better test performance. For this purpose, we only wanted to examine and demonstrate whether children with language disorders are able to self-regulate their brain activity.

Important aspect of neurofeedback concern stability and generalizability of trained frequencies. Theta/beta neurofeedback is aimed at altering brain activity using operant conditioning principles with the goal to improve behavior and neurocognitive functioning in children with ADHD. However, few studies

have demonstrated that actual learning takes place during neurofeedback treatment, which is an essential element for the effectivity of the intervention. The results of the study of Janseen and collaborators provide evidence that children with ADHD learned to decrease the theta/beta index over the sessions in a linear fashion, concordant with the training goals (Janssen et al., 2017).

If children are able to adapt theta or beta activity, the question is whether this leads to sustainable changes that also generalize to situations outside neurofeedback training sessions (Janssen et al., 2017).

Over the past two decades, the use of electroencephalographic (EEG) biofeedback has been shown to be beneficial for the enhancement of attentional processes in children and adults with attention deficit disorder (ADD) and attention-deficit hyperactivity disorder (ADHD). For these two groups the EEG biofeedback procedure has been used to help individuals normalize neurological functioning, thereby enabling them to process information and deal with sensory stimulation more effectively. Given the effectiveness of using EEG biofeedback for enhancing performance in individuals with ADHD and ADD, the next research question that needs to be answered is whether this EEG training can be used for the enhancement of attentional processing in normal individuals.

Our research included a small number of subjects, and future studies should include larger sample of respondents with specific language impairments. In the next period we will deal with long term impacts of neurofeedback treatment on cognitive functions in these children.

REFERENCES

- Alvarez, A., Pérez-Avalo, M. C., & Morenza, L. (1992). Neuropsychological assessment of learning-disorder children with paroxysmal EEG activity. *New Issues in Neurosciences*, IV, 40–50.
- Baddeley, A. D. (2003). Working memory and language: An overview. *Journal of Communication Disorders*, 36, 189–208.
- Barry, R. J., Clarke, A. R., Johnstone, S. J. (2003). A review of electrophysiology in attention-deficit/hyperactivity disorder: I. Qualitative and quantitative electroencephalography. *Clinical Neurophysiology*, 114(2), 171–183.
- Barry, R. J., Clarke, A. R., Johnstone, S. J., McCarthy, R., Selikowitz, M. (2009). Electroencephalogram α/β ratio and arousal in attention-deficit/hyperactivity disorder: evidence of independent processes. *Biological Psychiatry*, 66(4), 398–401.
- Bavin, E., Wilson, P., Maruff, P., Sleeman, F. (2005). Spatio-visual memory of children with specific language impairment: Evidence for generalized processing problems. *International Journal of Language and Communication Disorders*, 40, 319–332.
- Bishop, D. V. M. and Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: same or different? *Psychol. Bull.* 130, 858–886.
- Bishop, D. V. M., Carlyon, R. P., Deeks, J. M., & Bishop, S. J. (1999). Auditory temporal processing impairment: Neither necessary nor sufficient for causing language impairment in children. *Journal of Speech, Language, and Hearing Research*, 42, 1295–1310.
- Cantwell, D. P., & Baker, L. (1991). Association between attention deficit-hyperactivity disorder and learning disorders. *Journal of Learning Disabilities*, 24, 88–95.
- Chabot, R. J., di Michele, F., Pritchep, L., John, E. R. (2001). The clinical role of computerized EEG in the evaluation and treatment of learning and attention disorders in children and adolescents. *Neuropsychiatry and Clinical Neurosciences*, 13(2), 171–186.
- Clarke, A. R., Barry, R. J., McCarthy, R., Selikowitz, M. (1998). EEG analysis in attention-deficit/hyperactivity disorder: a comparative study of two subtypes. *Psychiatry Research*, 81(1), 19–29.
- Clarke, A. R., Barry, R. J., McCarthy, R., Selikowitz, M. (2001). EEG-defined subtypes of children with attention-deficit/hyperactivity disorder. *Clinical Neurophysiology*, 112(11), 2098–2105.
- Clarke, A. R., Barry, R. J., McCarthy, R., Selikowitz, M., Johnstone, S. J. (2007). Effects of stimulant medications on the EEG of girls with attention- deficit/hyperactivity disorder. *Clinical Neurophysiology*, 118(12), 2700–2708.
- Cohen, N. J., Vallance, D. D., Barwick, M., Im, N., Menna, R., Horodezky, N. B., & Isaacson, L. (2000). The interface between ADHD and language impairment: An examination of language, achievement, and cognitive processing. *Journal of Child Psychology and Psychiatry*, 41, 353–362.

- Conti-Ramsden, G., Mok, P. L., Pickles, A., & Durkin, K. (2013). Adolescents with a history of specific language impairment (SLI): strengths and difficulties in social, emotional and behavioral functioning. *Research in developmental disabilities*, 34(11), 4161–4169.
- Cowan, N., Elliott, E. M., Scott Saults J., Morey, C. C., Mattox, S., Hismjatullina, A., & Conway, A. R. (2005). On the capacity of attention: Its estimation and its role in working memory and cognitive aptitudes. *Cognitive Psychology*, 51, 42–100
- Dempster T. (2012). An investigation into the optimum training paradigm for alpha electroencephalographic biofeedback (PhD Thesis). U.K.: Canterbury Christ Church University
- Duncan, C. C., Rumsey, J. M., Wilkniss, S. M., Denckla, M. B., Hamburger, S. D., & Odou-Potkin, M. (1994). Developmental dyslexia and attention dysfunction in adults: Brain potential indices of information processing. *Psychophysiology*, 31(4), 386–401.
- Eisenmajer, N., Ross, N., Pratt, C. (2005). Specificity and characteristics of learning disabilities. *Journal of Child Psychology and Psychiatry* 46:10, 1108–1115
- Enriquez-Geppert, S., Smit, D., Pimenta, M. G., & Arns, M. (2019). Neurofeedback as a Treatment Intervention in ADHD: Current Evidence and Practice. *Current psychiatry reports*, 21(6), 46
- Facoetti, A., & Molteni, M. (2000). Is attentional focusing an inhibitory process at distractor location? *Cognitive Brain Research*, 10, 185–188.
- Fernández, T., Harmony, T., Fernández-Bouzas, A., Silva, J., Herrera, W., Santiago-Rodríguez, E., & Sánchez, L. (2002). Sources of EEG activity in learning disabled children. *Clinical Electroencephalography*, 33, 160–164.
- Finneran, D. A., Francis, A. L., & Leonard, L. B. (2009). Sustained attention in children with specific language impairment (SLI). *Journal of speech, language, and hearing research : JSLHR*, 52(4), 915–929.
- Gasser, T., Rousson, V., & Scheiter Gasser, U. (2003). EEG power and coherence in children with educational problems. *Clinical Neurophysiology*, 20, 273–282.
- Gasser, T., Rousson, V., Schreiter Gasser, U. (2003). EEG power and coherence in children with educational problems. *J Clin Neurophysiol*, 20, 273-282
- Gruzelier J. (2009). A theory of alpha/theta neurofeedback, creative performance enhancement, long distance functional connectivity and psychological integration. *Cognitive Processing*, 10(1), 101–109.
- Hanson, R. A., & Montgomery, J. W. (2002). Effects of general processing capacity and sustained selective attention on temporal processing performance of children with specific language impairment. *Applied Psycholinguistics*, 23, 75–93.
- Hillard, B., El-Baz, A. S., Sears, L., Tasman, A., & Sokhadze, E. M. (2013). Neurofeedback Training Aimed to Improve Focused Attention and Alertness in Children With ADHD: A Study of Relative Power of EEG Rhythms Using Custom-Made Software Application. *Clinical EEG and Neuroscience*, 44(3), 193–202.
- Hoffman, L., Gillam, R. (2004). Verbal and spatial information processing constraints in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 47, 114–125.
- Im-Bolter, N., Johnson, J., Pascual-Leone, J. (2006). Processing limitations in children with specific language impairment: The role of executive function. *Child Development*, 77, 1822–1841.
- Jäncke, L., & Alahmadi, N. (2016). Resting State EEG in Children With Learning Disabilities: An Independent Component Analysis Approach. *Clinical EEG and Neuroscience*, 47(1), 24–36.
- Janssen, T., Bink, M., Weeda, W. D., Geladé, K., van Mourik, R., Maras, A., & Oosterlaan, J. (2017). Learning curves of theta/beta neurofeedback in children with ADHD. *European child & adolescent psychiatry*, 26(5), 573–582.
- Leonard, L. B., Weismer, E. S., Miller, C. A., Francis, D. J., Tomblin, J. B., Kail, R. V. (2007). Speed of processing, working memory, and language impairment in children. *Journal of Speech, Language, and Hearing Research*. 50, 408–428
- Linden, M., Habib, T., Radojevic, V. (1997). A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities. *Biofeedback and Self-regulation*, 21(1), 35-49.
- Marzbani, H., Marateb, H. R., & Mansourian, M. (2016). Neurofeedback: A Comprehensive Review on System Design, Methodology and Clinical Applications. *Basic and clinical neuroscience*, 7(2), 143–158.
- McArthur, G., Hogben, J.H., Edwards, V.T., Heath, S.M., & Mengler, E.D. (2000). On the ‘specifics’ of specific reading disability and specific language impairment. *Journal of Child Psychology and Psychiatry*, 41, 869–874.
- Oken, B. S., Salinsky, M. C., & Elsas, S. M. (2006). Vigilance, alertness, or sustained attention: Physiological basis and measurement. *Clinical Neurophysiology*, 117(9), 1885–1901
- Omejc, N., Rojc, B., Battaglini, P. P., & Marusic, U. (2019). Review of the therapeutic neurofeedback method using electroencephalography: EEG Neurofeedback. *Bosnian journal of basic medical sciences*, 19(3), 213–220.

- Rasey, H., Lubar, J., McIntyre, A., Zoffuto, A., Abbot, P. (1996). EEG Biofeedback for the Enhancement of Attentional Processing in Normal College Students. *Journal of Neurotherapy*, 1(3), 15-21.
- Roca-Stappung, M., Fernández, T., Bosch-Bayard, J., Harmony, T., & Ricardo-Garcell, J. (2017). Electroencephalographic characterization of subgroups of children with learning disorders. *PloS one*, 12(7), e0179556.
- Ros T., Moseley M. J., Bloom P. A., Benjamin L., Parkinson L. A., Gruzelier J. H. (2009). Optimizing microsurgical skills with EEG neurofeedback. *BMC Neuroscience*, 10(1), 87
- Snowling, M. J., Bishop, D. V. M., Stothard, S. E., Chipchase, B., & Kaplan, C. (2006). Psychosocial outcomes at 15 years of children with a preschool history of speech-language impairment. *Journal of Child Psychology and Psychiatry*, 47, 759–765.
- Snowling, M., Bishop, D.V.M., & Stothard, S.E. (2000). Is preschool language impairment a risk factor for dyslexia in adolescence? *Journal of Child Psychology and Psychiatry*, 41, 587–600.
- Sterr, A. M. (2004). Attention performance in young adults with learning disabilities. *Learning and Individual Differences*, 14, 125–133.
- Tannock, R., Schachar, R. (1996). Executive dysfunction as an underlying mechanism of behavior and language problems in attention deficit hyperactivity disorder. Developmental, biological, and clinical perspectives. Cambridge University Press; Cambridge, England, 128–155.
- Tomblin, J.B., Records, N.L., Buckwalter, P., Zhang, X., Smith, E., O'Brien, M. (1997). Prevalence of specific language impairment in kindergarten children. *Journal of Speech, Language, and Hearing Research: JSLHR*, 40 (6), 1245-1260
- Tomblin, J.B., Zhang, X., Buckwalter, P., & Catts, H. (2000). The association of reading disability, behavioural disorders, and language impairment among second-grade children. *Journal of Child Psychology and Psychiatry*, 41, 473–482.
- Vernon D. J. (2005). Can neurofeedback training enhance performance? An evaluation of the evidence with implications for future research. *Applied Psychophysiol Biofeedback*, 30(4), 347–364.
- Victorino, K. R., & Schwartz, R. G. (2015). Control of Auditory Attention in Children With Specific Language Impairment. *Journal of speech, language, and hearing research : JSLHR*, 58(4), 1245–1257.
- Vydrova, R., Komarek, V., Sanda, J., Sterbova, K., Jahodova, A., Maulisova, A., Zackova, J., Reissigova, J., Krsek, P., Kyncl, M. (2015). Structural alterations of the language connectome in children with specific language impairment. *Brain and Language*, 151, 35-41.
- Willing, U., Brunner, E., Diendorfer-Radner, G., Sams, J., Sirsch, U., Eisenwort, B. Behaviour in children with language development disorders. *Canadian Journal of Psychiatry*. 2003;48:607–614.

The Use of Neurofeedback in the Treatment of ADHD -Review of Papers

Dušan Zečević^{1,2}, Marija Tešović^{1,2}, Saška Fatić^{1,2}

¹Life Activities Advancement Centre, Gospodar Jovanova 35a ,Belgrade, Serbia¹

²The Institute for Experimental Phonetics and Speech Pathology “Đorđe Kostić”,
Gospodar Jovanova 35, Belgrade, Serbia²
dusan_zecevic@yahoo.com

ABSTRACT

Neurofeedback is a non-invasive method of self-regulation that aims to alter cortical activity through the process of instrumental learning. Neurofeedback is actually brain function training, where the brain learns how to function more effectively and respond to a task. Attention deficit hyperactivity disorder (ADHD) is a neurodevelopment disorder that occurs in children and adolescents. ADHD is characterized by hyperactivity, impulsivity, and attention deficit disorder. The diagnosis is made on the basis of the Diagnostic and Statistical Manual (DSM-IV) and the International Classification Disorders (ICD 10) classification. ADHD is four times more common in boys than in girls. Symptoms

occur 7 years ago. For the diagnosis of ADHD, it is necessary for the symptoms to persist for at least 6 months in two different places, at school or kindergarten or at home.

Key words: neurofeedback, attention deficit hyperactivity disorder (ADHD)

1 INTRODUCTION

Attention deficit hyperactivity disorder (in further text- ADHD) is an etiological group of children and adolescents. It is one of the most common neurodevelopmental disorders in children and adolescents. The disorder is characterized by hyperactivity, impulsivity, and attention deficit disorder. ADHD shows an equal incidence across all races. The prevalence of this disorder ranges from 1% to 39% depending on the tests and diagnostic criteria that have been applied. Some researchers report an incidence of 2-11%. ADHD is four times more common in boys than in girls. The disorder occurs before the age of seven. Failure to recognize the disorder in a timely manner and therefore not adequately treated can lead to serious and long-term consequences for the child's development, both academically and socially. ADHD is not a recent phenomenon. Specifically, Hippocrates described a condition that could be compared to ADHD 2,500 years ago. Hippocrates described a patient who had accelerated responses to sensory stimuli while also showing less attention.

ADHD was first heard in the 19th century when English pediatrician George Still called this condition "morbid defects in moral control". Still described a group of children with behavioral disorders, believing that they were caused by a genetic disorder and not by environmental influences. The authors of the work from this period of time were symptoms such as hyperactivity, restlessness, and short-term attentiveness that led to birth defects. It was later noted that these symptoms were also present in children who had no birth trauma, so the new term "minimal brain damage" was introduced. In 1937, Dr Bradley presented children with behavioral disorders who showed a positive response to stimulant therapy. In 1957, the use of methylphenidate began, which soon became the most important therapeutic agent in the treatment of ADHD. By improving the diagnostic criteria, at the end of the last century as a part of the DSM IV classification, criteria were adopted according to which the diagnosis of ADHD is still made today.

1.1 Neurobiology of ADHD

In the pathogenesis of ADHD, the structures of the prefrontal cortex, the basal ganglia and the cerebellum are involved. The prefrontal cortex is associated with the basal ganglia and cerebellum. The prefrontal cortex is an area that regulates attention, inhibits processes, maintains attention for long periods of time, and separates the essential from the irrelevant. The prefrontal cortex controls the regulation of motor, movement.

Also, in the development of ADHD, more specifically in its pathogenesis, neurotransmitters, especially dopamine and noradrenaline, are responsible. Dopamine plays a role in motivational processes, its primary localization being in the prefrontal cortex.

1.2 Clinical picture

The clinical picture is dominated by symptoms of attention disorders, impulsiveness and hyperactivity. Attention disorders represent an inability to maintain attention to a specific stimulus for a long enough time, but we must know that this may also depend on the child's interest. The extent of attention is not the same for pre-school and school-age children. Attention is increasing as development itself flows. Most attention disorders are detected when a child enters school. The child has difficulty attending school, he can hardly master the material, although he has a good cognitive status. Attention disorders can occur in a particular area or in a particular type of learning. People like these are often impulsive, have a low threshold of tolerance for frustration, have difficulty controlling their emotions. Hyperactivity is reflected by increased motor activity. The fine motor skills of these children are not appropriate to their age, their movements are clumsy. In children with ADHD, secondary disorders can also develop with these disorders, which can be anxiety or depression. Sleep disturbances also occur, which further contribute to the disorder itself. It is very important for the parent to understand their child's problem on time and to make every effort to help him or her adequately.

1.3 Diagnostics

The diagnosis of ADHD is made on the basis of the clinical picture and according to the criteria of the International Classification of Diseases (ICD 10) set by the World Health Organization. In order to be diagnosed with ADHD, all three criteria (attention deficit disorder, impulsivity and hyperactivity disorder) must be met, while the DSM IV classification does not require the presence of all three symptoms. Symptoms of ADHD must appear before the age of seven and last at least six months. Symptoms should be present both at home and at school. The most important thing to make a diagnosis is that there is a disorder of behavior in at least one significant age, including interpersonal relationships, daily activities or academic activities. ADHD can also be diagnosed in adults, but as already noted, symptoms should generally be present before the age of seven.

The diagnosis of ADHD is made with the help of a multidisciplinary team of experts and parents. Parental cooperation is invaluable in therapy. When making a diagnosis, it is essential to take a detailed family history of the symptoms in family members and to pay particular attention to pre- and perinatal risk factors as well as to the complete psychomotor development of the child.

1.4 Incidence of ADHD

The incidence of ADHD in school children is about 2-3%. More often, the disorder occurs in boys than in girls, two to four times more. ADHD is present in all ages, races and environments. The most significant problem in diagnosing ADHD is comorbidity, especially with bipolar affective disorder, anxiety, depression, etc. They make it difficult to recognize the symptoms and thus set up a true and accurate clinical picture.

1.5 Development of ADHD

ADHD symptoms can be seen in the third year of life, even earlier. Symptoms become most apparent when a child goes to school and the first problems arise due to learning disabilities. Hyperactivity decreases during the adolescent period, but attention disorders remain. Symptoms vary over time.

1.6 Differential diagnosis

As mentioned above, most psychiatric and medical disorders can mask ADHD. Careful clinical evaluation will show which diagnosis is most appropriate for these children.

1.7 Treatment of ADHD

A complete cure is unfortunately still impossible today. What is very important is that the symptoms can be successfully controlled, which leads to improvements in relationships, in a narrow and broader social environment. The goal of treatment is to reduce the symptoms as well as to alleviate them, as well as to reduce the risk of new symptoms. In order for the treatment to be successful, it is necessary to cooperate with parents through education. Treatment begins with a pedagogical-educational and behavioral-cognitive program. If necessary, pharmacological therapy is introduced if it is not successful.

2 NEUROFEEDBACK

Neurofeedback (in further text- NFB) is a computerized non-invasive method of self-regulation that aims to achieve a change in cortical activity through the process of operational learning. With the help of NFB, brain dysregulation problems are identified and resolved.

It is believed that NFB is a direct training of brain functions by which the brain gradually learns how to function most effectively. During training, the brain functions in different tasks, and throughout the process feedback is given to the person who is being measured for their own brain activity (Gerjevic 2015). NFB is used in many pathological conditions, diseases, and disorders (Coben & Evans 2010).

In order for a person to undergo training, an accurate assessment must be made based on which treatment goals are set. Thanks to the plasticity of the brain, this method results in changes and fixation of synaptic connections.

Initially, the effects of the treatment are short-lived, but with constant exercise, pathological brain waves can improve and become non-pathological. NFB aims to increase cognitive flexibility and control (Hammond, 2006). In the 1960s, researchers came to the conclusion that it was possible to change the pattern of brain waves by increasing alpha rhythm activity (Hammond, 2006). NFB training should be understood as brain exercise, changing the current state of the brain by making the brain exercise what it needs to do. It is a type of unconscious learning that increases the chances that the brain will repeat the action for which it is rewarded audiotively or visually (Legarda, McMahon, Othmer& Othmer, 2011).

NFB is a type of brainwave training and is defined as the process by which an organism changes its behavior according to certain set goals. A protocol for the targeted brain regions is developed for each subject, depending on the diagnosis and insight into the medical records.

It is important to note that every respondent involved in NFB training is taught proper or deep breathing.

2.1 Theoretical foundations of learning

NFB rests on two basic concepts known in psychology, namely instrumental learning and classical conditioning. Instrumental learning or operative learning is a type of conditioning where the consequence of some behavior affects the likelihood of a particular form of behavior. What the respondent learns through NFB training is self-regulation within the nervous system that encompasses the thalamus, basal ganglia, and cortex (Thomson & Thomson, 2003). Classical conditioning was first described by Pavlov and refers to the attachment of a reflex situation and an external stimulus. The forms of learning used in NFB treatment are design, secondary substantiation, associative learning, elimination, and generalization.

2.2 Application of Neurofeedback in clinical population

In recent years, much has been said and researched about the impact of NFB treatment, which is an alternative to pharmaceutical therapy, which has successes in treatment but has a negative effect on the entire nervous system (Rosenberg, Gershon 2012). The disorders studied are actually those disorders that have an impact on the learning experience, including ADHD, intellectual disability, autism, mood disorders, depression, and anxiety. Given the high prevalence of these disorders, it was very important to develop some alternative methods such as NFB (Aagaard and Hansen, 2011). There are a number of diagnoses today that use the NFB method, but this research still lacks a satisfactory number of controlled researchers. Some investigations of particular disorders are characterized only by pilot investigations, case study studies. Disorders include ADHD, alcoholism, depression, disorders of school skills, learning disabilities, mood disorders, etc. The NFB method has been successfully used in the absence of disruption as well as for optimal functioning in certain spheres of social life.

3. THE USE OF NEUROFEEDBACK IN THE TREATMENT OF ADHD

Norouzi, Hosseini, and Solumani were tested whether, compared to a control condition, neurofeedback training (NFT) could improve bimanual coordination among children with ADHD. Sample was consisted of 20 children with ADHD (mean age 7.9 years; SD 2.11) were randomly assigned to either NFT or to a control condition. All participants was completed a bimanual coordination test at the following time points: baseline, assessment 1, assessment 2, assessment 3, and again 12 session later at posttest. NFT consisted of Sensory Motor Rhythm (SMR) training to achieve increased SMR in C3 and C4, while participants in the control condition were under mock NFT conditions. Bimanual coordination accuracy and consistency improved from baseline to completion of intervention (significant time effect), but in the NFT condition (significant time $\times$ group interaction). Compared to the control condition, the NFT group had fewer errors in both patterns of bimanual coordination (significant Group effect). Among children with ADHD, SMR neurofeedback training led to significant improvements in a bimanual coordination task. The SMR appears to have the potential to improve and enhance motor control of ADHD patients.

In the study of Pakdaman, Tajikzadeh and Jabalkandihe purpose was the comparison of neurofeedback with Ritalin and without Ritalin in treating children with ADHD. Participants were children aged 5-10 years with ADHD. Sample was consisted of 14 children. Seven participants were in neurofeedback group with Ritalin and seven in neurofeedback without Ritalin group according to random split and parent's conformation. Clinical Q, Conner's continuous performance test (CPT), and WISC-R were used before and after treatment. For analyzing data, they used descriptive statistical and Mann Whitney U tests. Results was showed that even if the two groups were modified in all components, modifications of commission and reaction time of the CPT and F4 theta/alpha of the clinical Q were more accurate in NF with Ritalin treatment rather than the other group. These findings were suggested that neurofeedback was efficient in improving some of the behavioral concomitants of ADHD in children whose parents favored non-pharmacological treatment.

In the next study of Baumeister and others the sample was consisted of children with ADHD (N = 16, mean age: 11.81, SD: 1.47). They were randomly assigned to either slow cortical potential (SCP, n = 8) based NFB or biofeedback control training (electromyogram feedback, n = 8) and performed a combined Flanker / NoGo task pre- and post-training. The effects of NFB, was compared to active control, and learning in transfer trials (approximating successful transfer to everyday life) were examined with respect to clinical outcome and functional magnetic resonance imaging (fMRI) changes during inhibitory control. After 20 sessions of training, children in the NFB group was presented reduced ADHD symptoms and increased activation in areas associated with inhibitory control compared to baseline. Subjects who were successful learners (n = 9) also showed increased activation in an extensive network inhibitor irrespective of the type of training. Activation was increased in an extensive inhibitory network following NFB training.

In the study of Clinical and neurophysiological data of neurofeedback therapy in children with ADHD, objective was to investigate the effect of NFB therapy on clinical status and parameters on the EEG in children with ADHD. In the period of 2007-2014 sample was consisted of 287 children (191 boys). Children of age 6-17 years were included into the study. Some children with ADHD had a coexisting disorders (tics, emotional, behavioral disorders, or dyslexia). The result showed that children with ADHD additionally was presented low self-esteem, anxiety and sleep disorders. The baseline theta/beta ratio in children with ADHD and ADHD with cooccurring dyslexia was >4.0 and in children with ADHD and coexisting tics 3.0-3.8, with coexisting behavioral disorders 3.7-4.0 and emotional disorders 3.3-3.7. After therapy, this ratio decreased significantly in all groups, but most significantly in ADHD and ADHD with dyslexia group. In the group with dyslexia theta and alpha activity in the left fronto-temporo-parietal region has been increased. In children with ADHD and behavior disorders right-sided paroxysmal changes in the form of slow and sharp waves in the temporo-centro-parietal regions were found. In emotionally disturbed children increased fast beta activity in the right hemisphere was observed. NFB therapy was reduced hyperactivity and impulsivity of children, improvement of attention was observed and eventually reduction of emotional and behavior disturbances was noticed. The therapy had a positive impact on the spatial organization of EEG in each group.

In the study of Electroencephalography in children with ADHD started with neurofeedback therapy theta/beta ratio didn't allow to differentiate groups of patients. Increase of theta and alfa activity was observed in children with ADHD. In children with ADHD and dyslexia delta and theta activity in occipital regions was increased. In children with ADHD and behaviour disorders paroxysmal localized changes with slow and sharp waves in the temporo-centroparietal regions were occurred more often. In the group with ADHD and emotional disorders higher share of fast beta activity in the centro-middle temporal regions with right hemisphere predominance was revealed, probably associated with higher level of agitation and anxiety.

Jacobs (2006) conducted a study to test the efficacy of neurofeeddback treatment in children with attention and learning disorders. The sample consisted of 24 subjects who received 48 treatments for 20 minutes each, twice a week for six months. After the implementation of NFB treatment, improvements were observed in the areas of functioning in the narrow and broad social community.

In a review of neurofeedback treatment for pediatric ADHD in 2011, Lofthouse, Arnold, Hersch, De Beus wanted to review all randomized published trials and unpublished conference presentations on the neurofeedback treatment of pediatric ADHD, and their relevance, strengths, and limitations. They concluded on the basis of the results obtained that NFB for pediatric ADHD can be currently considered as probably efficacious.

Cardo, Servera, Bernad and Meisel (2010) addressed the relationship between the impact of neurofeedback and pharmacological therapy on impulsivity in children with ADHD. The sample consisted of 23 children, which were divided into two groups. The first group underwent NFB training and the second group underwent pharmacological therapy. The results of this study showed that both treatments were effective and gave short-term results but the results are more visible in pharmacological therapy.

4 CONCLUSION

ADHD is a chronic disease that has its own developmental course. Etiological ADHD is related to the genetic background, but of course it also depends on the interaction of genes and environmental factors. Of paramount importance is early multidisciplinary diagnostics. The treatment of this disease is intended to alleviate the symptoms and allow the person in the community to function normally. It is also very important to emphasize that the cooperation and involvement of parents, as well as their education, is necessary.

Neurofeedback is a conditioning procedure where a person changes the amplitude, frequency of neurophysiological dynamics of their own brain with the help of quantitative methods and computers (Fox & Rudell, 1968; J.O. Lubar & Lubar, 1984). NFB is a form of learning self-regulation of brain function with the help of classified information. The purpose of this training is to identify the level of frequency at which the brain works and how we experience that state of mind and how to know when to move to another state that we need for a particular activity.

The results of the research presented in this paper focused most on the benefits that NFB has in improving children's learning potential, in the case of ADHD. It should be emphasized that NFB can also be applied to a population of typical development and is then used to optimize their specific skills.

Organization of functional systems, obtained through quantitative EEG reviews and based on Fast Fourier Transformation analysis, are the most relevant parameter for proper planning and implementation of NFB. This approach allows us to better understand the relationships between brain regions in the process of cognitive function, but it also provides a good basis for treating and monitoring the results.

REFERENCES

- Aagaard, L., & Hansen, E. H. (2011). The occurrence of adverse drug reaction reported for attention deficit hyperactivity disorder (ADHD) medications in the pediatric population :a quantitative review of empirical studies. *Neuropsychiatr Dis Treat*, 7, 729-744. doi: 10.2147/NDT.S26403
- Baumeister, S., Wolf, I., Hohmann, S., Holz, N., Boecker-Schlier, R., Banaschewski, T., Brandeis, D.(2019 Mar) The impact of successful learning of self-regulation on reward processing in the children with ADHD usin fMRI. *Attention Deficit Hyperactivity Disorders*; Vol. 11 (1), pp. 31-45
- Cardo, E., Servera, M., Bernard, M., & Meisel, V. (2010). Pharmacological treatment versus neurofeedback in typically symptomatology of attention deficit hyperactivity disorder. *European Neuropsychopharmacology*, 10, 584.
- Coben, R., Linden, M., & Myers, T. E. (2010). Neurofeedback for autistic spectrum disorder: a review of the literature. *Appl. Psychophysiol Biofeedback*, 35(1), 83-105. doi: 10.1007/s10484-009-9117-y
- Fox, S. S., & Rudell, A. P. (1968). Operant controlled neural event: formal and systematic approach to electrical coding of behavior in brain. *Science*, 162 (3859), 1299-1302.
- Gerjević, L. (2015). *Uloga neurobiofeedbacka u terapiji bolesnika s autizmom (doktorska disertacija)*. Univerzitet u Zagrebu-Fakultet za kineziologiju. Departman za opštu i primenjenu kineziologiju.
- Glavinić, S., Karaklajić, M., Ocokoljić, M., Đoković, S., Đukić, A., Borisavljević S. (2018). Efikasnost neurofidbek treninga u radu sa decom sa poremećajem iz autističnog spektra. *Beogradksa defektološka škola- Belgrade School of Special Education and Rehabilitation* Vol.24, No 2 , str.41-55
- Hamond, D. C. (2006). What is Neurofeedback. *Journal of Neurotherapy*, 10 (4), 25-36
- Holtman, M., Pniewski, B., Wachtlin, D., Worz, S., Strehl, U. (2014). Neurofeedback in children with attention-deficit/hyperactivity disorder (ADHD)- a controled multicenter study of a non -pharmacological treatment approach. *BMC Pediatrics* Vol. 14, pp 202.
- Kubik, A., Kubik, P., Stanios, M., Kraj, B. (2016). Clinical and neurophysiological data of neurofeedback therapy in children with ADHD. *Przegląd Lekarski* ,Vol. 73, pp. 148-51.
- Jacobs, E. H. (2006). Neurofeedback treatment of two children with learning , attention, mood, social, and developmental deficits. *Journal of Neurotherapy*, 9 (4), 55-70
- Legarda, S. B., McMahon, D., Othmer, S. (2011). Clinical neurofeedback: case studies, proposed mechanism, and implications for pediatric neurology practice. *Journal of Child Neurology*, 26 (8), 1045-1051
- Lofthouse, N., Arnold, Le., Hersch, S., Hurt, E., DeBeus, R. (2012). A review of neurofeedback treatment for

- pediatricADHD. *Journal of Attention Disorders* ;Vol.16 (5), pp. 351-72
- Norouzi, E. Hossieni, F., Solymani, M. (2018). Effects of Neurofeedback Trainig on Perfmorming Bimanual Coordination In-phase and Anti-phase Patterns in Children with ADHD. *Applied Psychophysiology And Biofeedback* Vol 43 (4), pp.283-292.
- Pakdaman, F., Irani, F., Tajikzadeh, F., Jabalkandi, SA. (2018). The efficacy of Ritalin in ADHD children under neurofeedback training. *Neurological Sciences: Official Journal Of The Italian Neurological Society And Of The Italian Society Of Clinical Neurophysiology*; Vol . 39 (12), pp. 2071-2078
- Rosenborg, D., & Greshon, S. (2012). *Pharmacotherapy of child and adolescent psychiatric disorders*. Hoboken: Wiley- Blackwell.
- Thompson, M., & Thompson , L. (2003). *The Neurofeedback Book: An Introduction to Basic Concepts in Applied Pychophysiology*. San Francisco. Association for Applied Psychophysiology and Biofeedback.

Attitudes of Pupils of Elementary School Age Towards Learning and Teaching Contents From Subject Knowledge of Nature in Inclusive Teaching Context

Ivana Ristić¹, Ivana Pavković², Aleksandra Milošević-Vasiljković³

¹College of Social Work ,Belgrade

²Life activities advancement center,Belgrade

³Clinical Center of Serbia, Belgrade

ABSTRACT

Attitude is always directed towards an object that can have a general social meaning, an individual character and can refer to some abstract or concrete content. A person who creates an attitude possesses a relatively lasting and consistent willingness or disposition to react favorably or unfavorably in each of many appropriate situations. A hearing impaired child forms his or her own views that arise from the attitudes that family, teachers, and peers have toward him or her. Positive attitudes of family, school and peers will help the hearing impaired child to sound healthy, feel satisfied and achieve good school success. The aim of the research was to examine the attitudes of the hearing impaired child towards: material, teacher, learning, learning conditions, family relationships and assistance that the hearing impaired child expects in order to master the material in the subject knowledge of society. The sample consisted of children attending the fourth grade of a regular elementary school. The analysis of the obtained results indicates that the attitudes of the hearing impaired child do not differ from the attitudes of children with orderly hearing. Equally, they have / have no difficulty in mastering school material in the subject of familiarity with society. Both groups of respondents have identical attitudes towards the school and the teachers. There is no statistically significant difference in the conditions in which the hearing impaired child and the hearing-impaired child master the school material, and there is no difference in learning aid as well.

Key words: teachers, students, attitudes, problems in school work

1 INTRODUCTION

The term attitude can be defined as a tendency of positive or negative in relation to an object (Pavković, 2000). Radoman 2003, Krech and Crutchfield (according to Radoman, 2003) define attitude as a permanent system of positive or negative response to the environment. English and English (according to Pavković, 2000) consider attitude to be “a permanently learned predisposition to a consistent course of conduct with respect to a given group of subjects”.

Zvonarevic (according to Pavkovic, 2003, 2013) provides a definition that has the elements of the “towards oneself” response week given by Zvonarevic (1981) and Pavkovic, Kovacevic (2012). This points to the existence of an attitude as "an acquired tendency to react either positively or negatively to persons, objects or situations outside of us, or to one's own qualities, ideas or actions" (Pavković, 2003).

Attitude is always directed towards an object and can have a general social meaning, individual character and can refer to some abstract or concrete content.

One of the conditions that influence attitude formation is the degree of agreement with the other person's point of view, which is probably the most pronounced in the family in the early development of the child, while in adolescence and adulthood, attitudes become less determined by the views of others. It is very likely that the attitudes and beliefs we first acquire are the most stable.

A person who creates an attitude possesses a relatively lasting and consistent willingness or disposition to react favorably or unfavorably in each of many appropriate situations. Until a situation

triggers the required reaction, the attitude remains latent. Positive attitudes arise in relation to the sources of beauty, pleasure, pleasure; the negative are formed according to the sources of annoyance, punishment, frustration, although we do not always come across such extremely pronounced relationships. "(Pavković, 2003; Pavković, Kovacevic, 2012) caused by it, and thus the latent reactions contained in an attitude can produce certain forms of manifest behavior whose manifestation will depend on many situational factors.

Examination of attitudes of 1138 teachers of mainstream elementary schools and schools for children with hearing impairment and youth in the City of Zagreb and the surrounding area with 48 variables related to the ability of hearing impaired children to master the regular curriculum, their social contact with peers and integration problems, (Radovančić et al., 1985), pointed out that there are differences in attitudes of teachers in the center of Zagreb, teachers from the periphery and defectologists. and defectologists.

From all this, it can be concluded that in order to form positive attitudes of teachers on inclusion of hearing impaired children in regular educational conditions, it is necessary for them to acquire, at least on an informative level, during their education, as Radovančić 1985 points out about the hearing about hearing impaired children. Therefore, it is necessary to include a defectologist in mainstream school who will assist the teacher in certain teaching and other forms of work in each school where the hearing impaired children or work independently with the hearing impaired children. (Andrejevic, 1992).

An empirical study of social attitudes states that the most frequently examined variables were the degree of close contact with a handicapped person, gender and age of the respondents. (Andrejevic 1992, 2005; Radoman 1995). When it comes to contact, research gives split results in confirming a positive connection and closeness with a handicapped person. Research has also shown that women and young people have a more favorable attitude towards handicap (Pavković, 2000; Pavković, Kovačević, 2012; Pavković, 2013).

Radoman (1991) studied three components of attitude toward the deaf:

- cognitive component showed that some of the characteristics of the deaf are characteristic ie. "They present stereotypes about the deaf, which are: to see better, to be more sensitive, and to be withdrawn. The cognitive component of attitude is predominantly positive, while the negative direction is less than half. Respondents shunned highly negative qualifications such as: "selfish "or" irresponsible. "

- Affective component of attitude towards the deaf showed that the respondents' answers about their feelings towards the deaf show the most positive feelings such as the desire to help and compassion for the deaf. Of the total number of possible rounds of negative feelings, only 6% are rounded. It can be stated that the affective component of attitude towards the deaf constitutes a predominantly positive direction.

The scale of social distance to the deaf indicates that people with normal hearing have a greater distance when it comes to close and lasting relationships with the deaf (sexual relations, child marriage with a deaf person), and less when it comes to more superficial and shorter contacts.

- The direction of the conative component of attitude is overwhelmingly positive (Radoman 1991).

It is very important for the family as well as for the hearing impaired child to be accepted by the environment in order to see their place in the community.

Hearing impairment is an obstacle (barrier) for quick and easy communication. Overcoming this barrier requires understanding and patience for which the society in which deaf people are found often lacks time. The remnants of the early prejudices of society that can still be seen today point out that disability is a mysterious accident, a hereditary flaw and punishment from above. Levin (1960), Pavkovic, (2003, 2013) conclude that part of the public known as the business world has prejudices and attitudes toward the handicapped and their families. It is clear that the basic problem of deafness is communication and the greatest difficulties of these persons arise from this problem.

Due to hearing loss, a deaf child suffers negative consequences both in terms of the emotional correlates of communicating with parents at an early age and in terms of cognitive learning and thinking (Radoman, 1995a). This problem becomes more drastic when a hearing impaired child goes to school.

There is a long tradition in our country of including deaf and hard of hearing children in the mainstream education system. This is evidenced by many records that describe the method and procedure for working with deaf students in regular classes. The earliest trace dates from 1834, when teacher Joseph Raušan taught deaf students with elementary hearing students at a primary school in Pancevo. Such a form

of organization of school work had a deep social note, because it did not single out disturbed children from the "normal" environment, but gave the name the opportunity to live and work in the same conditions as other children. In addition, such a starting point triggered a change in attitudes about the abilities and abilities of children with disabilities (Kovacevic and Radovanovic, 2006).

Deaf and hard of hearing students can successfully participate in regular school work (Kovacevic and Radovanovic, 2006a). Success will be conditioned by the degree of linguistic development, the ability to communicate with the teacher and other students through speech, intellectual status, emotional maturity, the ability to adapt to the environment, the attitude of the environment towards his problems and the degree of support of the school and the teacher. The implementation of direct and indirect support measures, regulated by the Law on the Basics of Education, as well as the Rulebook on Additional Educational, Health and Social Support to the Child and the Student and the Rulebook on Detailed Directions for Determining the Right to an Individual Educational Plan, its Implementation and Evaluation Deaf and hard of hearing students for quality education in an inclusive environment.

One of the most important factors is peer support. In order for children to embrace a developmentally disabled peer, they need to be prepared to have a child in the group who differs from them in some of their abilities, abilities, pace and ways of working. Children can be taught to respond positively to their peers with special needs as their attitudes develop through positive role models. Teachers and teachers of mainstream educational institutions should provide children with appropriate, concrete and clear information about particular developmental disabilities, in a language that is understandable to them, and by their behavior show that they accept the child. Preparation should give children the opportunity to learn what it means to be different and to have developmental disabilities. It is important that the student with special needs is presented in a positive light, as a child doing many things well and in some activities needing help, and thus encourage other children to think about how they can help peers with special needs. Students' attitudes toward peers with disabilities have been addressed by many authors (Guralnick, 1992; Gross, 1993; Acton and Zabatany, 1993; Rynders et al., 1994; Helmunt, 1997; Haug, 1999). Their studies indicate that studying in one school year in a built, integrated preschool environment has a positive impact on the inclusion process and that it raises social integration to a level comparable to children of regular psychophysical development. At the same time, the results of these and similar studies have influenced the creation of different educational models for working with children with special needs in different countries.

The attitude of teachers towards students with special needs is a particularly sensitive question. In order for a special needs child to accept a teacher and for a teacher to accept a special needs child, many conditions must be met. When it comes to a teacher, these are first and foremost professional competences for both educational and upbringing requirements, positive attitudes towards the child as a human being, love for the vocation, while when it comes to a child with special needs it is important to be prepared for school not only in intellectual but also in social terms, as well as to make the first experiences in contact with the school and the school environment positive. However, in practice, most of these conditions are not met. Often there is a lack of systematic teacher training for working with children with special needs, which causes a number of difficulties in working. Due to the lack of knowledge of the educational opportunities of children with special needs, teachers form a negative attitude and exhibit inappropriate behaviors towards children with special needs, such as ignoring in class, frequent complaints to the school's professional service that the child is a problem and they do not know what to do with it. the child is not for regular school but that he should be transferred to a special school, etc. The negative attitude of teachers towards children with special needs causes the development of negative attitudes and peers towards their peers with special needs. Children tend to severely punish all those who cannot adapt to their group activities, who cannot engage in collective games, who fall behind in physical activities, who have visual characteristics that separate them from the group of average children and depending on age. especially in a period when they have not yet established their standards of self-control, reacting by ridiculing such children, eliminating them from play and other activities, and sometimes, albeit very rarely, by physical calculation. And a child with special needs develops negative attitudes towards the inappropriate reactions of teachers and their peers. It most often responds by withdrawal, ie silence, crying, social isolation or aggressive behavior. This often creates a negative atmosphere in the classroom, which harms not only the student with special needs

but also the other students as well as the teacher himself (Kovacevic, 2010; Kovacevic, Macešić-Petrovic, 2012; Jacheva, Kovacevic, 2016). However, inclusive education in well-prepared settings and a supportive school environment can make a huge contribution to developing positive peer interaction and mutual acceptance of teachers and students with disabilities, as well as students with disabilities and their regularly developing peers

In this study, the attitudes of hearing impaired and neat hearing students were examined.

2 AIM

The aim of the research was to examine the attitudes and opinions of the hearing impaired child according to: material, teacher, learning, learning conditions, family relationships and assistance that the hearing impaired child expects in order to master the material in the subject knowledge of society.

3 METHODOLOGY

The sample consisted of children attending the fourth grade of a regular elementary school (six fourth-grade students). The survey method was a survey that included questions to look at student attitudes about the material (eight questions), student attitudes about the teacher (ten questions), student attitudes about themselves (six questions), student attitudes about learning conditions (four questions) and attitudes about the assistance teachers could provide to a hearing impaired student (seven questions). The survey was taken from the Institute for Educational Research in Belgrade. The data obtained are correlated with the student's achievement, achievement on the test of knowledge (which the students did) in the subject of knowledge of society, and with the grade in the subject on which the student expresses views. Survey responses were processed by Pearson Chi-Square statistical analysis.

4 RESULTS

The first group of questions about attitudes about material from the subject knowledge of society had eight questions. The following results were obtained in the correlation of test success and response. Correlation of grade and answer to the questions shows that students with hearing impairment have the same opinion as students with regular hearing. Both groups of respondents have problems with the material. There is also no difference in the answers about the words the teacher uses and the words in the textbook. These results were obtained because both groups of respondents understand the words the teacher uses. The material is linked to concepts encountered outside of school, so that deaf students do not lag behind students with orderly hearing. Also, both groups of respondents stated that the material was interesting. But they also claim that the material is excessive. The claim that the material was abundant was present in both groups of respondents. When learning, students do not notice important facts, which can be considered a problem in deduction. The results obtained from these answers from the first group of questions show that there is no statistical significance. On the claim that the student does not understand some parts of the material, the students gave positive answers $p > 0.05$. Hearing impaired students show no differences in attitudes about the material from students with orderly hearing. All students agree that the material is difficult and overwhelming.

The second group of questions related to students' attitudes about the teacher. Teacher: Moves quickly through the material, as claimed by both groups of respondents. Because the material is excessive, the teacher is forced to move quickly over the material. Faced with a lack of time, the teacher fails to explain the parts of the material, which are difficult and unclear. Both groups of respondents agree that the teacher teaches according to the textbook, but also that he often searches for knowledge and pieces of material that have not been processed. teaches by textbook. As all students had high grades, they did not consider the teacher to grade them unfairly. Deaf and tidy students say the teacher teaches interestingly. The opinion of

both groups of respondents is that the teacher does not pay attention to the students' problems. It is not uncommon that students from both groups of respondents are poorly rated and so punished for misbehavior. Students answered all these questions for which statistical analysis showed that there was no statistical significance $p > 0.05$. Hearing-impaired students show no difference in attitudes toward the teacher from students with orderly hearing.

The third group of questions related to the personal condition of the students. Students from both groups of respondents have no will to learn. There is also uncertainty among all students. Everyone is insecure about themselves. An explanation for deaf students could be sensory deprivation. There is no explanation for students with orderly hearing. All students have personal problems, but they are minimal. So it does not affect the respondents. Deaf students are as lonely as students with tidy hearing. This happens because the parents of both groups of respondents work a lot. Parents do not have time to devote themselves to children. This is why children feel lonely. Neither respondent has scattered attention. Class relations are good. This is why deaf students deny thinking they are not accepted. Students with tidy hearing had the same opinion. In this part, the students provided answers whose inspection did not establish statistical significance for the questions asked $p > 0.05$. Hearing-impaired students show no difference in attitudes about personal status from students with orderly hearing.

The fourth group of results related to the learning conditions of the students. Both groups of respondents had no objection to learning conditions. All students at home have learning conditions. Deaf and hearing-impaired students have good relationships in the home. All students have the necessary accessories for school and home work. Students' attitudes are positive so there is no statistical significance $p > 0.05$. Hearing impaired students show no differences in attitude from students with orderly hearing. Both groups of students have the necessary didactic resources to work.

Fifth group of questions related to additional help in learning in school work in the subject of knowledge of society. Deaf and hearing-impaired students need extracurricular classes (supplementary classes). No student wants a teacher to prepare special assignments for him. This is especially significant for deaf students. They confirmed that they did not want other tasks. This means that they negate hearing loss. They don't want to make it easy for them to learn. Both groups of respondents claim that they can ask the teacher questions at any time. This is important because it indicates that there are ambiguities in learning. All students, deaf and hard of hearing, need the help of teachers. This is about extra help from teachers. Students also need help from other students. They need help when they do not understand the material. Learning in small groups is also sometimes necessary for all students. Questions about attending classes outside of regular classes, and the help of teachers to explain after an hour everything that was unclear, also did not have statistical significance $p > 0.05$.

Hearing impaired students show no differences in attitude from students with orderly hearing. Both groups of students need extra classes outside of class.

In the correlation of achievement on the test of knowledge of society and the answers in the survey to the questions asked, we also have no statistical significance $p > 0.05$. All students answered the questions according to the test scores.

Thus, students who scored on the test gave positive on the test. There is also no difference in responses between deaf and tidy students. There is also no statistically significant $p > 0.05$ correlation between school success and the answers to the questions asked for the subject Knowledge Society and the answers in the survey. School success has no effect on the responses of deaf students. Even students with tidy hearing have no correlation between school success and answers to questions.

5 CONCLUSION

Based on the results of the research it can be concluded that:

1) Hearing impaired students have as little / no difficulty in mastering school materials as they do with hearing impaired students.

2) School success is not crucial to the attitudes of hearing impaired students and students with orderly hearing. All students, regardless of school achievement, have the same attitude about the material, the teacher, the personal condition, the learning conditions and the help they expect from the teacher.

3) Assessment in the hearing impaired students and the hearing impaired students does not play a significant role in shaping students' attitudes towards: material, teacher, personal status, learning conditions and the help they expect from teachers.

ACKNOWLEDGMENT

– The research was financed in part by the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the projects No. 178027 and No.32032.

REFERENCES

- Acton, H.M. & Zarbatany, L. (1988). Interaction and performance within cooperative groups: Effects on nonhandicapped students' attitudes toward their mildly mentally retarded peers. *American Journal on Mental Retardation*, 93(1), 16-23.
- Andrejević, D. (2005). Early Intervention in Europe - Trends in 17 European countries. Andrejevic Endowment. White City.
- Andrejević, D.(1992). Vocational training for the deaf English, H. B., & English, A. C. (1958). *A comprehensive dictionary of psychological and psychoanalytical terms: A guide to usage*. Oxford, England: Longmans, Green
- Gross, J. (1993). Special Educational Needs in the Primary school, Open University Press Celtic Buckingham
- Guralnick, M. J. (1986). The peer realtions of young handicapped and nonhandicapped children. In P. S. Strain, M. J. Guralnick & H. M. Walker (Eds.), *Children's social behavior* (93-140). Orlando: Academic Press.
- Haug, P. (1999). Formulation and realization of social justice the compulsory school for all in Sweden and Norway. *Special Needs Education*, 14, (3), 231-239
- Helmut, C.B. (1997). Introduction to a Structure of Nord Rhine Westfallen Educational Syistem.
- Hofman, M.L. (1963). Parent discipline and the childs consederation for others. *Child Development*. .
- Jačova, Z., Kovačević, J. (2009). Children with cochlear implants in inclusive classrooms: a perspective from Central Europe' *Support for Learning*, Volume 24, Number 2, pp 16-34
- Jachova., Z, Kovačević, J. (2016). The challenges in inclusive education of children with SEN, In Vlado Timovski (Eds) *10th International Balkan Education and Science Congress on the topic of "Education and globalization*. (pp. 961-970). Ss. Cyril and Methodius University-Skopje Faculty of Pedagogy,,St.Kliment Ohridski"-Skopje, Republic of Macedonia, ISBN 978-9989-823-49-7
- Kovačević, J., Radovanović, I. (2006). Teacher Readiness, Belgrade Defectology School, Belgrade, 3, pp.125-136.
- Kovačević, J., Radovanović, I. (2006a). Hearing impaired student in mainstream school, Belgrade, Innovation in teaching XIXbr 4, 56-67.
- Kovačević,J,Macéšić-Petrović,D(2012). Inclusive education – Empirical experience from Serbia, *International Journal of Educational Development*, vol. 32 br. 3, str. 463-470. <http://dx.doi.org/10.1016/j.ijedudev.2011.11.008>
- Kovacevic, J. (2010). Children with special needs in inclusive education, *Didactica Slovenica*, vol. 25. br.5, str. 63-75
- Kreč, D., Kračfild, R. S., i Balaki I. L. (1972). An individual in society. Belgrade: Institute for Textbooks and Teaching Aids of Serbia.
- Levandovski (1975). Attitudes of parents towards a mentally retarded child-attendant in secondary school in relation to some social-psychological family characteristics, master's thesis. School of Public Health, Med.Faculty, Zagreb (1975)
- Pavković I. (2000). Evaluation of the hearing impaired family of children, Master's thesis. Faculty of Defectology, Belgrade.
- Pavković, I. (2003). Family and child of hearing impaired. Andrejevic Endowment
- Pavković I., Kovačević J. (2017). From Integration to Inclusion - Perspectives and Challenges, Ministry of Education, Science and Technological Development of the Republic of Serbia, CUŽA, IEFPG, Belgrade p.160. ISBN 978-86-89431-27-8
- Pavković, I. (2013). Attitudes of parents and the environment towards the deaf child, Belgrade Defectology School, vol 19 (1), 67-81, Belgrade: Alliance of Defectologists Serbia and Faculty of Special Education and Rehabilitation, ISSN 0354-8759

- Pavković, I., Kovačević, J. (2012). Inclusive education, attitudes, teachers and parents in inclusive education. Belgrade Defectology School, vol. 18, (3) 467-485, Belgrade: Association of Defectologists of Serbia and Faculty of Special Education and Rehabilitation, ISSN 0354-8759
- Radoman, V. (2003). Students with developmental disabilities in a new child-friendly school.
- Radovančić, B. (1985). Teachers' attitudes towards the educational integration of hearing impaired children. Defectology. No. 21 (2). pp. 39-45.
- Radoman, V. (1995). An empirical study of attitudes toward different handicaps especially for deaf and deaf people, Defectology theory and Practice 1, Belgrade, 106-114.
- Radoman, V. (1995a). Surdopsychology, Faculty of Defectology, Belgrade.
- Radoman, V. (1991). Audit Competence and Adjustment of the Personality of Children and Young People with Impairment and Normal Hearing "Doctoral dissertation, Faculty of Philosophy, Belgrade, 1991
- Reynolds, M. C. and Ainscow, M. (1994). Education of children and youth with special needs: an international perspective. In: Husein, T. and Postiethwaite, T.N: The International Encyclopedia of Education Oxford: Pergamon
- Zvonarević, M. (1981). Social psychology. School book, Zagreb

Effects of Multimodal Treatment on Attention in Children with ADHD

Vladan Plecevic¹, Sanja Djokovic²

¹Defectological and Speech Therapy Office "Plecevic" Belgrade, Serbia

²University of Belgrade, Faculty of Special Education and Rehabilitation, Belgrade, Serbia

ABSTRACT

From a neuropsychological point of view, ADHD consists of impulsivity, planning problems, inattention, hyperactivity, problems with modulation of gratification and emotional regulation (Goldstein, Jansen, 2008). People with ADHD find it difficult to maintain attention, which makes them less effective than their peers. In the treatment of children with ADHD, combined therapy involving the use of medications, behavioral techniques and environmental modification is most commonly used. The aim of this paper is to determine the effect of multimodal treatment of attention in children with ADHD. It involved application of metacognitive strategies, neurofeedback training, psychomotor reeducation, and sports-recreational therapy. Method: The study included 15 children with ADHD, ages 7-17. The effect of multimodal treatment was evaluated after six months from the start of implementation of the mentioned programs. During this period, the children were not on medication. The attention index obtained from the assessment of verbal range (subtest of numbers -VITI), visual range (WMS-R), as well as mental control assessment (WMS-R) was evaluated. Also, a SNAP 4 scale filled in by parents was used. Results and Conclusion: The results obtained show a significant improvement in the measured aspects of attention. They point us to the conclusion that a multimodal approach, i.e. the application of metacognitive strategies, neurofeedback training, psychomotor reeducation and sports-recreational therapy are good choices when it comes to working with this population. Increased sensitivity to irrelevant stimuli in children with ADHD just leads to a state of distraction and impulsivity, so therapeutic work on attention resources is crucial, as the positive effects are also reflected on the problems of excessive motor activity and impulsivity.

Keywords: ADHD, attention, metacognitive strategies, neurofeedback, Psychomotor reeducation, sports and recreational therapy.

1 INTRODUCTION

Hyperkinetic disorders are a group of disorders whose characteristics are: exaggerated and disorganized activity, non-persistence in activities that require cognitive engagement, switching from one activity to another without completing it, and it sets off in early childhood, usually by the age of five (Popovic-Deusic, 1999)

Attention is a neuropsychological function that is difficult to define. Attention is not a unique function and refers to the organism's ability to receive different stimuli and start processing incoming information (Lezak, 1995, according to Pavlovic, 2012). Attention deficit disorder is a leading symptom of hyperkinetic syndrome. The attention of children with ADHD is under the "rule" of insignificant information, indicating impairment of its selective function. Symptoms of inattention are the inability to focus on details, the difficulty of prolonged attention displayed at home, at school, during play or other activities, the lack of attention in communication, the inability to carry out instructions or to complete tasks, difficulty in organized tasks, hesitation in initiating activities that require prolonged mental effort, frequent losing things, increased distractibility of attention and forgetfulness (Pavlovic, 2012). Increased sensitivity to irrelevant stimuli puts children with ADHD into a state of distraction and impulsivity. This disorder is considered to be a consequence of slow maturation of the frontal cortex (Ocic, 1998).

Children with ADHD often have impaired cognitive function. There is also a delay in the motor and speech-language development. It has been observed that 45% of children with ADHD have some form of speech and language disorder (Tiroch & Cohen, 1998), and most commonly present are social activity deficits, reduced auditory processing abilities, and information selection (Minchon, 1999). Secondary complications can be seen in form of dissociative behavior and poor self-esteem (Pavlovic, 2012). Learning disorders occur in just over 20% of children with ADHD, and the incidence of depression and anxiety is slightly higher (Goldstein & Jansen, 2008). One study found that children with ADHD have reduced school productivity (90%), poor performance (90%), reading disorder (20%), writing disorder (60%) (Zentall, 1975).

Treatment of children with ADHD

Treatment of children with ADHD involves applying different approaches. They contribute to better control of ADHD symptoms, thereby reducing specific difficulties in the child, his or her family and the environment. Children with ADHD have different symptoms and difficulties and their etiology is different too. This requires different approaches to therapy in order to help them not to feel less valuable and to achieve certain success in managing their way in the family, school and peer environment (Sekusak-Galeshev, 2005). The challenge for a family of a child's with ADHD is not only finding adequate therapeutic procedures, but also creating an environment that encourages creative work and effective learning in a broad sense.

Metacognitive strategies

Metacognition is the awareness of one's own cognitive processes that is used to control and improve cognitive processes.(Biggs & Moore, 1993; prema Gordon, 1996). It is a mental processing of content that is used to fulfill a particular cognitive task, which, by its nature, is intentional, planned, purposeful, and goal-and-future-oriented (Flavell, 1971). Metacognition consists of two related areas - cognitive knowledge and cognitive regulation.Cognitive knowledge consists of declarative, procedural, and conditional knowledge, and cognitive regulation involves a set of activities that help children improve their learning success and achievement. In line with the model of self-regulation, mental monitoring and enforcement processes that form metacognition occur in the form of verification, planning, self-management, and self-assessment (Hacker, 1998). Mastering metacognitive strategies contributes to independent, meaningful and permanent learning, whose ultimate outcome is the improvement of knowledge, skills and abilities in children with ADHD.

Neurofeedback Training

Neurofeedback (NFB) is a modern computer technique used to evaluate and treat various psycho physiological disorders. Some researches indicate that many psycho physiological disorders are associated with various changes in bioelectric brain activity (EEG), (Corydan Hammond, 2005). Neurofeedback is a self-monitoring method based on bioelectric measurement and feedback of internal activity. Neurofeedback treatment has been shown to influence the reduction of inattention, impulsivity, and hyperactivity in children with ADHD (Bakhshayeshet al., 2011). Training should be directed towards reducing theta wave activity, increasing SMR (sensorimotor rhythm) by lowering beta waves in certain regions. This kind of neurofeedback protocol has long-term effects. In 1976, Lubar and Shouse described the use of SMR neurofeedback in a child with hyperkinetic syndrome and confirmed that this method leads to a decrease in hyperactivity and distractibility (Lubar & Shouse, 1976). Lower beta wave training, the so-called sensorimotor rhythm (SMR), is performed in areas that are in charge of impulse control, thus trying to reduce hyperactivity. The protocol involves forty training sessions and more if needed.

Psychomotor reeducation

Psychomotor reeducation is a therapeutic approach that can affect the overall psychomotor organization of a child. It is oriented to the development of the expressive abilities of the child, which help him master its own body and to distribute his energy evenly. Children with ADHD exhibit poor muscle tone, poor resting motor control, dislateralization, poor attention, disorganization of psychomotor activity, discoordination (Bojanin, 1985). By applying the reeducation of psychomotorics and the relaxation method, one can affect the reorganization of the postural-tonic relation and the sensory field, which is in a syncretic relation with these structures (Bojanin, 1985). In the reeducation of psychomotorics, the functional integrity of the child's psychomotorics is reintegrated. Sensorimotor experiences are aroused and renewed, reinforced and enhanced through movement (Ispanovic-Radojkovic & Govedarica, 2006). In children with ADHD, paratonia is predominant and relaxation allows releasing from the tonic armor that the child uses as protection from the internal tension and replacement of this armor with new forms of freedom (Ispanovic-Radojkovic & Govedarica, 2006). In the frame of work with the children with ADHD, the following exercises are included: exercises for relaxation, exercises for estimating the duration and orientation in time, exercises for equalizing the muscle tone and the independence of movement, exercises for coordination of movements, rhythm exercises, exercises for impulsivity control, exercises for experiencing the body integrity, exercises for noticing and stabilizing lateralization, exercises for noticing the presence of another.

Sports and recreational therapy.

Sport and recreational therapy play a significant role in the process of rehabilitation and re-socialization, as well as in the achievement of results in sports competitions. Application of this type of treatment develops strength, speed, flexibility, agility, coordination, balance (static and dynamic) and brings emotions into a state of balance. Physical activity and sport have gained popularity among mental health professionals (Seefeldt, 1986). They use this method as an addition to other treatment methods, or refer their patients to physical education teachers, coaches or physiotherapists, as yet another way to treat their patients (Lufi & Parish-Plass, 2011). Several studies have been published on the effects of physical activity and sports treatment of children with ADHD. One of these studies found that sports training can be beneficial for these children in combination with behavior modification techniques (Pelham et al., 1990). One of the main hypotheses of research on sports and children with ADHD is that active participation in sports and physical exercise can lead to positive emotional outcomes, such as reduction of negative emotions, increased self-confidence and overall well-being of the organism (Biddle, 1993; Lufi & Parish-Plass, 2011). A possible explanation for the positive effects of sports therapy on ADHD can be found in various theories attempting to explain the existence of underlying symptoms of ADHD. For example, optimal stimulation theory (Anthrop, Roeyers, Van Oost, & Buysse, 2000; Zentall, 1975; Zentall & Zentall, 1983) explains that hyperactivity in children with ADHD may be increased in a low-stimulation setting relative to a typical population of children. This theory explains this as a necessary additional activity for children with ADHD to replace the stimuli that are lacking in a low-stimulating environment (Anthrop et al., 2000). A sports-recreational therapy program can address difficulties that arise in mindfulness, motor activity and impulsivity. By conceptualizing exercises using a neuropsychological approach, sports-recreational therapy can affect many abilities in children with ADHD such as attention, visual and verbal memory, working memory, executive and gnostic functions or practice.

2 METHOD

The study involved 15 children with ADHD, ages 7-17. The diagnoses of ADHD were made at the Institute of Mental Health by competent neurologists and psychiatrists and were then sent for rehabilitation to the Defectology and Speech Therapy Office Plecevic. Based on the downloaded medical records, information was obtained on the type and severity of the present disorder and this institution follows the protocol recommended by the American Academy of Pediatrics, 2000. At the time of testing, children with ADHD did not use pharmacotherapy, and the rehabilitation program they attended included metacognitive strategies, psychomotor reeducation, neurofeedback training, and sports and recreational therapy.

Children were tested to assess attention and concentration indices. Onesophobia is based on the assessment of verbal range (subtests -VITI), visual range (WMS-R), and mental control assessments (WMS-R). Range is the number of information in a sequence that the respondent can reproduce. In addition to repeating the numbers back and forth, the visual attention span of the back and forth is also examined (the order of the random squares shown). Mental control assessment consists of counting backwards (20 to 1), saying alphabet, as well as the serial summation task. These tasks have a time limit. The calculation is done by multiplying the raw scores obtained by evaluation of the verbal and visual range with two and adding the score obtained by the mental control assessment. The resulting value is found in the table (by age) and the score index is read from the table. Also, the SNAP 4 scale was used (Swanson, et al., 2012), which was filled by the parents. The scale has 18 tasks and tasks 1 to 9 are related to attention assessment, while tasks 10 to 18 evaluate excessive motor activity and impulsivity. Ratings are summed in each of the two symptom groups (attention and excessive motor activity / impulsivity). The obtained values are compared with the values given in the instruction. The effect of multimodal treatment was evaluated after six months from the start of implementation of the mentioned programs. In the statistical analysis, the methods of basic descriptive statistics were used - arithmetic mean, standard deviation, confidence interval and t test.

3 RESULTS

Table 1. Results of attention assessment before and after multimodal treatment in children with ADHD

Tasks	Multimodal treatment	ADHD (n=15)			T test	
		Mean±SD	95% confidence interval		t(df)	P
			Lower	Upper		
Verbal span	Before	10.47±1.88	-4.41	-2.25	-6.61(14)	0.000**
	After	13.80±2.85				
Visual span	Before	12.60±2.69	-3.44	-1.09	-4.14(14)	0.001**
	After	14.87±2.20				
Mental control	Before	3.87±1.35	-1.15	0.22	-1.45(14)	0.169
	After	4.33±1.44				
Total	Before	26.93±3.32	-20.02	-13.03	-8.34(14)	0.000**
	After	33.00±4.81				

Table 1 clearly shows that children with ADHD achieved better results after multimodal treatment in all the observed attention components as well as in the overall results. Statistically significant difference in $p < 0.05$ was recorded in verbal span, visual span, and overall scores. Only in the mental control and despite better results after treatment, the difference in results was not statistically significant.

Table 2. Results of the SNAP IV scale before and after multimodal treatment in children with ADHD						
SNAP IV	Multimodal treatment	ADHD (n=15)		T test		
		Mean±SD	95% confidence interval		t(df)	P
			Lower	Upper		
Attention	Before	17.50±3.61	1.07	5.06	3.32	0.005**
	After	14.43±4.05				
Excessive motor activity	Before	12.07±5.44	-1.33	3.05	0.84	0.414
	After	11.21±5.72				
Total	Before	29.57±7.56	3.36	7.35	5.80	0.000**
	After	24.21±6.32				

The results of the SNAP IV scale also showed that children with ADHD performed better after multimodal treatment (Table 2). Statistically significant differences at the $p < 0.05$ level were observed in attention and overall results, whereas the difference in excessive motor activity was not statistically significant.

4 DISCUSSION

Early diagnosis and an appropriate therapeutic approach are important factors in preventing the debilitating effects of ADHD. Treatment of children with ADHD involves the use of different approaches to control and alleviate the characteristic symptoms that significantly disturb the child and its family. Based on the results of our study using multimodal treatment, statistically significant effects on the verbal and visual attention span, as well as on the total score, were determined. Also, the results of the SNAP IV scale show significant progress in the attention span and overall score. No difference was found in mental control and excessive motor activity. Given that the performance on mental control tasks depends on the ability for serial organized activities, it is likely that excessive and irrelevant motor activity impairs mental control. Attention is a very important ability to perform tasks, especially if that activity is burdened by distractions. In order to successfully complete the task, a top-down control is required that suppresses distracters (Pavlovic, 2012). It is advisable to start treatment as soon as the first symptoms of ADHD are observed in the child, as this can prevent or alleviate the onset of additional difficulties in the form of behavioral disorders and psychological problems.

The limitations of this study are related to the small number of children in the sample and the uneven representation of girls and boys. With regard to the gender imbalance of the sample, the prevalence of ADHD is significantly higher in boys than in girls.

5 CONCLUSION

The results of this research, as well as the practical experience, indicate that the best results can be achieved if a multimodal approach is followed, and it involves the use of combined methods with the participation of a multidisciplinary team of experts. Such an approach affects all areas of children's development and produces positive results that are visible in the family environment, school and peer relationships. It should also be emphasized that further research should focus on examining the individual effects of multimodal treatment of the specific abilities of children with ADHD.

REFERENCES

- American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders - DSM-IV-TR. New York: American Psychiatric Publishing, 2000. <https://www.dsm.psychiatryonline.org/doi/book/10.1176/appi.books.9781585629992>
- Antrop, I., Roeyers, H., Van Oost, P., & Buysse, A. (2000). Stimulation seeking and hyperactivity in children with ADHD. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, 41(2), 225-231.
- Bakhshayesh, A. R., Hänsch, S., Wyschkon, A., Rezai, M. J., & Esser, G. (2011). Neurofeedback in ADHD: a single-blind randomized controlled trial. *European child & adolescent psychiatry*, 20(9), 481-491.
- Biddle, S. J. (1993). Children, exercise and mental health. *International Journal of Sport Psychology*, 24(2), 200-216.
- Bojanin, S. (1985). Neuropsihologija razvojnog doba i opšti reedukativni metod. Zavod za udžbenike i nastavna sredstva, Beograd.
- Flavell, J. H. (1971). First Discussant's Comments: What is Memory Development the Development of?. *Human Development*, 14(4), 272-278.
- Gordon, J. (1996). Tracks for learning. Metacognition and learning technologies. *Australian Journal of Educational technology*, 12(1), 46-55.
- Hacker, D. J. (1998). Definitions and empirical foundations. In *Metacognition in educational theory and practice* (pp. 15-38). Routledge.
- Hammond, D. C. (2005). Neurofeedback with anxiety and affective disorders. *Child and Adolescent Psychiatric Clinics*, 14(1), 105-123.
- Išpanović-Radojković, V., & Govedarica, T. (2006). Reedukacija psihomotorike i relaksacija kao terapijske metode u dečjoj psihijatriji. *Psihijatrija danas*, 38(1), 41-49.
- Lubar, J. F. (1991). Discourse on the development of EEG diagnostics and biofeedback for attention-deficit/hyperactivity disorders. *Biofeedback and Self-regulation*, 16(3), 201-225.
- Lubar, J. F., & Shouse, M. N. (1976). EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR). *Biofeedback and Self-regulation*, 1(3), 293-306.
- Lufi, D., & Parish-Plass, J. (2011). Sport-based group therapy program for boys with ADHD or with other behavioral disorders. *Child & Family Behavior Therapy*, 33(3), 217-230.
- Pavlović, D. (2012). *Neuropsihologija, bihevioralna neurologija i neuropsihijatrija*. Beograd.
- Pavlović, D., Pavlović, A. (2013). *Neuropsihološka dijagnostika*. Beograd.
- Pelham, W. E., McBurnett, K., Harper, G. W., Milich, R., Murphy, D. A., Clinton, J., & Thiele, C. (1990). Methylphenidate and baseball playing in ADHD children: who's on first?. *Journal of consulting and clinical psychology*, 58(1), 130.
- Popović-Deušić, S. (1999). *Problem mentalnog zdravlja dece i adolescenata*. Institut za mentalno zdravlje.
- Seefeldt, V. (1986). *Physical Activity & Well-being*. American Alliance for Health, Physical Education, Recreation and Dance Publications, PO Box 704, Waldorf, MD 20601.
- Sekušak-Galešev, S. (2005). *Hiperaktivnost. Dijeteidruštvo, Ministarstvo obitelji, branitelja i međugeneracijske solidarnosti*, 7(1), 40-59.
- Swanson, J. M., Schuck, S., Porter, M. M., Carlson, C., Hartman, C. A., Sergeant, J. A., ... & Wigal, T. (2012). Categorical and dimensional definitions and evaluations of symptoms of ADHD: history of the SNAP and the SWAN rating scales. *The International journal of educational and psychological assessment*, 10(1), 51-70.
- Zentall, S. (1975). Optimal stimulation as theoretical basis of hyperactivity. *American Journal of Orthopsychiatry*, 45(4), 549.
- Zentall, S. S., & Zentall, T. R. (1983). Optimal stimulation: a model of disordered activity and performance in normal and deviant children. *Psychological bulletin*, 94(3), 446-471.

The Impact of Medication During Pregnancy on Fetal Development

Marija Tešović¹, Ivana Bogavac¹

¹Institute for Research and Development - Life Activities Advancement Center,
Gospodar Jovanova 35, Belgrade, Serbia
marijamaki7vukic@gmail.com

ABSTRACT

In spite of the widespread opinion that drugs should be avoided in pregnancy, a great number of pregnant women take drugs with more or less justification. Administration of drugs in pregnancy requires additional attention because the health of both the mother and her unborn child must be protected. Majority of drugs administered in pregnancy have not been tested within the controlled studies performed on pregnant women, but their effect on the human fetus is based on assumptions and clinical trials performed on animals. Most often, the non-negative effects of the drugs used during pregnancy affect the anatomical basis of the fetal development as well as its psychophysiology of development. The aim of this review article is to put the emphasis on the importance of early detection and diagnosis of developmental disorders. Some potential developmental disorders in children can be detected in the prenatal period, and thus enable the early intervention and habilitation treatment of the psychophysiological abilities of such children. *Keywords:* drugs, pregnancy, childhood developmental disorders, psychophysiological abilities

1 INTRODUCTION

Women have traditionally been cautioned against taking medications during pregnancy, because there are no guarantees that any drug is safe. Most medications pass through the placenta and reach the circulation of the unborn baby (fetus). A medication may have different effects on the mother and the fetus depending upon when it is taken during the pregnancy. The only way to do that would be to put the drugs through controlled trials with pregnant women, and no one wants to assume the ethical or legal liabilities of exposing a pregnant woman and her fetus to potential harm.

This article provides an overview impact of medication during pregnancy on fetal development as well as the potential danger of subsequent psychophysiological development. The purpose of this review article is to highlight the importance of early detection and diagnosis of developmental disorders. The article is based on literature searches in PubMed in addition to the authors' own experience and research in this field.

The placenta as an organ of exchange between mother and fetus

The placenta is an organ of exchange allowing the mother to pass nutrients and medications to the fetus. Therefore, medications administered to pregnant women have the potential to affect the growing fetus. The fetus is generally at the greatest risk of developing teratogenic effects from medications during the first trimester, but it is drug specific. The use of medications in pregnancy should be evaluated for the benefits and risks to both the mother and fetus. Upon evaluation, some medications may be used sparingly during some trimesters and contraindicated in others (Briggs GG, Freeman RK, Yaffe A., 2005). All efforts should be made to optimize the risk benefit ratio. Drugs with low molecular weight, low maternal protein binding, low ionization, and high lipophilicity are more likely to cross the placenta and cause pharmacologic affects.¹ The developing fetus's body systems are not mature; therefore, the fetus may lack the ability to metabolize medications causing teratogenic effects (Briggs GG, Freeman RK, Yaffe A., 2005).

Safe and unsafe drugs during pregnancy

The transfer of drug occurs through the placenta during pregnancy through which the essentials nutrients required for the growth of fetus also pass through. It is also one of the barriers known as placental blood barrier. Fetus is more sensitive to drugs than mother since fetal hepatic enzymes function is less and rapidly growing fetal tissues are more susceptible to the effect (Tshering Pem, Vivek Gupta* and Gopal L. Khatik, 2016). During gravidity period there is increase in plasma proteins which binds drugs poorly, resulting in more amount of free drug.

Table 1. Safe drugs in pregnancy (PG Thorpe at all, 2013.)

S.No.	Safe Drugs (in pregnancy)	Function	Side effects(in fetus)
1.	Analgesic drugs (paracetamol, pethidine, Indomethacin, Allopurinol)	Analgesic, antipyretic, chronic arthritis and connective tissue disorder, gout and kidney stones	No fetal abnormalities, Administered at the first stage of labor (6-8hrs before delivery)
2.	Gastro-intestinal agent (laxative, antiemetic, anti-diarrheal)	Benefits in constipation, Inhibit action of emetics, diarrhea	No teratogenic or adverse effect, Treatment of morning sickness during first trimester, Anti spasmodic during pregnancy
3.	Antiasthmatic agent (Ephedrine, Aminophylline, Terbutaline)	Asthma, hay fever, bronchial asthma, Chronic asthma	No adverse effect and teratogenic effect
4.	Antihypertensive agent (Methyldopa, Hydralazine, Lidocaine)	Hypertension, Congestive heart failure, Cardiac arrhythmia	Decrease fetal wastage, Increase birth weight and length of gestation, No adverse effect
5.	Anti tubercular agent (Isoniazid)	Tuberculosis infection treatment	No adverse effect
6.	Anti-coagulants (heparin)	Anti coagulant action	Avoids feta neural damage
7.	Diuretics (Furosemide)	Edema, maternal illness	No adverse effect
8.	Miscellaneous drugs (tetanus, Pobenecid, calcium and vitamin D)	Antibiotics, Regulate the balance of salt	No adverse effect, Administered in second or third trimester

For the time being, drugs are teratogenic only for a limited time during embryogenesis. Teratogenicity is a condition when any drug a chemical substance that produces deviations or abnormalities in the development of the embryo. Therefore, it should be avoided in such problems it is very important to know which medicines are prescribed during pregnancy. Food and medicine the administration of America

applies the rule to categorize a drug that is contraindicated during pregnancy, so the classification was performed as follows (U.S. Food and Drug Administration, 2005) .

Pregnancy medication categories:

Category A: Controlled studies show no risk or find no evidence of harm.

Category B: Animal studies show no risks, but there are no controlled studies in pregnant women.

Category C: Animal studies have shown risk to the fetus, there are no controlled studies in women, or studies in women and animals are not available.

Category D: There is positive evidence of potential fetal risk, but the benefits from use in pregnant women may be acceptable despite the risk (i.e. life-threatening condition to mother).

Category X: Studies in animals or human beings have demonstrated fetal abnormalities, or there is evidence of fetal risk. The drug is contraindicated in women who are or may become pregnant.

Category N: is the confusing category. A medication gets this classification if there is insufficient data on its use during pregnancy. It could be safe or probably safe, or it could be potentially harmful.

There are various drugs which are safer and can be used for the treatment of ailment during pregnancy, such drug discussed below and showed in table 1 (Thorpe et al, 2013).

Drugs Affiliated With Some Risk

Some of the drugs which are associated with risk during pregnancy and referred as unsafe drug as discussed below and below and showed in table 2 (Nand &Kher, 2015).

Table 2: A list of unsafe drug during pregnancy

S.No.	Unsafe Drugs (in pregnancy)	Function	Side effects (in fetus)
1.	Antiasthmatic agent (Chromolyn sodium, Corticosteroids)	Prophylaxis in bronchial asthma	Slows down fetal growth but no teratogenic effect, Malformation and retardation
2.	Gastrointestinal agent (Antacid-aluminium hydroxide, sodium bicarbonate, anti-emetics, cyclizine, hydroxyzine, prochlorperazine, H2 blockers, cimetidine, ranitidine)	Relieve from stomach acidity, Nausea and vomiting, Acid reducer.	Adverse effect, Not good result shown, Frequent use should be prohibited
3.	Anti-microbial (chlorphenicol, nitrofurantoin, sulphonamide)	Relieve from Typhoid, UTI	Grey baby syndrome, bone marrow depression and haemolysis
4.	Antitubercular agent(Streptomycin)	Used in tuberculosis	Minor effect after crossing from placenta.
5.	Antihypertensive drugs (Diazoxide, Captopril)	Vasodilator, used in hypertension	Damage to the fetus by reducing BP
6.	Diuretics (Ethacrynic acid)	Edema and hypertension	Decrease placental perfusion
7.	Cardiac drugs(Calcium antagonist-Verapamil, nifedipine)	Anti hypertensive drug.	Safe but checking of fetus should be necessary
8.	Anti-malarial (Primaquine)	Malaria and pneumonia	Haemolytic anaemia in neonates and adverse effect
9.	Analgesic (Salicylates) birth weight	Pain reliever	Neonatal platelet dysfunction, haemorrhage and decrease
10.	Miscellaneous (Phenytoin, Phenobarbitone, sodium valporate)	Reduce seizures in epilepsy	Malformations

Drugs contraindicated in pregnancy

Some of the drugs which are contraindicated during pregnancy as discussed below and showed in table 3 (Hesse, Nelson, Kreps, Croyle, Arora, Rimer & Viswanath, 2005).

Table 3: A list of contraindicated drug during pregnancy

S. No.	Contraindicated Drugs (in pregnancy)	Function	Side effects (in fetus)
1.	Anti coagulants (Warfarin, coumarin)	Prevent coagulation	Mental retardation in fetus, congenital malformation, eye, abnormalities
2.	Analgesic (Colchicines)	Used in Gout, arthritis	High risk of miscarriage and teratogenic effect
3.	Antitubercular agent (Pyrazinamide, Ethoamide)	Treat tuberculosis	Adverse effect in the liver and cause toxicity
4.	Gastrointestinal agent (Laxative-castor oil, dibasic Sodium phosphate, atropine)	Constipation, spasm in the stomach	High risk of malformation, tachycardia, urinary retention and hyperthermia in neonates
5.	Antihypertensive agent (Reserpine, nitroprusside)	Treatment of chronic hypertension	Cause fetal death and acute hypotension in fetus
6.	Diuretics (Chlorthiazide)	Used in edema	Bone marrow depression and thrombocytopenia
7.	Antimicrobial (Tetracycline)	Used in bacterial infections	Calcification of bones or deposition of calcium in infants
8.	Oral hypoglycaemic agent (Sulfonylurea)	Anti diabetic	Malformation and fetal death
9.	Anti-malarial drugs (Quinine)	Treatment of malaria	Can cause abortion and premature labor
10.	Sedatives (Diazepam, Chlordiazepoxide)	Sleep inducer	Cleft lips and neonatal depression and adverse effect on CNS and heart
11.	Miscellaneous (antithyroid, lithium, estrogen and vaccines)	Used in rubella, mumps and measles	Teratogenicity and adverse Effect

Potential consequences on psychophysiological development

The safe and unsafe medication during pregnancy is a very important life perspective as they carry two lives connected over a period of time. During this period, both the mother and the fetus should be safe, healthy and grow healthy.

In a study of prenatal exposure to fetal antiepileptic drugs, mothers at 13 to 17 weeks of pregnancy were recruited in the population-based, prospective Norwegian Mother and Child Cohort Study from 1999 to 2009. The mothers reported on their child's motor and social skills, language, and behavior using items from standardized screening tools at 6 months (n = 78 744), 18 months (n = 61 351), and 36 months (n = 44 147) of age. the results show that these children are at increased risk of fine motor damage at 6 months after birth, especially in the group of children exposed to multiple antiepileptic drugs (Veiby, Engelsen, & Gilhus, 2013). Knowledge of such signs may promote early identification of children at risk.

Certain consequences of long use of certain medicines can also lead to complications in the length of pregnancy and preterm delivery. Premature infants are at high risk for developing psychophysiological disorders. Studies involving preterm school-age children have found a higher incidence of learning disabilities, lack of attention, hyperactivity, and behavioral problems in this population (Santos, Araújo & Porto, 2008). These future impairments may be reduced by early intervention. Hiding on the detection of abnormalities and developmental risks facilitates the establishment of therapeutic intervention, especially as the child grows up and his / her neuropsychomotor development is not fully achieved (Santos, Araújo & Porto, 2008).

The importance of early detection and diagnosis of children whose mothers used pregnancy medication aims to effectively and early detect problems in neuropsychological development that are observed through the development of speech and language, speech thinking of emotions, attention, behavior, and hyperactivity / impulsivity (Maksimović, Sovilj & Tešović, 2016).

2 CONCLUSION

With the new discovery of the drugs it is very important for the one to be aware of the contraindications during undergoing any medications. The first safe methods to refrain from such interaction during pregnancy are always consulting the medical practitioner and prescribe the drugs even of OTC category especially during the pregnancy as there are so many complications in it. One important and unrecognized reason is the poor compliance of pregnant women. It is important that the benefits and risk of stopping treatment to be explained and informed properly. Drug may also be less effective during pregnancy because of pharmacokinetic changes such as increased metabolism. Doses of these drugs may need to be adjusted during pregnancy. Taking medication during pregnancy can potentially have greater or less negative effects on the fetus, both on the anatomical growth and development of the fetus and on the psychophysiological development of the baby. The importance of early detection of developmental disorders, as well as their diagnosis, aims at effective and early habilitation and rehabilitation of problems in psychophysical development, which are viewed through aspects of the development of motor skills, speech and language, receptive communication and auditory attention, as well as emotions, attention and behavior (Tešović, Jeličić & Bogavac, 2019).

ACKNOWLEDGEMENT

This study was supported by the Ministry of Education, Science and Technological development of the Republic of Serbia within the project No. 178027.

REFERENCES

- Briggs GG, Freeman RK, Yaffe A. *Drugs in Pregnancy and Lactation*: 7th Edition. Philadelphia: Lippincott Williams & Wilkins; 2005.
- BW Hesse, DE Nelson, GL Kreps, RT Croyle, NK Arora, BK Rimer, K Viswanath. *Arch. Intern. Med.*, 2005, 165(22), 2618-2624.
- Gyri Veiby, Bernt A. Engelsen, & Nils Erik Gilhus. Early Child Development and Exposure to Antiepileptic Drugs Prenatally and Through Breastfeeding A Prospective Cohort Study on Children of Women With Epilepsy. *JAMA Neurol.* 2013;70(11):1367-1374.
- P Nand, KR Kher. *A text book of hospital and clinical pharmacy*, 13th edition, Birla Publication Pvt limited, 2015, 292-303.
- PG Thorpe, SM Gilboa, S Hernandez-Diaz, J Lind, JD Cragan, G Briggs, S Kweder, JM Friedman, AA Mitchell, MA Honein. *Pharmacoepidemiol. Drug Saf.*, 2013, 22(9), 1013-1018.

- Santos RS, Araújo AP, Porto MA. Early diagnosis of abnormal development of preterm newborns: assessment instruments. *J Pediatr (Rio J)*. 2008;84(4):289-299.
- Maksimović S., Sovilj M., & Tešović M. Perinatal risk factors and their impact on child development, Psychophysiological child development Prenatal, Perinatal and Postnatal Aspects, -1, vol. x, no. x, pp. 93 - 195, issn: 978-86-89431-12-4, udc: x, 2016.
- Tešović M., Jeličić Lj., & Bogavac I. Monografija: Rana stimulacija dece rođene sa rizikom-prevenција razvoјnih poremećaja. Centar za unapređenje životnih aktivnosti, Institut za eksperimentalnu fonetiku i patologiju govora, Beograd. Draslar Partner, Dalmatinska 47, Beograd, ISBN 978-86-89431-31-5
- Tshering Pem, Vivek Gupta* and Gopal L. Khatik. Safe and unsafe drugs during pregnancy. School of Pharmaceutical Sciences, Journal of Chemical and Pharmaceutical Research, 2016, 8(3):652-663
- U.S. Food and Drug Administration. Dietary Supplement Labeling Guide. Updated April 2005. Available at: <http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/DietarySupplements/DietarySupplementla>. [Accessed 20, November 2015].

Gender Effect on Reading Performance in Elementary School Children

Nina Stanojević^{1,2}, Saška Fatić^{1,2}, Milana Mitrović²

¹ Institute for Research and Development "Life Activities Advancement Centre", Belgrade, Serbia

² Institute for Experimental Phonetics and Speech Pathology "Đorđe Kostić", Belgrade, Serbia

ABSTRACT

The development of reading skills is based on the already established primary linguistic competence within verbal communication. When a child gains the ability to read, it is at the level of fluent reading, which implies accurate and fluent reading of the text and is accompanied by good reading comprehension. In this paper we discuss gender differences in reading speed, precision, and comprehension. The sample consisted of 120 children who are attending Second, Third and Fourth grade of primary school. For reading assessment we have used a three-dimensional reading test by Helene Sax. Reading speed was measured by the number of words read per minute, while reading comprehension was measured by the number of information about the text read. Our results showed that girls read faster than boys. There were no statistically significant differences regarding number of mistakes and reading comprehension.

Keywords: gender, reading, speed, precision, comprehension

1 INTRODUCTION

Reading, as an operational process, is a developmental task which involves the individual's sensory, motor and cognitive systems (Sousa, 2005). For any learner to succeed at reading, explicit basic perceptual aspects (both visual and auditory) are fundamental. Before learning to read, children have already acquired spoken language. Both spoken and written languages are based on the same lexical, grammatical, syntactic and textual rules. The first experience of beginners in reading is that the written material is a representation of the knowledge they already possess, ie. they should understand the connection between thoughts and written material. However, while spoken language usually develops without formal instruction, most children need explicit guidance in the process of learning and learning to read. Systematic training for the acquisition and development of reading skills begins at school. However, for a child to be able to develop this ability, a certain level of development other reading skills is required. Reading used to be seen as a passive activity in which the reader decodes written symbols, and finally arrives at meaning. A psycholinguistic model which fits with an emergent literacy and neo-Vygotskian perspective, suggests that the reader actively makes meaning and to do this has to interact with the written word, bringing to it prior knowledge of the way in which language works and some expectations of what a particular text is likely to contain (Goodman, 1973). This model presupposes that reading is a holistic process, which implies that learning to read is not a question of learning the prerequisite subskills, which once consolidated, can then be applied to actually reading and that the primary way to learn to read is by reading, (Meek, Warlow, & Barton, 1977). According to (Whisler, 1974), visual discrimination is an essential skill for reading readiness. For this reason, assessments of reading readiness often employ visual discrimination as a

component. In order to read successfully, students must maintain the task of word recognition, the precursor of which is the ability to discriminate similarities and differences among letter and word forms, or visual discrimination.

When a child develops the ability to read, it is at the level of fluent reading that implies an accurate and fluent reading of the text and is accompanied by a good comprehension of what has been read (Kuhn & Stahl, 2003). Reading fluency develops through experience. Various studies have addressed the links between reading accuracy, speed, and reading comprehension (Bourassa, Levy, Dowin, & Casey, 1998).

Some studies have dealt with gender differences in reading performance (Fuller, Hua, & Snyder, 1994; Gambell & Hunter, 2000; Hogrebe, Nist, & Newman, 1985). In her meta-analysis study, Lietz (2006) concluded that studies between 1970 and 2002 show that girls are superior in this ability. In our study, we investigated speed, precision and comprehension of reading ability in relation to gender.

2 METHOD

The survey was conducted on a sample of 120 second, third and fourth grade elementary school children, in the territory of Serbia. A group of girls consisted of 60 examiners, and the same number was in a group of boys.

Three-dimensional reading test by author Helene Sah was used for reading performance examination. The test consists of two articles printed in Cyrillic and Latin. One article is a test for younger age, while another is a test for older age. For the purposes of our research, we used a test for younger age in Cyrillic letters. The text contains 71 words and 2 three-digit numbers, of which 22 words are one-syllable, 21 two-syllable and the other 30 words are multi-compound. Syntactically, it consists of 5 sentences, three of which are 17-21 words, and the remaining two are 6-9 words.

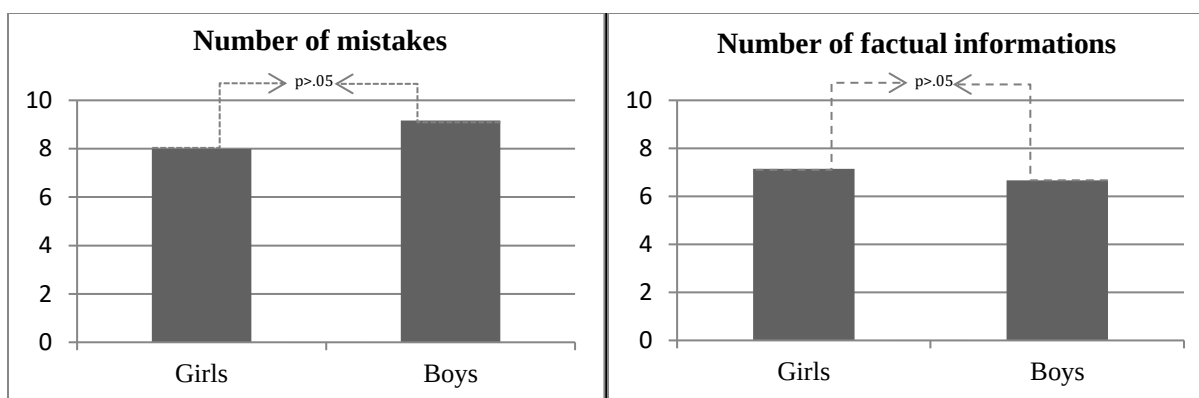
For the purposes of our research, we recorded the reading speed expressed in the number of words read per minute, the number of errors as well as the number of factual data that respondents produced after reading the text. A stopwatch was used to measure the reading speed. Errors included: ignorance of letters, difficulty in connecting two letters, difficulty switching from consonant to vowel and vice versa, interruptions in the middle of words, syllabic consonants, consonant additions, consonant substitutions, vowel substitutions, vowel additions, vowel substitutions, vowel substitutions, syllable additions, syllable inversions/metathesis, word omissions, word additions, returning to the same row, or jumping the row. The assessment of the reading comprehension was assessed with the request to persuade the text, and the number of factual information the respondent memorized was recorded.

The study was conducted individually with each child, with the prior consent of the parents and the school. The results of the research were quantitatively and qualitatively processed, analyzed and presented in tables and graphs.

Statistical analysis were performed using SPSS 20.0 software package. The Man-Whitney test was used to measure statistical significance.

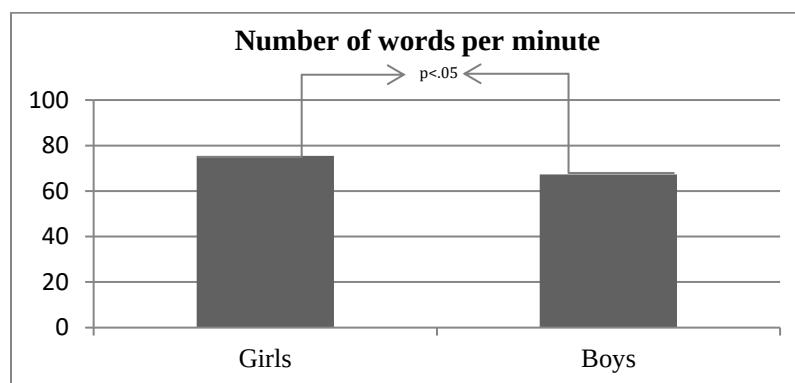
3 RESULTS

Our results showed that arithmetic mean (AS) for the number of mistakes was 7.99 with standard deviation (SD) of 6.63 for girls, and AS was 9.17 with SD=6.52 for boys. These results do not show statistically significant difference ($z=-1.374$, $p>.05$) (Graph 1). When it comes to reading comprehension, AS for factual informations was 7.14 with SD=3.31 for girls, and 6.67 with SD=3.12 for boys. Although girls gave a higher number of factual informations, there was no statistically significant difference ($z=-1.124$, $p>.05$).



Graph1 Number of mistakes and factual informations in both groups

Results for reading speed showed that AS for the number of word per minute in group of girls was 75.43 (SD=24.81), and 67.34 (SD=26.16) in group of boys (Graph 2). These results show statistically significant difference ($z=-1.955$, $p<.05$).



Grah 2 Number of words per minute for both groups

4 DISCUSSION

Our aim was to investigate whether there is a differences between gender in reading speed, precision and comprehension in elementary school children. Our results showed that there is no difference in reading precision and comprehension between boys and girls, but that girls read faster thanboys.

We can view reading speed as a dependent variable that is influenced by the ability to read correctly and to comprehend what is read (Carver & Hoffman, 1981). Children that read faster, also make less mistakes (Stanojević, Golubović, Panić, Mitrović, & Stokić, 2017). In the most developed reading models, more efficient decoding is thought to lead to better understanding and better integration of the two abilities, leading to faster automatic word identification (Perfetti, Beck, & Hughes, 1987). Experience leads to the development of this skill so it is expected that with each age as well as the time since the acquisition and development of the technique began, the speed of reading will increase. When we look at our gender-related results we can conclude that girls read faster than boys. McKenna, Kear, and Ellsworth (1995) in their study, which dealt especially with the comparison of reading ability differences between the gender, found that girls read faster and more accurately than boys., Logan and Johnston (2009) also explained this difference with the different attitudes.

REFERENCES

- Bourassa, D. C., Levy, B. A., Dowin, S., & Casey, A. (1998). Transfer effects across contextual and linguistic boundaries: evidence from poor readers. *J Exp Child Psychol*, 71(1), 45-61. doi:10.1006/jecp.1998.2459
- Carver, R. P., & Hoffman, J. V. (1981). The effect of practice through repeated reading on gain in reading ability using a computer-based instructional system. *Reading Research Quarterly*, 16, 374-390.
- Fuller, B., Hua, H., & Snyder, C., Jr. (1994). Focus on gender and academic achievement. When girls learn more than boys: the influence of time in school and pedagogy in Botswana. *Comp Educ Rev*, 38(3), 347-376. doi:10.1086/447256
- Gambell, T., & Hunter, D. (2000). Surveying gender differences in Canadian school literacy. *Journal of Curriculum Studies*, 32(5), 689-719.
- Goodman, K. (1973). *Psycholinguistic universals in the reading process*. Arizona: Wayne State University Press.
- Hogrebe, M., Nist, S., & Newman, I. (1985). Are there gender differences in reading achievement? An investigation using the high school and beyond data. *Journal of Educational Psychology*, 77(6), 716-724.
- Kuhn, M. R., & Stahl, S. A. (2003). Fluency: A review of developmental and remedial. *Journal of Educational Psychology*, 95(1), 3-21.
- Lietz, P. (2006). A Meta-Analysis of Gender Differences in Reading Achievement at the Secondary School Level. *Studies in Educational Evaluation*, 32(4), 317-344.
- Logan, S., & Johnston, R. (2009). Gender differences in reading ability and attitudes: examining where these differences lie. *Journal of Research in Reading*, 32(2), 199-214.
- McKenna, M., Kear, D., & Ellsworth, R. (1995). Children's attitudes toward reading: A national survey. *Reading Research Quarterly*, 30(4), 934-956.
- Meek, M., Warlow, A., & Barton, G. (1977). *The Cool Web: the pattern of children's reading*. London: Bodley Head.
- Perfetti, C., Beck, I., & Hughes, C. (1987). Phonemic knowledge and learning to read are reciprocal: A longitudinal study of first grade children. *Merrill-Palmer Quarter*, 33, 283-319.
- Sousa, D. (2005). *How the brain learns to read*. California: Corwin Press.
- Stanojević, N., Golubović, S., Panić, M., Mitrović, M., & Stokić, M. (2017). Korelacija brzine čitanja, broja grešaka i razumevanja pročitano kod dece mlađeg školskog. *Pedagogija*, 17(4), 482-490.
- Whisler, N. (1974). Visual-memory training in first grade: Effects on visual discrimination and reading ability. *The Elementary School Journal*, 75, 50-54.

Characteristics Of Developmental Abilities In Young Children

Milica Janić, Miodrag Stokić

Institute for Experimental Phonetics and Speech Pathology
35 Gospodar Jovanova, 11000, Beograd
milicajanica3@gmail.com

ABSTRACT

The purpose of this study was to identify differences in speech and language development of third and fourth - grade elementary school children as well as to identify differences in speech and language development between boys and girls. The sample consisted of 108 subjects: 54 children of the third-grade of primary school and 54 children of the fourth-grade of primary school. Assessment of speech and language skills was performed using: Global Articulation Test (Kostić, Đ., Vladislavljević, S., 1983), Speech development test (Vasić S., 1991), Three-dimensional reading test, which is an adapted version of the Helen Sax reading test (Kostić, Vladislavljević i Popović, 1983), Lateral dominance test (Kostić, Vladislavljević i Popović, 1983) and Acadia test (Subtest 9, Subtest 10 and Subtest 11).

The results of the research showed that irregular articulation is more common in third grade elementary school children. Right-handedness is dominant regardless of class and gender. The results of the Three-Dimensional Reading Test indicate that fourth-grade children read faster than third-grade children, while there is no significant difference in Reading Speed and Error Count between the two groups of children. Using the Test for Speech Development, the following results were obtained: fourth-grade children achieved higher scores compared to third-grade children. Also, there is a significant effect of gender on achievement on the test: fourth-grade girls achieve significantly better results than boys. Using Acadia subtests 9, 10, and 11, the following results were obtained: third-grade children scored higher on Subtest 9 (Concept Making Skill) and Subtest 10 (Acquired Linguistic Treasure) compared to fourth-grade children. Gender has a statistically significant effect on the Acadia Subtest 11 (Automatic Linguistic Treasure). The results show that both third and fourth-grade girls scored higher on this subtest compared to third and fourth-grade boys.

Key words: speech and language development, articulation, reading, lateral domination

1 INTRODUCTION

Man is a multifaceted communicative being. His communication is complex and varied. Some authors believe that the reason for a man's need to speak was not so much the need to express his thoughts (he could do this through his body gesture), but for the problem of communicating with busy hands. The use of hands was the basis for survival. Hands were needed for crafting tools, hunting and cultivating the land, forcing a man to find another method to express his ideas, that is, to specialize the pantomime of lips and tongue. With the development of the central nervous system (CNS), a man has trained his hands to work instead of moving, and parts of the respiratory and digestive tract to produce the acoustic signals that over time have turned into speech as the most effective mean of communication. Man does not possess a specific organ of phonation; he has adapted the airways and part of the digestive tract during evolution for this function. The most important factors that could have influenced the development of phonation were upright walking, CNS development, and the need for verbal communication. (Petrović - Lazić, Kulić, 2014).

The primary mean of communication is language. Language is a mean of establishing relations with other humans and achieving different goals (Jovanovic Simic, Slavnic, 2009). The speech and language development is usually followed through the development of expressive and impressive language. Receptive language is ability to understand the information. It means understanding the words, sentences, and meaning of what others say or what is read. The secondary auditory cortex of the left cerebral

hemisphere plays a role in this process. An acoustic analysis of phonemes takes place in the upper parts of this area and enables the understanding of perceived words. For this reason, phonemic hearing disorders cause disturbances in expressive language. Expressive language is ability to put thoughts into words and sentences, in a way that makes sense and is grammatically accurate. The kinesthetic cortex of the left cerebral hemisphere is responsible for processing expressive language.

According to Golubović, (2000, 2011, 2012, 2016) by developing speech, the child develops a symbolic system that his environment uses for communication, although in ontogenesis non-verbal communication precedes verbal communication. Through the development of speech, the child simultaneously masters word meanings and relations between them (semantics), grammatical construction (syntax) and the way of expressing communicative intent (pragmatics). Speech development not only implies the development of pronunciation of voices, words and grammar, but also implies contextual use of speech. That is, in which situations, at what point, in what way, and to whom we can say something. Every healthy child has the vocal and anatomical ability to learn the speech sounds of any language. However, the development of these abilities requires the interaction of the child and his or her social environment.

Speech development is gradual and has a predictable sequence. In order to understand speech development, it is necessary to know the stages of speech and language development that provide us with guidance in the development of a child's speech, but we must bear in mind that each child develops individually. The ability to read and write is developed by stimulating proper articulation, fine motor skills and visuomotor coordination.

In the third and fourth grade children, proper articulation of all Serbian speech sounds is expected as well as differentiated manual laterality. Semantics developed to a degree of understanding of abstract concepts, fluent reading and appropriate language use.

2 THE AIM OF RESEARCH

The aim of this study was to identify differences in speech and language development of third- and fourth-grade elementary school children as well as to identify differences in speech and language development between boys and girls. We also wanted to determine if there was an association between the results obtained on the tests applied.

3 METHOD

The sample consisted of N = 108 subjects: N = 54 children (of which N = 28 girls and N = 26 boys) of the third-grade of primary school and N = 54 children (of which N = 27 girls and N = 27 boys) of the fourth-grade of primary school. Children were recruited from primary school „Mihailo Petrović Alas“ in Belgrade.

Assessment of **voices** pronunciation was performed using the *Global Articulation Test* (Kostić, Dj., Vladislavljević, S., 1983) individually for each child. The test consists of 30 accented words in which the examined voices are in the interconsonant position (vowels) and in the initial position (consonants). The child is instructed to listen to the examiner and repeat the requested word. The examiner writes down the pronunciation of the vowels and writes "+" in the appropriate column if the requested voice is well articulated, "+/-" if the voice is distorted and "-" if it is omitted or substituted by another voice. The type of distortion is also written in the appropriate column.

Speech development was assessed on the basis of the *Speech Development Test* (Vasić S., 1991). Speech Development Test – Definition Test, consists of the five most common nouns in children's vocabulary. These are words with a high frequency of use and familiarity with meaning. The child should answer the five questions: “What is man, mother, life, house, sun?” The development of the ability to define can be valued by measuring the length of the sentence and the category of the definition. There are eight categories - eight developmental stages through which the definition process goes: omissions, echolalia, erroneous responses, functional definitions, descriptive definitions, logical definitions, logical definitions

with specific characteristics, and complete logical definitions. The length of the sentence and the process of defining are closely related to cognitive development, and certain categories of definition occur only when certain stages of cognitive development have been reached: preoperational, operational and formal thinking, but there is also the influence of age and environmental factors.

The Opposite Adjectives Test is a screening test, based on associative techniques. It consists of four adjectives that enter the top 50 most common in our language: big, good, black, and free. The test requires the child to say what the opposite of an adjective is.

A *Three-dimensional Reading Test* was used to assess reading, which is an adapted version of the Helena Saks reading test (Kostić, Vladislavljević, & Popović, 1983). The test consists of two texts printed in Cyrillic and Latin: TM: test for young children and TS: test for older children and adults. The text for young children is from the children's sub-section of the newspaper "Politika", while the text for older children and adults consists of announcements from the newspaper "Politika". In this study, a TM (test for young children) printed in Cyrillic letters containing 71 words and 2 three-digit numbers was used.

The reading ability of each child was analyzed in terms of reading speed (time expressed in seconds), number of errors (total number of errors), and number of reported data when recounting (understanding the text read). The reading speed was measured with a stopwatch. Errors were written down on a separate sheet and included: failure to recognize lowercase and/or uppercase, printed and Cyrillic letters, skipping letters in words, skipping consonant groups, skipping functional words, repetition of initial letters or syllables, repetition of already read part of words, or whole words, syllabic reading, illogical separation of consonants, vocal omissions, vocal additions, vocal substitutions, syllable omissions, syllable additions. Comprehension of the read text was assessed by the number of facts stated during the retelling of the read material.

A *Lateral Dominance Test* was used to evaluate lateralization (Kostić, Vladislavljević, and Popović, 1983). The test assesses the lateralization of the paired senses, organs or muscle groups, and the dominance of the hemispheres.

Manual lateralization is assessed by movements that are performed daily in the social field and by movements that are learned. The child is asked to show the requested action with a specific item. All tasks are performed with the subject standing, and the examiner places a pen or other object on the table, far enough from the children, and suggests that he always take the object with one hand and imagine that it is a comb, a knife, etc.

The *Akadia Test* was constructed in Canada because of the need for a measuring instrument that could quickly and cost-effectively diagnose the cause of failure in the learning of elementary school children. Its authors are Atkinson, Johnston and Lindsey (1972), Thomas Tillemans (1979). The test contains 13 subtests, each designed to measure some aspects of children's developmental skills that are required to successfully master elementary school curriculum. The test can only be applied from the second semester of first grade when the children have mastered reading and writing techniques. Part of the tasks in the subtests are given in non-verbal form, and part of the subtests examine verbal and psychomotor abilities. The Akadia Test can be administered individually or in groups. In this study, children were tested in groups. Subtest 9, Subtest 10 and Subtest 11 were used.

Subtest 9 consists of an image section and a text section. Tasks require knowledge of relations and the classification, and some tasks require the ability to read and write. Subtest consists of 20 tasks.

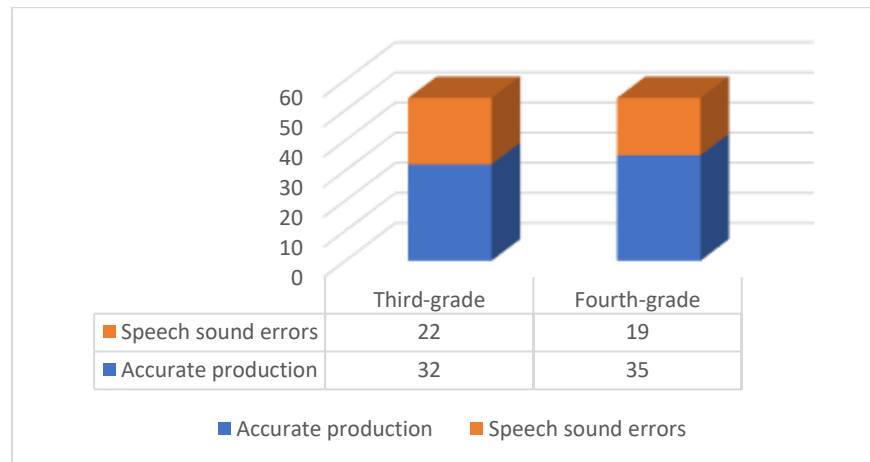
Subtest 10 - the child should circle the word that corresponds to the image or complete the word that is being asked. In most tasks, requests are presented orally. Subtest consists of 20 tasks.

Subtest 11 consists of 20 tasks in which the child has to circle a word or group of words to complete the sentence spoken by the examiner - speech therapist. This subtest evaluates pronunciation and grammar.

4 RESEARCH RESULTS AND DISCUSSION

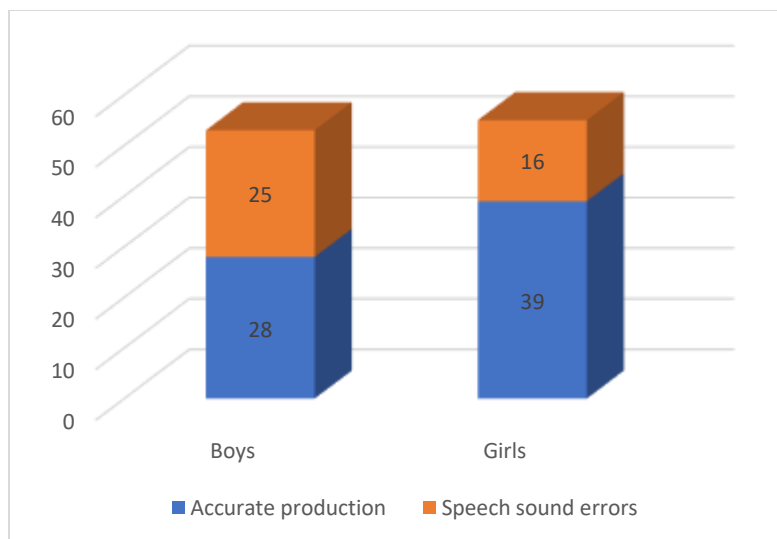
Graph 1 shows the results of Global Articulation Test in third and fourth-grade elementary school children, showing that correct articulation was determined in N = 32 (59.26%) third-grade children and N

= 35 (64.81%) fourth-grade children. The irregular pronunciation of the speech sounds was determined in N = 22 third-grade (40.74%) and N = 19 fourth-grade (35.19%) children.



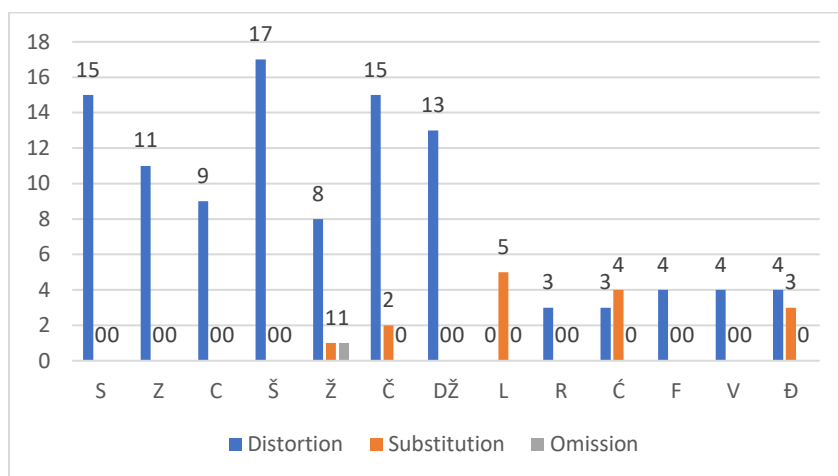
Graph 1: Distribution of accurate speech sound production and speech sound errors between third-grade and fourth-grade children

Chart 2 shows the results of Global Articulation Test in girls and boys of the third and fourth grades of primary school, showing that the correct articulation was established to almost the same degree in N = 38 (52.83%) boys and N = 39 (70.91%) girls. Irregular pronunciation was found to varying degrees: N = 25 boys (47.17%) and N = 16 girls (29.09%).



Graph 2. Distribution in percentages of accurate speech sound production and speech sound errors for gender

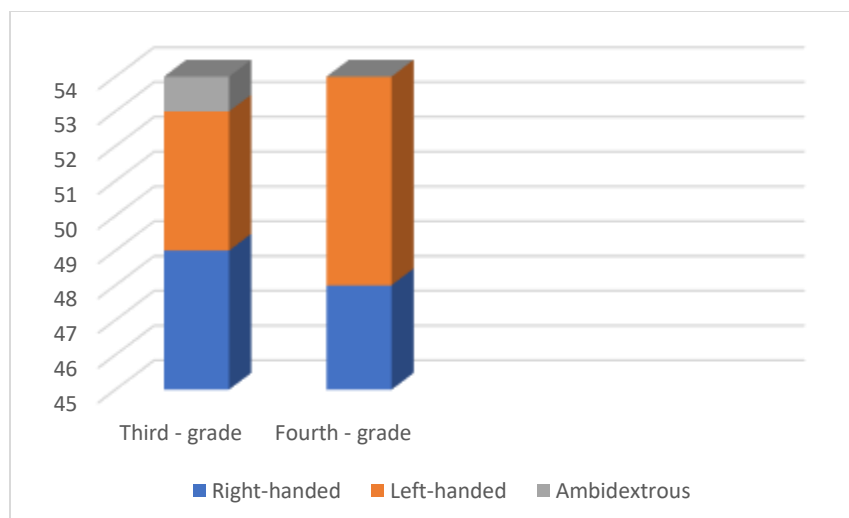
Graph 3 shows the incidence of speech sound errors in young children, for each speech sound individually. Incorrect speech sound pronunciation was found in 40.74% (N = 22) of third-grade children and 35.19% (N = 19) of fourth- grade elementary school children. In these children, the most frequently incorrectly articulated voices are: / S / (N = 8 in third-grade children; N = 7 in fourth-grade children), / Z / (N = 5 in third-grade children; N = 6 in fourth-grade children) , / C / (N = 5 in third-grade children; N = 4 in fourth-grade children), / W / (N = 7 in third-grade children; N = 10 in fourth-grade children), / W / (N = 4 in third-grade children; N = 5 in fourth-grade children), / Ć / (N = 7 in third-grade children; N = 10 in fourth-grade children), / J / (N = 6 in third-grade children; N = 7 in fourth-grade children), / L / (N = 3 in third-grade children; N = 2 in fourth-grade children), / R / (N = 2 in third grade children; N = 1 in fourth-grade children), / Ć / (N = 4 in third-grade children; N = 1 in fourth-grade children), / F / (N = 3 in third-grade children; N = 1 in fourth-grade children), / V / (N = 2 in third-grade children; N = 2 in fourth grade children), / Đ / (N = 3 in third-grade children; N = 4 in fourth grade children).



Graph 3: Speech sounds errors

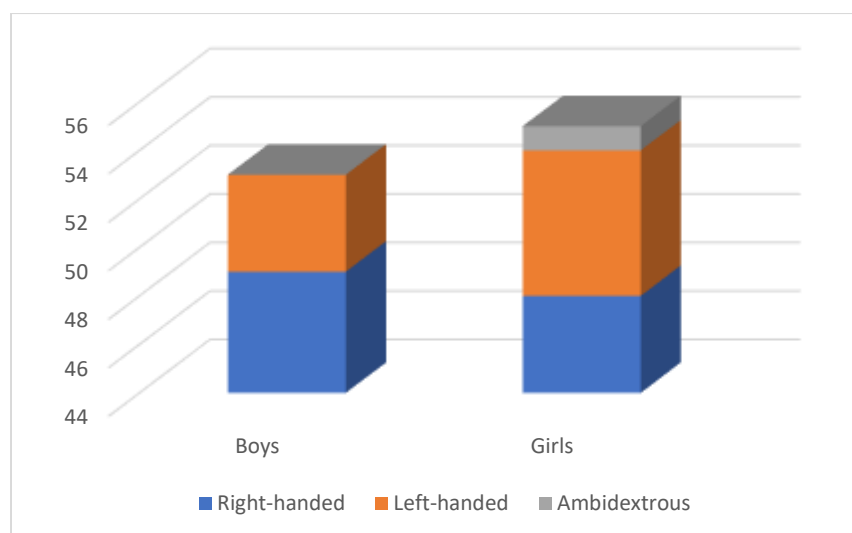
62.04% examinees had accurate production of all speech sounds, while the incorrect pronunciation of speech sounds occurred in 37.96% of children. The incidence of mispronunciation is lower in fourth-grade children (35.19%) compared to third-grade children, where mispronunciation is found in 40.74% of children. The results show that in both fourth-grade and third-grade children, the most frequently incorrectly articulated speech sounds are / S, Z, C, Š, Ž, Č, J, L, R, Ć, F, V, Đ /. The most common type of incorrect pronunciation is distortion except for speech sounds / L / i / Ć /. The second most frequent type of mispronunciation is the substitution of the speech sounds / L / and / Ć /. Voice / L / is more frequently substituted with speech sound / W / in third-grade children (N = 3) than in fourth-grade children (N = 2), while speech sound / L / is substituted in the same number of third- and fourth-grade children (N = 2). Omissions are the least common type of mispronunciation and occur only in fourth-grade children (voice / W / N = 1).

Using the Lateral Domination Test, the highest number of children in the third-grade 90.7% (N = 49) and fourth-grade 88.9% (N = 48) were right-handed (Graph 4). Significantly fewer children were left-handed: 7.4% (N = 4) in the third- grade, 11.1% (N = 6) in the fourth-grade. Only one third-grade student was ambidextrous (1.9%, N = 1).



Graph 4. Distribution of manual lateralization between third-grade and fourth-grade children

In terms of gender, the results are very similar. The highest number of boys: 92.5% (N = 49) and girls: 87.3% (N = 48) were right-handed (Graph 5). It is slightly higher number of left-handed girls: 10.9% (N = 6) compared to left-handed boys: 7.5% (N = 4). Only one girl was ambidextrous (1.8%), while in boys the ambidexterity was not found.



Graph 5. Distribution of manual lateralization for gender

Research results using the MANOVA test showed following results:

1. There is statistically significant effect of age on achievement on Subtest 9: $F(1,104) = 32.163$, $p < 0.001$. Third-grade children scored higher on Subtest 9 compared to fourth-grade children which indicate differences in the knowledge of word relation and classification. A possible explanation is that the examined material is part of the curriculum for the third-grade of primary school.

2. The results of the study indicate differences in language proficiency in third- and fourth-grade children: there is statistically significant effect of grade on achievement on Subtest 10 ($F(1,104) = 12.156$, $p < 0.01$). Third-grade children scored higher on Subtest 10 compared to fourth-grade children.

3. Fourth grade children have better pronunciation and grammar skills than third grade children as indicated by Subtest 11: $F(1,104) = 14.539$, $p < 0.001$. Girls of third: $F(1,52) = 5.874$, $p = 0.019$, and fourth grade: $F(1,52) = 8.966$, $p = 0.004$, scored higher on Subtest 11 than boys.

4. There is no statistically significant effect of grade or gender on the Number of memorized factual data after reading as well as no statistically significant effect of grade or gender on Number of reading errors.

5. There is statistically significant effect of the grade on Reading speed expressed through the number of words read per minute: $F(1,104) = 8.039$, $p = 0.006$. Fourth grade children read faster than third grade children. This result can be explained by a richer vocabulary and better reading technique that fourth-grade students have. No statistically significant effect of gender on reading speed has been identified, although there is a slight trend for fourth grade girls to read faster than boys.

Scores on Akadia subtests 9, 10 and 11 correlate with all three aspects of reading. A positive correlation was found between all three Akadia subtests, Number of memorized factual data after reading, and Reading speed, while a negative correlation was found between all three Akadia subtests and Number of reading errors. This means that children with a richer vocabulary, better grammar, better pronunciation, and better knowledge of the word classification read unfamiliar text with greater comprehension (inferred from the number of memorized factual data provided after reading), faster and with fewer errors than children who achieved lower scores on Akadia subtests.

Within the examined aspects of reading, we have concluded that there is a negative correlation between the Number of reading errors and the Reading speed, as well as between the Number of reading errors and the Number of memorized factual data after reading. These results indicate that children who make fewer reading errors read faster and with greater comprehension (inferred from the number of memorized factual data provided after reading) than children who have more reading errors. A positive correlation between the Number of memorized factual data after reading and the Reading speed indicates that children who read faster have a better understanding of the text read. There is no statistically significant difference between third- and fourth-grade children in the Number of reading errors and the Number of memorized factual data after reading.

The results of the Speech Development Test show that fourth-grade children achieve higher scores compared to third-grade children. Also, there is a significant effect of gender on achievement on the test: fourth-grade girls achieve statistically significantly better results than boys. This result could be confirmed by numerous studies of gender differences in speech development that revealed that speech develops slightly faster in girls than in boys.

A negative correlation with Reading - Number of reading errors indicates that better results on the Test for Speech Development result in lower number of errors when reading.

Two Akadia Subtests: 9 and 10 do not correlate with the Speech Development Test, while Subtest 11 correlates positively with this test. Subtest 11 involves knowledge of grammar and pronunciation, which defines speech and language development and explains the connection between the two tests.

All three Akadia Subtests used in this study, as expected, correlate positively with each other. These results show us the gradualness and comprehensiveness of linguistic and speech development.

5 CONCLUSION

This study started from the assumption that there are differences in the developmental abilities of third and fourth-grade children, that is, that there are differences in speech and language abilities among these children. An analysis of the results found that these differences existed and were in favour of fourth-grade children, which reinforced the initial assumption.

Parents and caregivers need to provide a language – rich environment to stimulate a child's speech and language development. Through this process, the child is developing verbal skills necessary for both social and cognitive maturation. Verbal skills form the basis of school systems and level of verbal ability determinates the child's academic success. So, it is not surprising that children with early language disorders, in most cases, have learning difficulties in school. For this reason, early screening is crucial for the prevention of early language disorders. By recognizing these children and providing them with adequate speech therapy learning difficulties like dyslexia and dysgraphia could be prevented.

REFERENCES

- Golubović, S. (2016). *Razvojni jezički poremećaji*. Treće, izmenjeno i dopunjeno izdanje. Beograd: Društvo defektologa Srbije, Tonplus. 59
- Jovanović Simić, N., Slavnić, S. (2009). *Atipičan jezički razvoj*. Beograd: Društvo defektologa Srbije, Big štampa. 8
- Kostić, Đ., Vladislavljević, S., Popović, M. (1983). *Testovi za ispitivanje govora i jezika*. Beograd: Zavod za udžbenike i nastavna sredstva.
- Petrović – Lazić, M., Kulić, M. (2014). *Biološki aspekti komunikacije laringektomiranih bolesnika*. Beograd: Dijamant print. 11-12
- Povše Ivkić, V., Govedarica, T. (2001). *Akadia test*. Beograd: Institut za mentalno zdravlje.
- Izvor podataka WEB: <https://www.afasic.org.uk/about-talking/more-about-speech-language-and-communication/>.

Orthomolecular Psychiatry – The Importance of Nutrition and Micro-Nutrients in the Improvement of Mental Health

Tijana Antin¹ Pavlovic, Bojana Stankov²

Child and Adolescent Psychiatry Medical Practice „Dr Antin Pavlović“, Bulevar Mihajla Pupina 163/16, Belgrade, Serbia

Institute for Experimental Phonetics and Speech Pathology “Đorđe Kostić“, Gospodar Jovanova 35, Belgrade, Serbia
ordinacija@dr-antinpavlovic.rs

ABSTRACT

Mental health implies the way we think, the way we make decisions, the way we feel, how we treat others and deal with stress. Even though nowadays we live in abundance, research and empirical data show suboptimal levels of vitamins, minerals and omega 3 fatty acids in our nutrition because of global pollution, overused lands and inadequate nutrition habits. This is the reason why the professional public shows interest in different ways of nutrition. The intake of micronutrients through dietary supplements can act preventively in the field of mental health, and also affect the degree and course of mental disorders. This is the field of interest of orthomolecular psychiatry.

There are many studies and results that explain the role and significance of micronutrients in advancement of mental health. The significance of omega 3 fatty acids stands out as they are essential components in cell membrane of neurons, they regulate the activity of neurotransmitters, they also have anti-inflammatory and anti-apoptotic effect and they enhance neuroplasticity. Vitamins from B group, Fe, Zn, Ca participate in many biochemical reactions which are significant for development and functioning of the central nervous system. Deficit of vitamin D is associated with neurodevelopmental disorders. Lipid peroxidation of the cell membrane of neurons, caused by high levels of oxidative stress, represents one of the biochemical processes included in occurrence and development of mental health problems. With the aim to control oxidative stress, it is pointed out the significance of the oxidants (vitamin C, vitamin E, beta carotene, polyphenols).

With the aim of advancement of mental health, it is crucial to enrich the knowledge of health care professionals, parents and young generations about significance of good eating habits and physiological functions of micronutrients which are essential for mental health.

Key words: mental health, orthomolecular psychiatry, balanced nutrition, micronutrients

1 INTRODUCTION

According to statistical data from World Health Organization mental disorders are among leading causes of disability and some of them may have a higher prevalence in developed countries comparing to undeveloped. Pharmacologically focused approaches have achieved a moderate reduction in the worldwide burden of poor mental health; however, indicators suggest that the burden of disease attributable to mental disorders will continue to rise worldwide during the coming decades (Baxter et al., 2013; Whiteford et al., 2013). Mental disorders in general, and major depression and anxiety disorders in particular, account for a large burden of disability worldwide (Whiteford et al., 2013). Based on epidemiological studies conducted over the past 50 years, the prevalence of ASD appears to be increasing globally. It is estimated that worldwide 1 in 160 children has an ASD. This estimate represents an average figure, and reported prevalence varies substantially across studies. Some well-controlled studies have, however, reported figures that are substantially higher. The prevalence of ASD in many low- and middle-income countries is so far unknown.

Rapid urbanisation, and an overall transition from traditional lifestyles (concerning diet, physical activity, and social structures), which are some of the most pressing global and environmental issues of our time, have both been linked to increases in depression and other mental disorders (Logan and Jacka, 2014). Indisputably, depression and other common mental disorders are already, and will probably become increasingly, part of an epidemic of comorbidity between physical and mental ill- health, with diet being a crucial common determinant (Jacka et al., 2014).

The current state, wherein populations in both developed and emerging economies preferentially consume nutrient-poor, energy-dense, highly processed foods, is historically unique—many people are both overfed and undernourished. Although caloric intake has increased, many individuals in developed nations do not meet the recommended intakes of several brain-essential nutrients, including B-group vitamins, zinc, and magnesium (Parker, Goldman and Moshfegh, 2014).

A traditional whole-food diet, consisting of higher intakes of foods such as vegetables, fruits, seafood, whole grains, lean meat, nuts, and legumes, with avoidance of processed foods, is more likely to provide the nutrients that afford resiliency against the pathogenesis of mental disorders.

Orthomolecular medicine describes the practice of preventing and treating disease by providing the body with optimal amounts of substances which are natural to the body (vitamins, minerals, trace elements, amino acids, essential fatty acids). Orthomolecular is a term that comes from “ortho”, which is Greek for "correct" or "right," and "molecule," which is the simplest structure that displays the characteristics of a compound; it literally means the "right molecule". Two-time Nobel Prize winner, and molecular biologist, Linus Pauling, Ph.D., coined the term "Orthomolecular" in his 1968 article "Orthomolecular Psychiatry" in the journal "Science."

Orthomolecular psychiatry use the principles of orthomolecular medicine for treatment of mental disorders that aims to correct underlying biochemical dysfunctions and imbalances - balanced diet and nutritional intake through dietary supplements can prevent the onset or affect the degree and course of mental illness.

The human brain operates at a very high metabolic rate, and uses a substantial proportion of total energy and nutrient intake; in both structure and function (including intracellular and intercellular communication), it is reliant on amino acids, fats, vitamins, and minerals or trace elements (Logan and Jacka, 2014; Berk et al., 2013). Dietary habits modulate the functioning of the immune system, which also moderates the risk for depression (Berk et al., 2013). The antioxidant defence system, which is also implicated in mental disorders, operates with the support of nutrient cofactors and phytochemicals. Brain tissue is particularly susceptible to oxidative damage due to high extent of metabolic process, high content of polyunsaturated fatty acid and a relatively low level of antioxidant defence system. Additionally, neurotrophic factors make essential contributions to neuronal plasticity and repair mechanisms throughout life, and these too are affected by nutritional factors (Molendijk et al., 2011).

The purpose of this paper is to upgrade knowledge particularly regarding the need to move towards a new integrated framework in psychiatry, whereby consideration of nutritional factors should be standard practice.

2 NUTRITION, MICRO-NUTRIENTS AND MENTAL HEALTH

In the past several years, links have been established between nutritional quality and mental health, and scientifically rigorous studies have made important contributions to the understanding of the role of nutrition in mental health. Many epidemiological studies, including prospective studies, have shown associations between healthy dietary patterns and a reduced prevalence of, and risk for, depression (Lai et al., 2013; Psaltopoulou et al., 2014) and suicide (Nanri et al., 2013). Maternal and early-life nutrition is also emerging as a determinant of later mental health outcomes in children (Jacka et al., 2013; Steenweg-de Graaff et al., 2014) and severe macronutrient deficiencies during crucial developmental periods have long been implicated in the pathogenesis of both depressive and psychotic disorders (Brown et al., 1995; Susser et al., 1992).

A recent systematic review has now confirmed a relation between unhealthy dietary patterns and poorer mental health in children and adolescents (O'Neil et al., 2014). In view of the early age of onset for depression and anxiety, these data suggest that diet is a key modifiable intervention target for prevention of the initial incidence of common mental disorders. Indeed, although not statistically powered to assess the prevention of de-novo depression, results from the large European PREDIMED study (Sánchez-Villegas et al., 2013) showed a strong trend towards a reduced risk for incident depression for individuals randomly assigned to a Mediterranean diet with nuts, and this protective effect was particularly evident in those with type 2 diabetes. Similarly, results of an indicated prevention trial (Stahl et al., 2014) showed that dietary counselling was as effective as psychotherapy at prevention of transition to case-level depression in older adults. A randomised controlled trial designed to test the efficacy of dietary improvement as a treatment for major depression is underway (O'Neil et al., 2013).

Convincing data suggest that select nutrient-based supplements (in isolation, or in combination) (Rucklidge et al., 2013) might provide many neurochemical modulatory activities that are beneficial in the management of mental disorders. Examples of these nutrient-based supplements include omega-3 fatty acids, S-adenosyl methionine (SAME), N-acetyl cysteine (NAC), zinc, B vitamins (including folic acid), and vitamin D. Various clinical investigations support the potential usefulness of omega-3 fatty acids for disorders including, but not limited to, bipolar depression, post-traumatic stress disorder, and major depression, and they are indicated in the prevention of psychosis (Mischoulon and Freeman, 2013). Omega-3 fatty acids can provide a range of neurochemical activities via the following mechanisms: modulation of neurotransmitter (noradrenaline, dopamine, and serotonin) re-uptake, degradation, synthesis, and receptor binding; anti-inflammatory and antiapoptotic effects; and the enhancement of cell membrane, fluidity and neurogenesis via upregulation of brain-derived neurotrophic factor (BDNF) (Mischoulon and Freeman, 2013; Sarris, Mischoulon, and Schweitzer, 2012). SAME is an endogenous sulphur-containing compound that is an important neurochemical component involved in the one-carbon cycle responsible for the methylation of neurotransmitters that regulate mood. Clinical trials have shown that SAME is an effective antidepressant (Sarris et al., 2014) and clinically significant augmentation effects occur with antidepressants (Papakostas et al., 2010). NAC has evidence of efficacy in bipolar depression, schizophrenia, trichotillomania, and other compulsive and addictive behaviours (Berk et al., 2013). This aminoacid-based compound has glutamate modulatory effects, and anti-inflammatory, antioxidant, and neuroprotective activity (Berk et al., 2013). Zinc is an abundant trace element that is involved in cytokine modulation and hippocampal neurogenesis via upregulation of BDNF, and also modifies N-methyl-D-aspartate and glutamate activity (Lai et al., 2012). Zinc deficiency has been linked to increased depressive symptoms, and evidence is emerging that zinc supplementation improves depressed mood, mainly as an adjunctive intervention with antidepressants (Lai et al., 2012). B vitamins are needed for proper neuronal function, and a deficiency of B9 (folate) has been reported in depressed populations, and in poor responders to antidepressants (Fava and Mischoulon, 2009). Several studies have assessed the antidepressant effect of folic acid with concomitant antidepressant use, and results of most either showed an increase in the proportion of participants who had an antidepressant response, or improved the onset of response. Vitamin D is a neurosteroid, with data suggesting that low maternal concentrations are implicated in schizophrenia risk, and deficiency is likewise linked to increased depressive symptoms (Eyles, Burne, and McGrath, 2013). A combination of nutrients that match the natural physiological needs of the body, and also better represent the broad range of nutrients present in food, might prove even more effective than isolated nutrients alone (Rucklidge, Johnstone and Kaplan, 2013).

3 FUTURE DIRECTIONS

During the past several years, high-quality research into nutrition and mental health—a specialty that has been neglected—has grown rapidly and is finally starting to develop its potential. In view of the changes related to rapidly growing urbanicity and the globalisation of the food industry, resulting in profound shifts away from traditional dietary patterns, the ways in which overall diet and specific nutritional elements, multinutrient interventions, or both can affect mental health clearly need to be identified. In view of the widespread use of nutrient supplements by individuals with and without mental disorders, scientifically rigorous methods should be used to assess the efficacy of these supplements and to identify what dose of a nutrient supplement is needed, by whom, when, and under what circumstances. From this resultant research, the evidence needs to be communicated to clinicians via educational programmes, and to the wider public via public health campaigns. Formal medical education should include training that focuses on the role of diet and nutrients in brain function and mental health.

Recommendations for governments to take more substantive actions to improve food quality and promote healthier dietary practices should be considered to address the substantial burden of disease that results from unhealthy diets. Importantly, the activities of the food industry need to be examined at a governmental level, and relevant policies need to be designed to reduce the worldwide burden of physical and mental ill-health attributable to poor diet (Jacka et al., 2014).

Such policies are advised to stimulate substantial public change in dietary habits back towards a traditional whole-food diet (dependent on the culture). Further, better education of the public and clinicians about the role of nutrients in the brain, and the link to mental health, is crucially needed.

4 CONCLUSION

Present treatment of psychiatric disorders can be improved and greater attention can be given to preventive efforts. As a result of the immense burden of mental disorders, modifiable targets to reduce the incidence of mental disorders are now urgently needed. Diet and nutrition offer key modifiable targets for the prevention of mental disorders, having a fundamental role in the promotion of mental health. Now is time for the recognition of the importance of nutrition and nutrient supplementation in psychiatry. Nutritional medicine should now be considered as a mainstream element of psychiatric practice, with research, education, policy, and health promotion supporting this new framework.

REFERENCES

- Baxter, A. J., Patton, G., Scott, K. M., Degenhardt, L., and Whiteford, H. A. (2013). Global epidemiology of mental disorders: what are we missing? *PLoS One* 8, e65514.
- Whiteford, H. A., Degenhardt, L., Rehm, J., et al. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *Lancet* 382, 1575–86.
- Logan, A. C., and Jacka, F. N. (2014). Nutritional psychiatry research: an emerging discipline and its intersection with global urbanization, environmental challenges and the evolutionary mismatch. *J Physiol Anthropol* 33, 22.
- Jacka, F. N., Sacks, G., Berk, M., and Allender, S. (2014). Food policies for physical and mental health. *BMC Psychiatry* 14, 132.
- Parker, E., Goldman, J., and Moshfegh, A. (2014). America's nutrition report card: comparing WWEIA, NHANES 2007–2010 usual nutrient intakes to dietary reference intakes. *FASEB J* 28 (suppl): 384.2.
- Bowman, S., Friday, J., Thoirig, R., Clemens, J., and Moshfegh, A. (2014). Americans consume less added sugars and solid fats and consume more whole grains and oils: changes from 2003–04 to 2009–10. *FASEB J* 28 (suppl): 369.2.
- WHO. Global action plan for the prevention and control of noncommunicable diseases 2013–2020. Geneva: World Health Organisation, 2013.

- Berk, M., Williams, L. J., Jacka, F. N., et al. (2013). So depression is an inflammatory disease, but where does the inflammation come from? *BMC Med* 11, 200.
- Molendijk, M. L., Bus, B. A., Spinhoven, P., et al. (2011). Serum levels of brain-derived neurotrophic factor in major depressive disorder: state-trait issues, clinical features and pharmacological treatment. *Mol Psychiatry* 16, 1088–95.
- Sarris, J., Logan, A., Akbaraly, T., et al. International Society for Nutritional Psychiatry Research consensus position statement: nutritional medicine in modern psychiatry. *World Psychiatry* (in press).
- Lai, J. S., Hiles, S., Bisquera, A., Hure, A. J., McEvoy, M., and Attia, J. A. (2014). Systematic review and meta-analysis of dietary patterns and depression in community-dwelling adults. *Am J Clin Nutr* 99, 181–97.
- Psaltopoulou, T., Sergentanis, T. N., Panagiotakos, D. B., Sergentanis, I. N., Kostis, R., and Scarmeas, N. (2013). Mediterranean diet, stroke, cognitive impairment, and depression: a meta-analysis. *Ann Neurol* 74, 580–91.
- Nanri, A., Mizoue, T., Poudel-Tandukar, K., et al., and the Japan Public Health Center-based Prospective Study Group (2013). Dietary patterns and suicide in Japanese adults: the Japan Public Health Center-based Prospective Study. *Br J Psychiatry* 203, 422–27.
- Jacka, F. N., Ystrom, E., Brantsaeter, A. L., et al. (2013). Maternal and early postnatal nutrition and mental health of offspring by age 5 years: a prospective cohort study. *J Am Acad Child Adolesc Psychiatry* 52, 1038–47.
- Steenweg-de Graaff, J., Tiemeier, H., Steegers-Theunissen, R. P., et al. (2014). Maternal dietary patterns during pregnancy and child internalising and externalising problems. The Generation R Study. *Clin Nutr* 33, 115–21.
- Brown, A. S., Susser, E. S., Lin, S. P., Neugebauer, R., and Gorman, J. M. (1995). Increased risk of affective disorders in males after second trimester prenatal exposure to the Dutch hunger winter of 1944–45. *Br J Psychiatry* 166, 601–06.
- Susser, E. S., and Lin, S. P. (1992). Schizophrenia after prenatal exposure to the Dutch Hunger Winter of 1944–1945. *Arch Gen Psychiatry* 49, 983–88.
- O’Neil, A., Quirk, S. E., Housden, S., et al. (2014). Relationship between diet and mental health in children and adolescents: a systematic review. *Am J Public Health* 104, e31–42.
- Sánchez-Villegas, A., Martínez-González, M. A., Estruch, R., et al. (2013). Mediterranean dietary pattern and depression: the PREDIMED randomized trial. *BMC Med* 11, 208.
- Stahl, S. T., Albert, S. M., Dew, M. A., Lockovich, M. H., and Reynolds, C. F. 3rd. (2014). Coaching in healthy dietary practices in at-risk older adults: a case of indicated depression prevention. *Am J Psychiatry* 171, 499–505.
- O’Neil, A., Berk, M., Itsiopoulos, C., et al. (2013). A randomised, controlled trial of a dietary intervention for adults with major depression (the “SMILES” trial): study protocol. *BMC Psychiatry* 13, 114.
- Rucklidge, J. J., and Kaplan, B. J. (2013). Broad-spectrum micronutrient formulas for the treatment of psychiatric symptoms: a systematic review. *Expert Rev Neurother* 13, 49–73.
- Mischoulon, D., and Freeman, M. P. (2013). Omega-3 fatty acids in psychiatry. *Psychiatr Clin North Am* 36, 15–23.
- Sarris, J., Mischoulon, D., and Schweitzer, I. (2012). Omega-3 for bipolar disorder: meta-analyses of use in mania and bipolar depression. *J Clin Psychiatry* 73, 81–86.
- Sarris, J., Papakostas, G. I., Vitolo, O., Fava, M., and Mischoulon, D. (2014). S-adenosylmethionine (S-AdoMet) versus escitalopram and placebo in major depression RCT: efficacy and effects of histamine and carnitine as moderators of response. *J Affect Disord* 164, 76–81.
- Papakostas, G. I., Mischoulon, D., Shyu, I., Alpert, J. E., and Fava, M. (2010). S-adenosylmethionine (S-AdoMet) augmentation of serotonin reuptake inhibitors for antidepressant nonresponders with major depressive disorder: a double-blind, randomized clinical trial. *Am J Psychiatry* 167, 942–48.
- Berk, M., Malhi, G. S., Gray, L. J., and Dean, O. M. (2013). The promise of N-acetylcysteine in neuropsychiatry. *Trends Pharmacol Sci* 34, 167–77.
- Lai, J., Moxey, A., Nowak, G., Vashum, K., Bailey, K., and McEvoy, M. (2012). The efficacy of zinc supplementation in depression: systematic review of randomised controlled trials. *J Affect Disord* 136, e31–39.
- Fava, M., and Mischoulon, D. (2009). Folate in depression: efficacy, safety, differences in formulations, and clinical issues. *J Clin Psychiatry* 70 (suppl 5), 12–17.
- Eyles, D. W., Burne, T. H., and McGrath, J. J. (2013). Vitamin D, effects on brain development, adult brain function and the links between low levels of vitamin D and neuropsychiatric disease. *Front Neuroendocrinol* 34, 47–64.
- Rucklidge, J. J., Johnstone, J., and Kaplan, B. J. (2013). Magic bullet thinking—why do we continue to perpetuate this fallacy? [letter]. *Br J Psychiatry* 203, 154–55.
- Pauling, L., (1968). Orthomolecular psychiatry. Varying the concentrations of substances normally present in the human body may control mental disease. *Science*, 160(3825), 265–71.

Nivoi opštenja od biomolekula do noosfere – novi uvidi

Lela Šurlan

Klinički Centar Srbije, Beograd, Srbija

ABSTRACT

The new century has brought significant new insights into the fields of natural and information sciences, daring the spiritual/philosophical sciences to step-up from behind the scene, announcing „new“ but, in fact, somewhat ancient concepts. The latest generation measuring devices as well as computer systems of a massive capacity and speed of data processing have made it possible to detect, measure and display in a cognitive-friendly manner a range of unexplained physical phenomena and subtle energies - precisely those, until recently, unmeasurable phenomena, but defined in the textbooks of spiritual and theosophy disciplines.

Accordingly, communication systems and „data“ exchange, starting from the level of supramolecules, then intercellular communication, information flux within the individual, within the community, communication at the living species level, to higher levels of orderliness - biosphere and, why not - the noosphere, become the subject of expanding and fundamental renewal of theoretical concepts. Distant to a degree and highly specialized scientific disciplines became more interlinked and complemented. By giving a partial synthetic insight into the boundaries of modern natural sciences and informatics, it is aimed to briefly comment on the physical nature and levels of information exchange within the increasingly overlapping scope of study of contemporary:

- Physics (physics of Ether, quantum mechanics and quantum biology, physics of time within biosystems,...)
- Biology (biophotonics, wave genomics, bioenergetics ...)
- Informatics (quantum computers, bioinformatics, morphogenetic fields, artificial intelligence, ...)

From the very names of its sub-disciplines it can be concluded that the age of mechanistic materialism and the neverending dissection of science on super-narrowed disciplines has ended!

Based on new breakthroughs in natural and IT sub-disciplines mentioned above, psychology and sociobiology became armed with new methodological tools too, coming closer to the Holy Grail or the „subject of study“ of these sister sciences, namely: human soul and „soul of the species / soul of the world“.

Consequently – Homo and his place on the spiritual scale of the Universe became a permissible topic again. Somewhat ironic: precised quantum mechanics instruments and soulless IT software - unintentionally, but definitely not "accidentally" – bring back ontology and spirituality to the world of exact science.

1 UVOD

Poslednjih decenija prirodne i informatičke nauke su u značajnom zamahu u pogledu eksperimentalnih, ali i teorijskih postavki. Nova saznanja vode preklapanju predmeta istraživanja između nekad strogo razdijeljenih nauka, uz već podrazumevanu višedisciplinarnost pristupa, omogućavajući konačno čvrst metodološki okvir za dijalog sa filozofski utemeljenim naukama. Ceo kompleks filozofskih, religijskih i društvenih nauka, zahvaljujući materijalističkoj paradigmi industrijskog doba, tokom 19. i 20. veka postaje skrajnut iz sistema visokobudžetske podrške i prestižnog sci-indeksiranog sistema objavljivanja. Informatičkom revolucijom i dolaskom „internet doba“ način i brzina obrade podataka su u potpunosti promenjeni, stvorivši prostor za otvoreno, necenzurisano iznošenje novih teorijskih i tehničkih postavki. Istraživačima 21. veka predat je neprocenljiv dar – uslovna nezavisnost od represivnih sistema (bilo institucionalnih, državnih ili korporativnih) uz mogućnost javnog prikupljanja sredstava za istraživački rad, trenutne i otvorene razmene mišljenja sa najširoom naučnom zajednicom, a time i višestruke provere valjanosti samih rezultata rada. Posledično, novi dijalog materijalnog i duhovnog na videlo iznosi osvežene i eksperimentalno potvrdive mnoge davnashnje postavke. Tehnologija novog veka – precizni merni uređaji

najnovije generacije i računarski sistemi ogromnog obuhvata i brzine obrade podataka donose čvrstu i kognitivno prijemčivu platformu za opažanje, merenje i prikaz niza do jučer nerasvetljenih fizikalnih pojava i izuzetno suptilnih energija.

Pod lupom savremene nauke su doskora nemerljivi fenomeni, ali jasno imenovani u pojmovnicima duhovnih i teozofskih disciplina. Jedan od najboljih primera koji oslikava ovu vrstu pomaka u svetu učenjaka je odnos prema „etru“, praktično zabranjenom pojmu u zvaničnoj fizici, koja se datim fenomenom imala baviti. Eksperimentom Mičelisona i Morlija, 1887.godine [1] 300-godišnja rasprava o etru okončana je njegovim progonom iz pojmovnika prirodnih nauka i potonjim utemeljenjem specijalne teorije relativiteta kao okvira fizike 20.veka. Skoro 100 godina kasnije, pod okriljem US AirForce-a, dati ogled je ponovljen [2,3], sa jednakom postavkom, ali novim mernim instrumentarijem. Pojava interferencije ukrštenih svetlosnih snopova koja je etar valjala „dokazati“ je 1986. zabeležena! Etar se danas naziva mnogim imenima: „poljem nulte tačke“, „kvantnim poljem“, „izvorom“, „poljem Akaše“, „božanskim matriksom“, gde šarolikost leksike sjajno ilustruje važnost povezivanja i međuopštenja savremenih nauka. Stvarnost se stoga tumači višeslojno, „svet tvarnog“ je već polovinom 20.veka zamenjen „svetom energija“ da bi danas „informacija“ postala ključem tumačenja sveta, postepeno u žižu vraćajući izučavanje fenomena svesti i duha, ovoga puta omeđenih naučnom metodologijom.

Uronjeni u etar, samim time suštinski povezani - sistemi opštenja i razmene informacija (počev od nivoa supramolekula, međucelijske komunikacije, protoka informacija unutar jedinice, potom unutar zajednice, na nivou žive vrste, sve do viših nivoa uređenosti: biosfere te polja delovanja svesti – noosfere [4], danas postaju predmetom obimnih istraživanja i temeljnog obnavljanja teorijskih okvira. Za ovakav pristup neophodna je saradnja više disciplina i dešava se vidno preklapanje predmeta posmatranja današnje fizike, biologije, biomedicine i informatike. Neposrednu korist od ovih istraživanja imaju i stručnjaci iz psihologije, sociobiologije i duhovnih nauka, bivajući opremljeni novim metodološkim alatima pri proučavanju fenomena psihe i svesti, društva i duhovnosti, pitanja postanka i opstanka sveta.

Svaki pohvalno obojen osvrt na današnje domete naučne misli valjalo bi potkrepiti temeljnim i sistematizovanim pregledom učinka gorepomenutih oblasti, jer su one i dalje pritisnute dogmatskim svetonazorima, eksperimentalno nedokazanim „zvaničnim teorijama“ i delatnim cenzorskim i autocenzorskim sistemima. Teškoće s kojima se suočavaju današnji naučni pregaoci sjajno je izložio Šeldrejk u svojim kritičkim radovima [5,6], dok ovaj delimični pregled ima jedino skromnu nameru da ukaže kako i u datom ozračju ima razloga za optimizam.

U rasponu od biomolekula do polja svesti – naučnici su spremni da postave sofisticirane uređaje, uposle računarske procesore i pokušaju rastumačiti ogromne količine zabeleženih i uvezanih podataka. Tako je polje kolektivne svesti iz Jungovih knjiga preseljeno u laboratorije, gde je Field REG® i sličnim uređajima uticaj svesti bilo moguće „izmeriti“, omogućivši da radovi Radina i Nelsona [7,8] daju zamah sličnim istraživanjima u naučnim ustanovama širom sveta (ISRICA eksperiment Instituta V.P. Kaznjačeva [9] i mnogi drugi: videti u pregledu Dina Radina „Svesni Svemir“ [10]). Bioenergetska polja se danas mere raznovrsnim uređajima zasnovanim na pionirskom radu Semjona Kirliana iz 1939.[11] i genijalnog Gurviča iz 1944.[12] poput : PIP/NEV kamere Harija Oldfilda [13], GDV kamere i Bio-Well terapijskih uređaja K.Korotkova [14]. Supramolekulski nosilac genoma na materijalnoj ravni - molekul DNK se danas izučava kao talasni, svetlosni i lingvistički fenomen zahvaljujući pionirskom radu Gurviča s početka 20.veka i današnjem prodoru Garjajeva (tvorca „talasne genetike“, [15]). Uređaji koji se danas koriste za proučavanje DNK su od naprednih spektrofotometara usavršeni do nivoa na kome nalaze biomedicinsko-terapijsku primenu (generatori matrica, WaveR® i dr.). Ne samo da je složeni molekulski sistem poput DNK otkrio svoju „informacionu“ prirodu već se pokazao izvorom stalnog UV fotonskog zračenja (eksperimentalni rad Frica Popa, s početka 70-tih, [16]), tj. hromozomi su pokazani nosiocima koherentnih stojećih talasa, po Garjajevu. I manji biološki molekuli su danas sagledani u novom svetlu. Azot monoksid, minijturni signalni molekul koji se nalazi na raskrsnici brojnih metaboličkih puteva koji određuju sudbinu ćelije, biva sve značajniji kod izučavanja sprege ćelijskih struktura i mahanizama memorije [17], a budući da se NO među ćelijama kreće neometano poput „talasa“ gasa, očekuje se da će nova istraživanja doneti još iznenađenja na polju istraživanja fenomena prizivanja sećanja i same mehanike ovih procesa na nivou neuralnih mreža.

Problem održivosti klasičnih modela stvaranja dugotrajnog pamćenja (tumačenih „sporim“ biohemijskim proteinskim sintezama i stvaranjem međucelijskih sinapsi) u svetlu opažanja fenomena skladištenja ogromne količine podataka i trenutnog pristupa podacima u vidu složenih slika i bljesaka sećanja (koji se ne mogu objasniti „sporim“ sintezama unutar neurona) premošćen je radom Pribrama i saradnika [18], koji je uspešni nastavljajući pionirskih eksperimentalnih postavki Lešlija, iz 30-tih godina 20.veka [19]. Molekul DMT – tzv. „molekul duše“ je još jedan objekat izučavanja koji se iz domena biohemije i fiziologije preselio na polja izučavanja svesti, postavši 2000.godine junak Štrasmanove knjige [20] i zvezda Šulcovog naučno-popularnog filma 2010.godine [21]. Pitanjima fizičko-energetske prirode svesti danas se bave kvantni fizičari (Hagelinova „univerzalna teorija kosmičkih struna“ [22]), elektrotehničari (pretpostavljeni objekat k10 – tzv. „teslion“ kao čestica svesti u koordinatnom sistemu hijerarhijski uređenih stvarnih fizičkih objekata različite „gustine energije“, po modelu univerzuma KGE, [23]), psiholozi (tim Elizabete Targ, [24]), ali i timovi naučnika pod okriljem vladinih institucija u cilju poboljšanja sistema državne bezbednosti (Puthof – Targov eksperiment „viđenja na daljinu“ sa Stanford Univerziteta[25]).

Kao izuzetno značajan konceptualni pomak valja pomenuti rad Žaka Benvenista [26], koji je samom naučniku doneo mnogo problema u stručnoj javnosti, ali je danas temeljem ne samo homeopatskog lečenja [27], već i nosiocem priznanja prednosti „vibracionog“ i „talasnog“ nad „molekulskim“ prenosom biološkog signala. Zahvaljujući njemu danas znamo da svi molekuli poseduju svoj jedinstveni vibracioni otisak koji je aktivni nosilac komunikacije unutar živih sistema, te je na primeru delovanja prilazećeg liganda ka membranskim receptorima daljinski uticaj primaran dok je hemijska reakcija sekundarna i u službi produženog delovanja na primopredajnom kaskadnom signalnom putu. Vibracioni otisak bioaktivnih molekula je moguće digitalizovati (digitalni antigen) i naknadno emitovati kroz medijum gde se opaža biološki učinak jednak molekulskom vezivanju[28].

Ne samo da se rad enzima danas delom objašnjava pojmovima iz kvantne fizike – postojanjem „kosmičkih crvotočina“ unutar proteinske konformacije već se dati kvantni tunel-efekti pominju kao odgovorni za tačkaste mutacije DNK [29]. Osobina „superprovodljivosti“ koju neživa materija ima na temperaturama blizu apsolutne nule se opaža eksperimentalno unutar, za klasičnu fiziku potpuno suprotnog sistema - tople i haotično uskomešane citoplazme [30, 31]!

Osobine vode u živim organizmima su neočekivane: voda u vidu superprovodljivih tečnih kristala duž vlakana kolagena služi kao transportni „brzi“ međucelijski portal akupunkturnog sistema [32]; voda putem brzih lokalnih promena hidrofobnog pritiska skuplja i opušta super-navoje DNK, time otvarajući i zatvarajući mikrodomene DNK za čitanje genomske informacije [33]; voda koja „pamti“ – čuvajući otiske molekula koje je rastvarala dugo nakon potpunog uklanjanja istih (DNK – fantom efekat Poponina i Garjajeva [34]). Ovo su samo neki od fenomena koji danas povezuju fizikalna polja, živa bića i svet informacije. Njima pripadajuće nauke danas barataju istim pojmovima, sa zajedničkim pridevom „kvantni“: kvantna polja, kvantni računari, kvantna spregnutost...

Stiče se utisak da su sva pobrojana otkrića i pomaci s uspehom objasnili većinu nepoznanica iz domena noosfere, dok je zapravo njima samo otvoreno mnogo novih – starih pitanja. U fizici su to pitanja prirode i definicije vremena, problem prirode mase i komplikovanosti sistema elementarnih čestica, nedostatka sveobuhvatnog fizičkog zakona prirode... U biologiji su to pitanja kontrole ukupnih bioprocesa unutar živog sistema, pitanja skladištenja i pristupa memoriji, osobenosti biološkog vremena na nivou jedinke, problem kontrole razvojnih programa i veze sa nasledno-genetskom mašinerijom itd. I pred informatičkim naukama su brojni izazovi (razvoj IT platformi koje kopiraju rad ljudskog mozga, granice daljeg ubrzanog usavršavanja AI sistema i računarskih mreža, po nesagledivoj ceni narušavanja prava ljudi na privatnost...).

Ako se pokuša izvući jedan povezujući činilac od ključnog značaja za dalju primenu pomenutih naprednih tehnologija, a u službi razumevanja prirode, živog sveta i informacije kao monete između svih pomenutih sistema opštenja – može li to biti fizički nosilac date monete sam po sebi? Gde je i šta je konačni „nosilac podataka“ pogodan za sve nivoe razmene informacija od mikro- do makrosвета, takav da pokriva fenomene koje odlikuje: nelokalnost, trenutni prenos i „ne-vremenost“? Ako se opisuje pojmovima informatike preduslovi za savršenog kandidata su: neograničeni kapacitet, trajnost i pouzdanost skladištenja, mogućnost trenutnog i preciznog pristupa informacijama odnosno ultra-brza prenosivost

podataka. Bez ovakve informacione „ulaz-izlaz-procesor-memorijska“ platforme, samoodrživost negativno-entropijskih sistema (jedna od materijalističkih definicija živog bića) i njihova ponovljivost u linearnom vremenu - dakle i sam Život kao pojava - nisu mogući. Isto načelo se može primeniti i na složenije komunikacione sisteme: od nivoa vrste, društva, biosfere, zvezdano-planetarnih sistema i ostalih nivoa organizacije pojavnog Svemira.

Još uvek smo daleko od saglasja po ovom pitanju, ali neka od postojećih otkrića i radova ukazuju na „dovoljno dobrog“ kandidata – stari dobri etar sa početka ovog pregleda. Pribramova teorija po kojoj je pamćenje uskladišteno van anatomsko-organskih struktura, u vidu „talasnih interferencijskih memorijskih obrazaca“, za koje mozak služi kao visoko i precizno podešeni lični prijemnik-odašiljač [35] je upravo putokaz koji je istraživače odveo korak dalje, već je prva provera - rad bračno-naučnog para de Valoa potvrdio Pribramove premise [36]. Vakuum, (budući po prvobitnim proračunima beskonačno gust medijum svega pojavnog, nanovo je preračunavan i re-normalizovan na gustinu od 10^{93} g/cm³) danas je u samoj žiži interesovanja fizičara koji su u potrazi za „jedinstvenom teorijom“. Onoj koja bi objasnila i obuhvatila i prirodu svesti i Života, pomirila Njutnove svetove makro-objekata i Šredingerove kvantne mikro-svetove. Rad Nasima Haramejna vakuum postavlja kao sveprožimajući kvantifikovano-strukturirani univerzalni medijum sa neograničenim kapacitetom skladištenja informacija u diskretnim jedinicama, tj. neku vrstu „kvantne sapunice“ sa diskretnim okcima veličine Plankove konstante koja čuvaju informacije trajno i pouzdano [37]. Podsticajni pregledi dosadašnjih izučavanja na polju fizike univerzuma (Talbotov „Holografski svemir“, [38]) i univerzalnog polja („Polje“, Mektagartove [38]) omogućili su i stručnoj i širokoj javnosti da sagleda trenutna granična polja i goruća pitanja savremenih nauka.

2 ZAKLJUČAK

Na temelju skorašnjih otkrića prirodoslovnih, informatičkih, sociobioloških, psiholoških i duhovnih podoblasti ne bivamo li korak bliže Svetom Gralu ljudskog traganja za ukupnim smislom i odgonetanju duhovnih nivoa stvarnosti? Nisu li danas visoke tehnologije i njihovi precizni bešćutni alati i softveri nehotice, ali nikako „slučajno“ - vratili ontologiju i duhovnost u egzaktne nauke? Posledično - ljudska duša, duša roda i/ili duh sveta, Čovek kao entitet i njegovo mesto na duhovnoj lestevici Svemira ponovo jesu dopuštene teme, ali i veliki izazov akademskoj nauci.

REFERENCE:

- Michelson A.A., Morley E.W., On the Relative Motion of the Earth and the Luminiferous Ether. *American Journal of Science*, 1887; 34 (203): 333–345
- Aspden H., How to Test Special relativity. *Nature*, 1986; 321 (734)
- Psimopoulos M., Theocharis T., How to Test Special relativity. *Nature*, 1986; 319 (269)
- Вернадский В.И., Биосфера и Ноосфера. Айрис Пресс, Москва 2008. Београд 2012. ISBN 978-86-519-1331-3(СГ)
- Sheldrake R., Science set free: 10 paths to new discovery. Deepak Chopra, 2013. ISBN-13: 978 - 07704367282013
- Sheldrake R., Shermer M., Arguing Science: A Dialogue on the Future of Science and Spirit. Monkfish Book Publishing, 2016. ISBN-13: 978 -1939681577
- Nelson R.D., Radin D.I., Evidence for consciousness-related anomalies. *Foundations of Physics*, 1989; 19 (1499–1514)
- Nelson R.D., Radin D.I., When immovable objections meet irresistible evidence. *Behavioral and Brain Sciences*, 1987; 10(600-1)
- ISRICA experiment info: <http://rexresearch.com/kaznachv/kaznachv.htm>

- Radin D.I., The Conscious Universe: The Scientific Truth of Psychic Phenomena. HarperOne, 2009; ISBN-13: 978-006177899
- Kirlian S.D., Method for Receiving Photographic Pictures of Different Types of Objects, Patent, N106401 USSR. 1949
- Gurvich A.G., The Theory of Biological Field, Soviet Science, 1944
- NEV: New Energy Vision Camera by Harry Oldfield, Oldfield Systems Ltd.; http://www.electrocrystal.com/nev_android.html i PIP: Polycontrast Interference Photography imaging system, by Harry Oldfield: <http://www.electrocrystal.com/pip.html>
- Korotkov Konstantin, GDV sistem: <https://gdvcamera.com/electrophotonics-scientific-basis/>
- Gariaev P., Wave Genetics official site: <http://eng.wavegenetic.ru/>
- Popp F.A., Einige Moglichkeiten fur Biosignale zur Steuerung des Zellwachstums. Archiv fiir eschwulstforschung, 1974; 44 (295-306)
- Paul V, Ekambaram P., Involvement of nitric oxide in learning & memory processes. Indian J Med Res, 2011 133(5): 471–478.
- Pribram K., Languages of the brain; Experimental paradoxes and principles in neuropsychology (Prentice-Hall series in experimental psychology). Prentice Hall 1st ed. NY 1971; ISBN-13: 978-0135227305
- Lashley K.S., Brain Mechanisms and Intelligence: Brain Mechanisms and Intelligence. University of Chicago press, 1930; ASIN: B000IG0HX6
- Strassman R., DMT: The Spirit Molecule: A Doctor's Revolutionary Research into the Biology of Near-Death and Mystical Experiences. Park Street Press, 2001; ISBN-13: 978-0892819270
- Mitch Shultz Movie, DMT - The Spirit Molecule: <https://www.imdb.com/title/tt1340425/>
- Hagelinn J.S., Is Consciousness the Unified Field? A Field Theorist's Perspective. *Modern Science and Vedic Science*, 1987; 1 (29–87).
- Marjanović G., Model KGE, <http://users.beotel.net/~gmarjanovic/skrverpr.pdf>
- Sicher F., Targ E et.al., A randomized double-blind study of the effect of distant healing in a population with advances AIDS: report of a small scale study. *West J of Med*, 1999; 168(6): 356-63
- Puthoff H., Targ R., A perceptual channel for information transfer over kilometer distances: historical perspective and recent research», Proceedings of the IEEE, 1976; 64(3): 329-54.
- Benveniste J, Arnoux B., Hadji L.; Highly diluted antigen increases coronary flow of isolated heart from immunized guinea-pigs, *FASEB Journal*, 1992; 6: A1610
- Schiff M., The Memory of Water: *Homeopathy and the Battle of New Ideas in the New Science*. HarperCollins, 1994: 22
- Benveniste J. et al., Digital Recording/Transmission of the Cholinergic Signal. *FASEB Journal*, 1996,10: A1479
- Trixler F., Quantum Tunneling to the Origin and Evolution of Life. *Curr Org Chem*, 2013; 17(16):1758–1770.
- Al-Khalili J., McFadden J., The origins of quantum biology, *Proc Math Phys Eng Sci*. 2018; 474(2220)
- Al-Khalili J, McFadden J., 2014, Life on the edge: the coming of age of quantum biology. London, UK: Bantam Press.
- Mae-Wan Ho, Super-Conducting Liquid Crystalline Water Aligned with Collagen Fibres in the Fascia as Acupuncture Meridians of Traditional Chinese Medicine. Forum on immunopathological diseases and therapeutics, 2012; 3. 221-236
- Feng B.et al, Hydrophobic catalysis and potential biological role of DNA unstacking induced by environment effects, *PNAS*, 2019; 116 (35): 17169-17174
- Poponin V., Gariaev P.P., https://www.bibliotecapleyades.net/ciencia/ciencia_genetica04.htm (ref.6. Vacuum DNA phantom effect in vitro and its possible rational explanation. *Nanobiology*, 1995)
- Pribram K., Rethinking neuronal networks: Quantum Fields and Biological data, 1st ACBN. Psychology Press, 1993; ISBN-13: 978-0805814668

de Valoa R.& K., Spatial Vision, 1st ed, Oxford UP 1988; ISBN-13: 978-0195050196

Haramain N, Brown W.D., Val Baker A. The Unified Spacememory Network: from Cosmogenesis to Consciousness, Neuroquantology 2016; *Vol.14 (4)*

Talbott M., Holographic Universe, The Revolutionary Theory of Reality. Harper Perennial 2011; ISBN-13: 978-0062014108

Mc Taggart L., The Field: The Quest for the Secret Force of the Universe. Harper Perennial 2008; ISBN-13: 978-0061435188.

Adaptive Endfire Microphone Array for Ambient Noise Suppression in Speech Therapy Treatment by KSAFA-D Device

Zoran Šarić, Miško Subotić, Ružica Bilibajkić

Life Activities Advancement Center

Gospodar Jovanova 35, 11000 Belgrade, Serbia

sariczoran@yahoo.com, m.subotic@add-for-life.com, r.bilibajkic@add-for-life.com

ABSTRACT

Ambient noise is a problem in speech communication. The problem is even more serious when the noisy speech has to be processed by spectral modification methods usually used in speech therapy practice. One of the most efficient speech therapy methods in Serbian language area, based on "Kostich's selective auditory filtering amplifier" (KSAFA), has the similar problem with ambient noise. In this case, noise reduction can be efficiently conducted by the microphone array using minimum variance distortionless response (MVDR) beamformer. Unfortunately, performance of the MVDR beamformer is poor in real reverberant room due to multipath wave propagation and cancelation of the desired speech. In order to optimise the performance of the MVDR based microphone array for the specific scenario related to the speech therapy treatment, we applied a few advancements. Under assumption that the positions of the therapist and the patient are apriori known, and that the microphone array can be physically oriented towards the active speaker, we used endfire configuration of the array, because endfire configuration provides the maximal directivity index of the array. Noise reduction is further improved by using unidirectional microphones instead of usually used omnidirectional microphones. Calibration of the microphone array is performed during speech activity, while adaptation on the ambient noise is performed in pause of the speech. Theoretical limits of the proposed method are analysed on the model of the MVDR beamformer with multiple constraints applied to the diffuse noise model. The equivalent generalised sidelobe canceler (GSC) is proposed for real time application and its performance is analysed for particular array model. The experimental results confirmed the good performance of the array that was predicted by the theoretical analysis.

Key words: Auditory stimulation, KSAFA-D, Speech enhancement, Microphone array, MVDR beamformer, Super-directive microphone array

1 INTRODUCTION

Impaired speech development in children today is a serious problem. Many studies aim to facilitate speech therapy and increase its effectiveness. Various technical means are used in order to improve speech therapy. One of the commonly used technical devices in Serbian practice is "Kostich selective auditory filtering amplifier" (KSAFA), Figure 1.1a. The purpose of this device is to adjust its transfer characteristics in order to highlight certain phonetic elements, to adjust the auditory stimulus with auditory capacities of the child, as well as to adapt itself to the characteristics of a speech therapist's voice. The modern version of KSAFA device uses a standard PC computer as signal processing platform which provides advanced digital signal processing, Figure 1.1b. The benefits of the advanced digital KSAFA version are better speech processing, easier manipulation, distant speech therapy treatment and integration into the E-logoped system, (Šarić & Subotić, 2016).

Although these benefits considerably improve speech therapy by KSAFA-D device, the presence of ambient noise can seriously disturb speech therapy treatment. The problem of ambient noise also appears in various areas such as hands-free speech communication by voice over internet protocol (VoIP), hands-

free telephony in car, teleconferences, voice recognition, and so on. This problem is even more serious in speech therapy carried out by KSAFA device because KSAFA amplifies noise along with speech. Amplified noise degrades speech, which reduces positive effects of the speech therapy. To prevent speech degradation, noise suppression has to be applied, Figure 1.2.



Figure 1.1a. Standard (analog) KSAFA-M device.

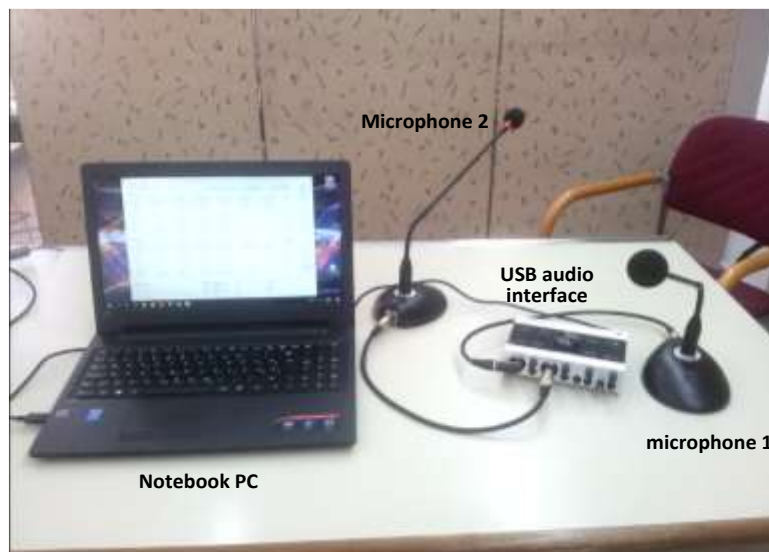


Figure 1.1b. Advanced (digital) KSAFA-D device.

In some of the speech communication areas, various single-channel methods are used for ambient noise suppression (Ephraim & Malah, 1984; Cohen, 2003; Valin, 2007). Unfortunately, these methods cannot be applied in speech therapy because they usually cause nonlinear distortion of the speech. Instead of single-channel noise reduction methods, the more suitable solution for speech therapy is using a microphone array. The advantage of the microphone array based methods is that they don't produce any

distortion of the speech signal (they are distortionless methods). The drawback of these methods is their low efficiency in noise suppression in real reverberant room. Namely, multipath acoustic wave propagation in real reverberant room prevents adaptive beamforming algorithm to efficiently suppress acoustic interference.

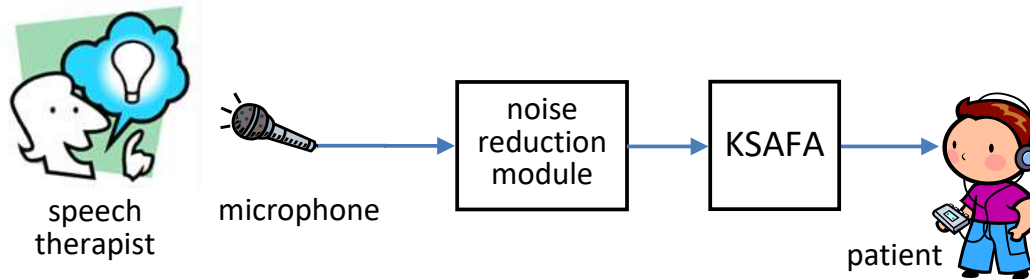


Figure 1.2. Noise suppression in speech therapy treatment by KSAFA device.

Problems related to the application of the microphone array in the reverberant room have been analysed in (Saric & Jovicic, 2004; Jovicic, Saric, & Turajlic, 2005; Papp, Saric, Jovicic, & Teslic, 2007; Saric, Simic, & Jovicic, 2011; Šarić, Subotic, Bilibajkic, & Barjaktarovic, 2019). Saric and Jovicic (2004) proved that multipath propagation, calibration error and steering error can cause cancellation of desired speech in both MVDR, (Van Trees, 2002; Frost, 1972) and GSC beamformers (Griffiths & Jim, 1982). The proposed solution of the problem is adaptation during pause of speech. Application of the maximum signal-to-noise ratio criterion in adaptive algorithm by using signal and noise covariance matrices estimated during speech and pause of speech intervals is proposed in (Jovicic et al. 2005). A robust procedure for MVDR parameters estimation based on estimates of signal and noise covariance matrix is proposed in (Papp et al., 2007). This method combined with advanced postfilter is proposed in (Saric et al., 2011). An integrated solution of ambient noise suppression for teleconferences using hands-free microphone and voice over internet (VoIP) protocol is proposed in (Papp et al., 2011). The new microphone array approach is based on the spherical microphone array - array of microphones placed on the rigid sphere. Although this approach is promising in the area of ambient noise reduction, for nowadays this approach is rather expensive because of the number of microphones that have to be engaged and the needed processing power to process up to 64-channel signals (McDonough & Kumatani, 2012).

A solution of bidirectional microphone array for teleconferences and speech therapy treatment is proposed in (Šarić et al. 2019). When it is used with KSAFA device the same microphone array can be shared by the speech therapist and patient. Receiving direction is controlled according to the activity of the speakers.

Taking into account the advantages and disadvantages of the microphone array and standard single-channel ambient noise reduction procedures, the application of a two-stage ambient noise reduction procedure is proposed in this paper. In the first stage, an advanced self-calibrated MVDR beamformer with adaptation in pause of speech is applied. In the second stage the residual noise is suppressed by standard single-channel noise reduction procedure. The level of the noise reduction is adjusted so to provide a compromise between desirable noise reduction and demand for perceptually negligible nonlinear speech distortion. The efficiency of the proposed ambient noise suppression procedure was tested on a laboratory model of microphone array. Tests in real room environment showed a good noise reduction without any perceptible speech distortion.

2 AMBIENT NOISE SUPPRESSION BY MICROPHONE ARRAY

Suppression of the ambient noise by microphone arrays is based on the fact that speech signal arrives at each microphone with fixed time delays that can be attenuated by linear filters. After time delay compensation, speech signal has the same phase at each of the microphone channels. Summing all channel signals and multiplying the output by the gain $g_M=1/M$, where M is the number of microphones, speech signal at the output of the beamformer is undistorted with unit gain. Contrary to the speech signal, additive noise in channel signals has random phase. Summing all channels and multiplying them by gain g_M , noise is attenuated. By using adaptive filters with specially estimated weights it is possible to suppress interference for any particular spatial positions of speaker and noise sources. This technique is known as adaptive beamforming, which is widely used in various fields, such as adaptive interference suppression in radio communication, in wave source localization (radio goniometry), in sonar, and so on. For M (acoustic) sensors it is possible to cancel $M-1$ interference sources. If there are some reflections of the noise waves, as it is case in real reverberant room, we can only partially suppress ambient noise. The particular case is diffuse noise field where the noise is uniformly distributed in all directions. Performance analysis of the microphone array is usually evaluated for this worst case.

The well-known beamforming method is minimum variance distortionless response (MVDR) beamformer which optimizes microphone signals' weights so to minimize noise power at the output of the beamformer with unit gain constraint for desired signal response¹. Due to the multiple reflections of acoustic waves that occur in a real reverberant room, the level of ambient noise suppression achieved by the MVDR beamformer is often insufficient. In order to increase noise reduction by the microphone array in the specific speech therapy scenario, we propose advanced and more efficient noise suppression procedure. The improvement of the noise suppression by the proposed adaptive beamforming is based on the following:

- Uniformly linear microphone array with endfire configuration is applied in accordance with the results presented in (Pan, Chen, & Benesty, 2014).
- Elements of the array are unidirectional (cardioid) microphones instead of usually used omnidirectional microphones which provide 4.8 dB better SNR, (Elko, 2004).
- Self-calibration of the microphone array is conducted during desired speaker activity, similarly as it was performed in (Hoshuyama, Sugiyama, & Hirano, 1999),
- Adaptation of the adaptive noise cancelling (ANC) module is conducted during pause of speech. This prevents unwanted desired speech cancellation caused by the leakage of the desired speech into reference signal space (Hoshuyama et al., 1999; Saric & Jovicic, 2004)

Block diagram of the improved beamformer in the form of generalised sidelobe canceler is displayed in Figure 2.1.

¹ Unit gain for the desired signal actually means response without any distortion.

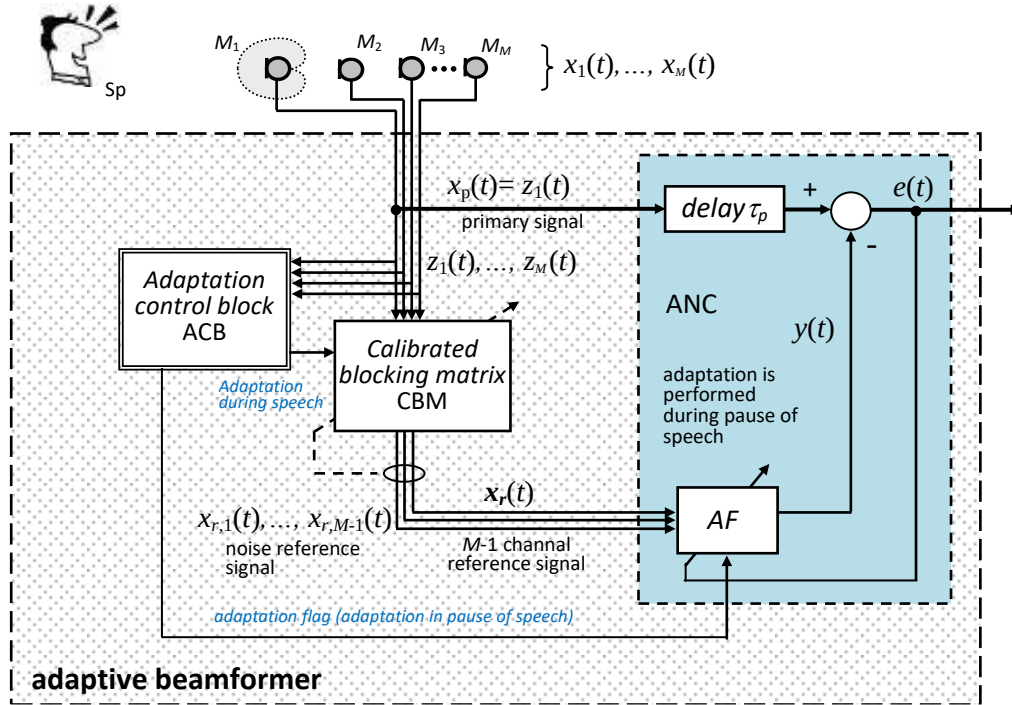


Figure 2.1. Proposed adaptive beamformer in the form of the generalized sidelobe canceller (GSC).

Residual ambient noise can be suppressed by standard single-channel noise suppression method, (Ephraim & Malah, 1984; Cohen et al. 2002; Cohen, 2003; Valin, 2007). Block diagram of the proposed processing method is shown in Figure 2.2 in which adaptive beamformer is followed by single-channel noise reduction module. Speech therapist is allowed to switch on or off second processing stage in accordance with his own assessment of the quality of the processed speech.

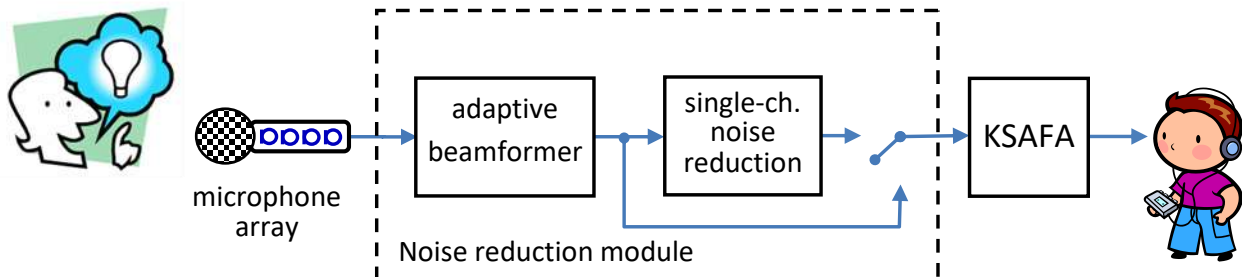


Figure 2.2 Speech pre-processing by microphone array and by one-channel noise reduction module (optionally).

3 RESULTS

The performance of the proposed noise reduction procedure is tested in real reverberant room. A laboratory model of four-microphone array with proposed digital processing procedure followed by KSAFA-D device is used to evaluate whole processing chain. Microphone array was Proel BMG2

conference microphone upgraded with three additional unidirectional electret microphones, coolvox MDN-318, mounted on the goose neck holder, Figure 3.1. Microphone capsules were equally spaced at a distance of five centimetres. Microphone capsules were oriented so to have optimal sound reception towards the speaker Sp1 which was placed in front of the microphone array in end-fire position, Figure 3.2. The sound acquisition was performed by USB audio interface *Native instruments Komplete Audio 6*, which is a standard component of speech therapy set, KSAFA-D.



Figure. 3.1 Conference microphone Proel BMG2 with additional three unidirectional electret microphones coolvox MDN-318. Distance between adjacent microphones is five centimetres.

Recordings were conducted in a real reverberant room with dimensions $8 \times 6 \times 2.8 \text{ m}$. Reverberation time T_{60} was 0.4 s . Arrangement of the objects in the room is schematically displayed in Figure 3.2. Desired speaker (speech therapist) was replaced by loudspeaker Sp1 placed at distance of 0.9 m in front of the microphone array. Sound pressure level (SPL) generated by SP1 was 65 dB at a distance of one meter. There were two ambient noise sources. The first one was air conditioner mounted at a distance of 6.2 m from the microphone array. SPL of the air conditioner was 40 dB . The second ambient noise source was a cooler (fan) of the PC placed on the working table at distance of 1.1 m from the microphone array, Figure 3.2. SPL of the PC cooler was 56 dB at position of the microphone array.

Speech signal, played on Sp1, was composed of one male and one female speaker who pronounced sentences: “Four hours of steady work faced us” and “He knew the skill of the great young actress”. Speech recordings were taken from the “Harvard Sentences” database, <http://www.cs.columbia.edu/~hgs/audio/harvard.html>. Male and female speakers were speaking alternatively two times with pause of 1 s between them.

Signal acquisition was performed by our own software written in Microsoft Visual C++. Software was run in Windows 10 OS. Signals were recorded with 48000 Hz sampling frequency. Recorded signals were decimated by 3 before processing. Digital signal processing was performed in Matlab with sampling frequency $f_c = 16000 \text{ Hz}$.

Calibration of the microphone signals were performed during speech intervals. Estimation of the beamformers parameters was performed during pause of speech in adaptive noise canceller (ANC), Figure 2.1. Pause intervals were determined by adaptation control block (ACB), Figure 2.1. Speech quality improvement provided by adaptive beamformer and post processing by single-channel noise reduction module was evaluated by two measures:

- Signal to Noise Ratio Enhancement – SNRE, (Simmer, Bitzer, & Marro, 2001),
- Perceptual evaluation of speech quality (PESQ), (Recommendation, 2001).

Signal to Noise Ratio Enhancement measure was calculated by

$$SNRE = SNR_{out} - SNR_{in} \quad (1)$$

where SNR_{in} is signal-to-noise ratio of unprocessed speech (on reference microphone 1) calculated by

$$SNR_{in} = 10 \log_{10} \frac{\frac{1}{t_2 - t_1 + 1} \sum_{t=t_1}^{t_2} s_{speech}^2(t)}{\frac{1}{t_4 - t_3 + 1} \sum_{t=t_3}^{t_4} s_{pause}^2(t)} \quad , \quad (2)$$

where (t_1, t_2) is speech interval, (t_3, t_4) is pause interval, while $s_{speech}(t)$ and $s_{pause}(t)$ are speech and pause signals at reference microphone M_1 respectively. $SNRE_{out}$ is signal-to-noise ratio of the processed speech, calculated by (2) in which $s_{speech}(t)$ and $s_{pause}(t)$ are speech and pause signals at the output of the digital processing module.

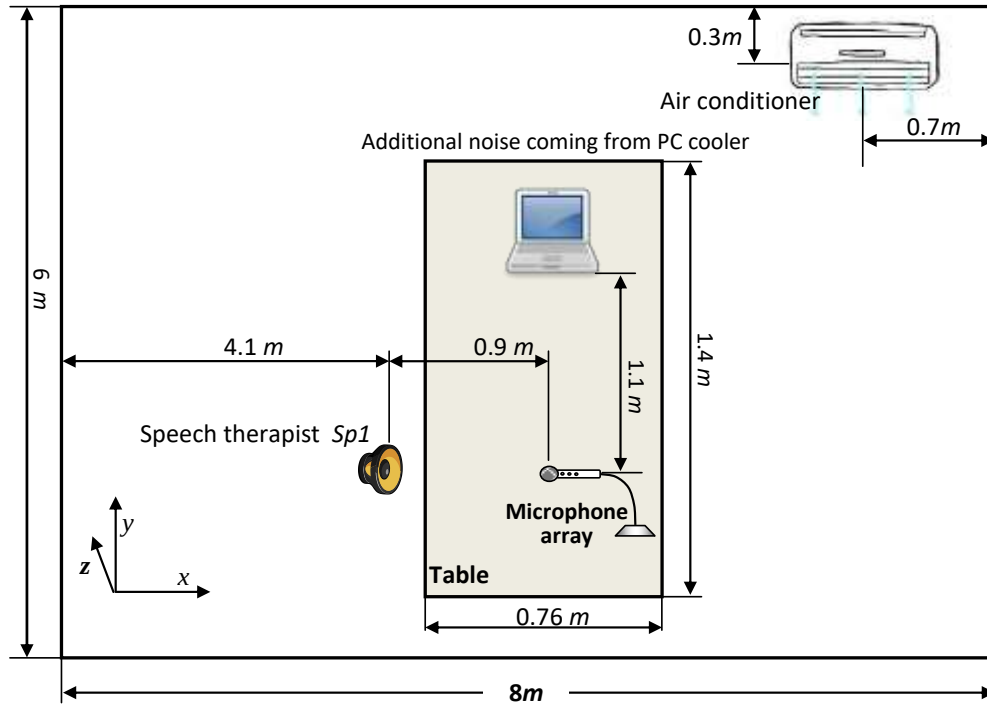


Figure 3.2. Recording scenario in real room with reverberation time $T60=400$ ms.

To evaluate the contribution of the particular processing module to SNRE improvement, SNRE measure was calculated on some typical points:

- SNRE improvement measure at output of the beamformer,
- SNRE improvement measure at output of the post-processing noise reduction module,

- SNRE improvement measure at output of the KSAFA-D module using M1 microphone signal processed by KSAFA-D transfer function as a reference.

Obtained SNRE measures at specified test points are shown in Table 1 and graphically displayed in Figure 3.3.

Table 1: SNRE measures in comparison to the SNR on the reference microphone

Test point	SNRE [dB]
output of the beamformer	17.0897 [dB]
output of the post-processing noise reduction module	27.658 [dB]
output of the KSAFA-D device	26.690 [dB]

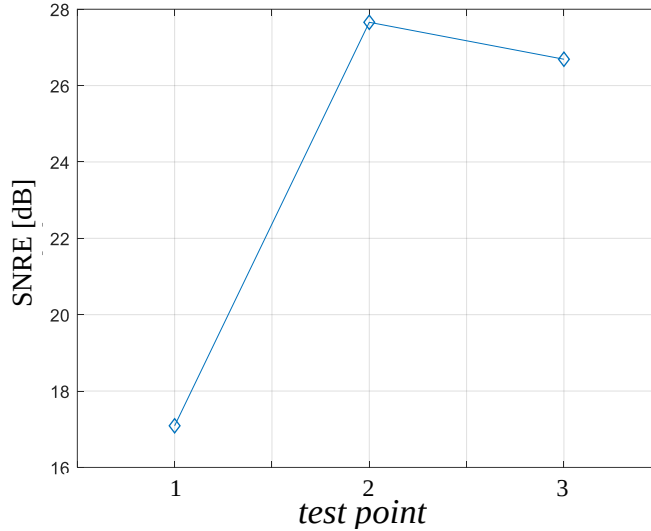


Figure 3.3: Graphical display of the calculated SNRE measures: (1) SNRE at the output of the beamformer, (2) SNRE at the output of the post-processing noise reduction module, (3) SNRE at the output of the KSAFA-D using KSAFA processed M1 signal as reference.

PESQ is a speech quality measure widely used in the assessment of speech degradation caused by various factors such as additive noise, nonlinear and spectral distortions. Although the measure is objective since it is calculated by machine, it is highly correlated with subjective perception of the speech degradation. PESQ measure has a range from 0 (for total distortion of speech) to 5 (for excellent speech signal without any distortion).

To evaluate PESQ measure we need a reference (undistorted) speech signal. In this study we used original speech signal as a reference. In addition to the ambient noise and room reverberation, total speech distortion in this particular case is increased by distortions caused by loudspeaker Sp1 and microphones and electronic noise of their amplifiers. Hence, PESQ measure in this case shows relative signal quality improvement provided by combination of used signal processing methods. PESQ measures were calculated on these test points:

- Microphone M_1 ,
- The output of the beamformer,
- The output of the post-processing noise reduction module,
- The output of the KSAFA-D module.

Calculated PESQ measures are shown in Table 2 and graphically displayed in Figure 3.4.

Table 2: PESQ measures

Test point	PESQ
Mic 1	2.274
output of MVDR beamformer	2.374
output of the postprocessor, when noise reduction is limited to 10 dB	2.434
output of KSAFA	2.370

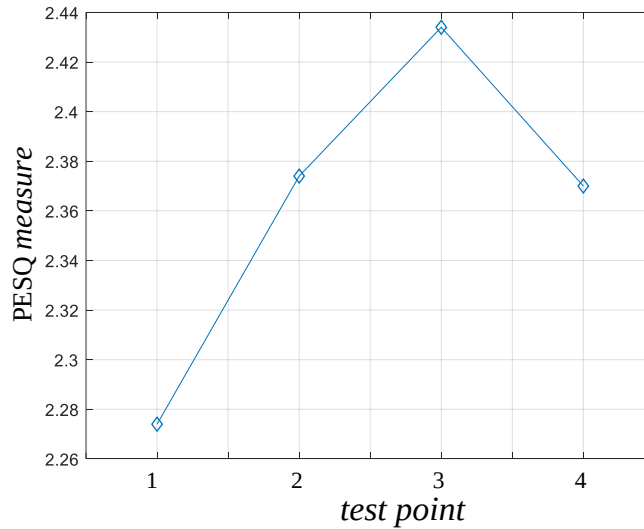


Figure 3.4: Graphical display of the PESQ measures on typical test points: (1) PESQ on microphone M_1 , (2) PESQ on output of the beamformer, (3) PESQ on output of the post-processing (noise reduction module), (4) PESQ on output of the KSAFA-D.

4 DISCUSSION

From the Table 1, we see that the adaptive beamformer, proposed in this paper, considerably improves the SNR by 17 dB. Such a major improvement of SNR is a somewhat surprising result. The reason for this such a good result is that ambient noise is composed of two types of the noises. The first is diffuse noise which originates from the multiple reflections in the room. The second is coherent noise that

originates from direct path of the PC fan and air conditioner. As the MVDR beamformer almost ideally suppresses coherent noise, suppression of the additive mixture of the coherent and the diffuse noise is more successful than the suppression of only diffuse noise.

Post-processing additionally increases SNRE by approximately 10 dB, (see the second row in Table 1). This result is in accordance with our expectations taking into account that the noise suppression in post processing module is limited to 10 dB. This limit of the noise suppression is a good compromise between residual noise suppression and quality of the speech.

The last row of the Table 1 shows that processing of the speech by KSAFA device decreases SNR, by approximately 1 dB. This always happens when KSAFA device enhances spectral components with low SNR.

The first row of the Table 2 shows that the value of PESQ measure at the output of the reference microphone M_1 is 2.27. This PESQ measure is result of the presence of the combination of the various distortions such as ambient noise, room reverberation, nonlinear distortions of loudspeaker Sp1, additive white noise of reference microphone M_1 amplifier, and nonlinear frequency transfer function from Sp1 to M_1 . MVDR beamformer increase value of PESQ measure to 2.37, (see the second row of the Table 2). Post-processing increases PESQ quality measure to 2.434, (see the third row of the Table 2). Increase of the PESQ measure by post-processing is consequence of the noise reduction in this processing module.

The last row of the Table 2 shows that processing by KSAFA device causes some degradation of the speech quality. The reason for this is SNR reduction caused by amplification of the spectral components with low SNR.

5 CONCLUSION

In this paper we considered the problem of ambient noise reduction during speech therapy treatment by KSAFA-D device. We proposed two-step solution for noise suppression. In the first step, noise reduction is performed by microphone array and improved adaptive beamforming which provides noise suppression with no speech distortion. The performance of the microphone array is improved by the following improvements. First, we applied end-fire configuration which is proven to provide better ambient noise reduction in comparison to the broadside configuration. Second, we applied unidirectional microphone capsules which provide 4.8 dB more noise reduction in comparison to the omnidirectional ones. Third, we developed and implemented automatic self-calibration of the microphone array during speech activity which eliminates unwanted self-cancellation of the desired speech. Fourth, we used adaptation control block for adaptation of the beamformer's adaptive filter parameters during pause in speech. Finally, residual noise at the output of the beamformer is suppressed by post-processing single-channel noise reduction module. Speech distortion in the last processing module is prevented by two methods. Firstly, single-channel noise reduction module is applied at the output of the beamformer where sufficiently high signal to noise ratio provides low distortion of the speech. Secondly, we limited maximal noise reduction in this module which also contributes to naturalness of the speech.

Test of the proposed noise reduction method conducted in a real room environment showed good performance when it is applied as pre-processing module for KSAFA-D speech therapy device.

Acknowledgements: This research was supported by grants 178027, TR32032 and TR32035 from the Ministry of Education, Science and Technological Development of the Republic of Serbia.

REFERENCES

Cohen, I., & Berdugo, B. (2002). Microphone array post-filtering for non-stationary noise suppression. In 2002 IEEE International Conference on Acoustics, Speech, and Signal Processing (Vol. 1, pp. I-901). IEEE.

- Cohen, I. (2003). Noise spectrum estimation in adverse environments: Improved minima controlled recursive averaging. *IEEE Transactions on speech and audio processing*, 11(5), 466-475.
- Elko, G. W. (2004). Differential microphone arrays. In *Audio signal processing for next-generation multimedia communication systems* (pp. 11-65). Springer, Boston, MA..
- Ephraim, Y., & Malah, D. (1984). Speech enhancement using a minimum-mean square error short-time spectral amplitude estimator. *IEEE Transactions on acoustics, speech, and signal processing*, 32(6), 1109-1121.
- Frost, O. L. (1972). An algorithm for linearly constrained adaptive array processing. *Proceedings of the IEEE*, 60(8), 926-935.
- Griffiths, L., & Jim, C. W. (1982). An alternative approach to linearly constrained adaptive beamforming. *IEEE Transactions on antennas and propagation*, 30(1), 27-34.
- Hoshuyama, O., Sugiyama, A., & Hirano, A. (1999). A robust adaptive beamformer for microphone arrays with a blocking matrix using constrained adaptive filters. *IEEE Transactions on signal processing*, 47(10), 2677-2684.
- Jovicic, S. T., Saric, Z. M., & Turajlic, S. R. (2005). Application of the maximum signal to interference ratio criterion to the adaptive microphone array. *Acoustics Research Letters Online*, 6(4), 232-237.
- McDonough, J., & Kumatani, K. (2012). Microphone arrays. *Techniques for Noise Robustness in Automatic Speech Recognition*, 6.
- Pan, C., Chen, J., & Benesty, J. (2014, May). On the noise reduction performance of the MVDR beamformer innoisy and reverberant environments. In *2014 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)* (pp. 815-819). IEEE.
- Papp, I. I., Saric, Z. M., Jovicic, S. T., & Teslic, N. D. (2007). Adaptive microphone array for unknown desired speaker's transfer function. *The Journal of the Acoustical Society of America*, 122(2), EL44-EL49.
- Papp, I. I., Saric, Z. M., & Teslic, N. D. (2011). Hands-free voice communication with TV. *IEEE Transactions on Consumer Electronics*, 57(2), 606-614.
- Recommendation, I. T. (2001). Perceptual evaluation of speech quality (PESQ): An objective method for end-to-end speech quality assessment of narrow-band telephone networks and speech codecs. *Rec. ITU-T P*. 862.
- Saric, Z. M., & Jovicic, S. T. (2004). Adaptive microphone array based on pause detection. *Acoustics Research Letters Online*, 5(2), 68-74.
- Saric, Z. M., Simic, D. P., & Jovicic, S. T. (2011). A new post-filter algorithm combined with two-step adaptive beamformer. *Circuits, Systems, and Signal Processing*, 30(3), 483-500.
- Šarić M. Z., & Subotić M. (2016). Multifunctional speech therapy set for treatment of patients with developmental disorder in verbal communication. In: S. T. Jovičić, Z. Šarić & M. Subotić (eds.). *Specific applications of information technology and signal processing in speech disorder diagnosis and therapy* (pp. 263-322). Belgrade: LAAC and IEPSP.
- Šarić, Z., Subotić, M., Bilibajkić, R., & Barjaktarović, M. (2019). Bidirectional microphone array with adaptation controlled by voice activity detector based on multiple beamformers. *Multimedia Tools and Applications*, 78(11), 15235-15254.
- Simmer, K. U., Bitzer, J., & Marro, C. (2001). Post-filtering techniques. In *Microphone arrays* (pp. 39-60). Springer, Berlin, Heidelberg.
- Valin, J. M. (2007). The speex codec manual version 1.2 beta 3. *Xiph.org Foundation*.
- Van Trees, H. L. (2002). *Modulation Theory, Part IV, Optimum Array Processing*. New York: Wiley.

The Peer Relations of Students with Special Educational Needs in University: The Sociological and Cultural Aspects to Importance of Speech and Language Interactions

Maria Drossinou Korea

School of Humanities and Cultural Studies, Department of Philology, University of Peloponnese
E-mail drossinou@hotmail.com, drossinou@uop.gr

ABSTRACT

Students with special educational needs (SEN) are generally less accepted by peers in Universities and have fewer friendships than those without SEN. However, little research has examined peer relations across multiple dimensions, relative to severity of need and in relation to the sociological and cultural aspects to importance of speech and language interactions from the lecture classroom experiences and individual behavioural characteristics. This study aimed to extend understanding of the peer relations of students with differing levels and categories of SEN. Also, we see the differing attainment levels of social contact between the non-formally recognised SEN and the importance of speech and language interactions to the student groups working study.

Three hundred and forty 18-32-year-old students recruited from 6 classes in 2 University, the first from the south of Greece (Peloponnese) and the second from Agricultural University (Athens). Fifty-two students had been identified as having a SEN and had been facilitated to entry in the university exercises. From them 40 had a official statement of specific learning difficulties (dyslexia). Student sociometric questionnaires provided the importance of speech and language interactions and the range of peer relations measures and the contact with peers. The speech and language interactions into six months was rated by the student's coordinators of study groups.

Compared to students without SEN, students with a statement of SEN had lower levels of peer acceptance, fewer reciprocated friendships, and were less integrated into groups study. Whilst internalising language behaviours, such as word phrases with social anxiousness and anxiety content, and externalising speech behaviours, such as aggression words and hyperactivity, were related to peer relations measures and the sociological and cultural aspects for the SEN status.

Findings point to the crucial role of meaningful social contact with the speech and language interactions in the university lecture classrooms for the students' s relationships with peers in group study.

Key words: peer relationships, dyslexia, socio-cognitive mapping, university

1 INTRODUCTION

Students with Special Needs Education (SEN) following Salamanca Declaration and the Needs Education and training Framework in Paris (UNESCO, 1994) and the rights, as they have formulated for the education of people with disabilities from the Educational, Scientific and Cultural Organization of United Nations (UNESCO, 2015) are treated equally in university education. Despite their new look at their training (Terzi, 2011) they are generally less well-tolerated than their college students and have fewer friendships than those without SEN (Schwartz; Gorman; Dodge; Pettit & Bates, 2008). So, few researches have examined relationships between them in multiple dimensions, in relation to the severity of special needs and in relation to sociological and cultural aspects. Most researches focus on primary education, where researchers such as Avramidis in the European Journal of Special Education and Training refer to the social relationships of pupils with special educational needs in the main class of the primary class and examine participation in groups of respondents who also evaluate social behaviour (Avramidis, 2010). Changing policy and legislation and its implications for inclusive education has created new perspectives

for special education in England (Norwich, 2014) where educational experiences between children and young people with disabilities are discussed (Chatzitheochari; Parsons, & Platt, 2015).

Researchers (Jones, & Fredrickson, 2010) have studied multi-informational predictors of social inclusion in pupils with autistic spectrum disorders attending the general school. Also, (Hirschfield, & Gasper, 2011) have reported on the relationship between school engagement and criminality in childhood and early puberty. Positive relationships between the conversant are linked to academic achievements in secondary education (Gallardo; Barrasa, & Guevara-Viejo, 2016). The behavioural basis of acceptance, rejection, and perceived popularity is noted in the content of interactions, relationships that are created with group members (Asher, & McDonald, 2011).

In addition, researchers have examined social development with multiple concepts in consensus groups by applying social cognitive mapping (Neal, & Neal, 2012) in the context of special education, evaluating students with learning disabilities by meta-analyses of sociometric studies (Ochoa, 1995). The role of friendship and the sense of adolescence in belonging to a specific school (Hamm, & Faircloth, 2005) has been studied in the context of the new directions for the development of children and adolescents in America in San Francisco. The central social networking and sociometric situation has been explored by (Gest; Graham-Bermann, & Hartup, 2001) regarding the common and unique features of the number of friendly relationships that have been developed (Kinderman, & Gest, 2011). It is important to note that the social networking of the social networking is not a problem.

The importance of linguistic interactions from teaching experiences in amphitheatres and workshops is combined with the individual characteristics of behaviour (Bryan; Freer & Furlong, 2007) with emphasis on linguistic and communicative difficulties for minors. Friendship starts from childhood and extends into adolescence by cancelling prejudices and responding to the problems of special inclusive education (Armstrong, 2017). Promoting friendly contacts (Bagwell, & Schmidt, 2011) reduces bullying tendencies (Frederickson, 2010).

This study aims to extend the understanding of the relationships between the students in tertiary education. This refers to different levels of undergraduate education and to different categories of SEN, with emphasis on specific learning difficulties (dyslexia) arising from neurological disorders and neuropsychiatric autism spectrum disorders (ASD) (Jones, & Fredrickson, 2010) and others difficulties in communication and the language interactions. It also refers to students who have physical and sensory special needs, students who have social, emotional and mental health and students without SEN / Disabilities. So, it examines whether there is substantial contact with the oral language and physical interactions in the relations of students with special educational needs and disabilities in the University with their students..

2 METHODOLOGY

The methodology has development in the space of Special Education and Training (SET) according the methodology of observations and interventions. The participating from the Universities departments provide information on class presentations in the lessons of the year through the e-secretary, status and achievements of SEN students. The combined measure of achievement was based on the rating of the most recent students performance in the Special Education and Training (SET) (1), Academic inclusive education of students with SENs (2), Teaching students with specific learning difficulties (Dyslexia) (3), Educational integration and teaching social skills in pupils with autism (4), Training skills to the people with special abilities (5) and Mnemonic techniques (6) in AUA (Drossinou Korea, 2017 c). The rankings utilised the participation of students in small -thematic works on a certain topic. The groups were mixed and were attended by two to ten members, students with or without SEN, both Gender and the both departments of Philology (1) and the History of Archaeology and Management of Cultural Studies (2). Also, from all the faculties of the AUA, with an electronic message of participation in the Interconnection Office supported with the individual meetings of special education.

2.1. Main Objectives

This study had four main objectives. Firstly, it was aimed at examining the nature of student relations at two levels of need and how they differ from those of students without SEN and students. Secondly, it examining the students who owe more than 70% of their academic curriculum and perform poorly. To this end, the main measures of the relations between the students studied were acceptance and rejection, reciprocal and unilateral friendships, and integration and central position in the study groups dealing with specific subjects. Another objective was to examine the extent to which peer relationships can be related to endogenous factors such as the level of support to special educational needs, internal and external behaviours, social, antisocial behaviours and delinquent behaviours (Hirschfield, & Gasper, 2011). Thirdly, the study aims at examining the connection between the essential social contact with the fellow students in the amphitheatre, the measures of the relations between the students and the attitudes towards the cooperation with the fellow students. The final aim of this study was to examine to what extent the behavioural intrinsic characteristics of the student and the substantial contact with the students better predict the different measurements of student relations beyond the SEN status.

2.2. The Participants Students with SEN/Ds in the University

Participants were three hundred and forty (N = 340) 18-32-year-old students from 6 classes attending 2 universities, one regional and one metropolitan. The first is located in the south of Greece (Peloponnese) and focuses on students of the School of Humanities and Cultural Studies (SHCS), N = 280 students, University of Peloponnese in Kalamata and the second from the Agricultural University of Athens. Sixty students were recognized by public diagnostic services as having SEN and were facilitated to enter the university. Of these, (N = 40) had an official statement of specific learning difficulties (dyslexia, dysorthograpia, dyscalculia, dysgraphia), (Table, 1).

The diagnosis of SEN and disability is controversial and is often used to refer to a wide range of different needs under legislation 3699/2008. At the time of this research, the Agricultural University of Athens (AUA) and the University of Peloponnese were in the process of changing legislation and expanding them with corresponding parts of the Higher Technological Institutes that are integrated into the Universities. The study included students with all forms of SEN, the largest category was the one with special learning difficulties (N = 40 students, 36 from the AUA and 4 from the SHCS, (Kalamata). Also, students (N = 10) with the communication difficulties and interaction, 4 from the Agricultural and 4 from the SHCS, and students (N=7) with the physical and sensory special needs, 5 from the Agricultural and 2 from the SHCS. Finally, students, (N = 15) with the social, emotional and mental health 5 from the AUA and 10 from the SHCS.

The remaining 270 students were not registered as having SEN, 10 from the AUA and 260 from the SHCS. The research was carried out in the framework of the four cognitive subjects in the SHCS and the Interconnection Office, with a referral the students by the Office Social Care of AUA, for individual and small group specialization counselling sessions with emphasis on the mnemonic techniques.

Table 1: Students with SEN and Disabilities

Students, N = 340, 18-32-year-old	School of Humanities and Cultural Studies (SHCS) N=280	Agricultural University of Athens (AUA)	Total
Students with SEN/ Disabilities,	20, 7%	50, 83%	70, 20%
-specific learning difficulties (dyslexia)	4	36	40
-difficulties in communication /interaction	4	4	8
-physical and sensory special needs	2	5	7
-social, emotional and mental health	10	5	15
Students, without SEN / Disabilities	260, (70%)	10 (0,2%)	270 (79%)

2.3. Research Tools

The research tools where be used contain the sociometric questionnaire and the socio-cognitive mapping and the groups videos which the students created with goal to be presented their study work to others classmates.

The Sociometric questionnaire and socio-cognitive mapping were approached with a sociometric control questionnaire, which was given for complete to the 38 coordinators of the groups and to the members of the students of the SHCS. Also, the questionnaire completed, from the students, who participated in the small group laboratories with subject the mnemonics techniques in AUA. The subjects of the questionnaire are asking the coordinators and participants to declare their preferences at a five-level scale (too much-5, much-4, Little-3, Very little-2, Minus-1). Thus, indirect information was gathered about students' unilateral and mutual friendships, perceived frequency of collaboration, peer status, size, central position, role within the group.

The sociometric questionnaire of the coordinators of the group's work was completed at an entire classroom meeting under the supervision of the researcher and with additional help from two potential adult researchers to special education and training (SET) who help those who need clarification and support. Students were initially invited to report from a list of jobs that were included in the course workload that had been sent electronically to the individual documents of each group. In the first and second part of the questionnaire he asked the student, according to the experience gained from his participation in the lesson and the group, to state how much he thinks his participation helped him to better understand the work (1) and that his involvement the group helped him to understand his / her individual positions and habits, the way he / she is studying. In particular, in this part, he asked to be placed on the issues:

1. defining and maintaining timetables
2. the fragmentation of the themes of the work
3. feelings about working with others
4. Individual difficulties in the study
5. the composition of opposing views in the amphitheatre or in the workshop
6. the agreement for the joint undertaking of a certain project by the member of the group, for example an English-language article
7. creating new friends
8. control the course of your study in the courses you are preparing for the exam

9. the wording of the argument with arguments

10. interactive difficulties with team members

In the third and fourth part of the questionnaire it is asked the student, according to the experience gained from his participation in the lesson and the team, to state how much he thinks he would assess his concentration of attention (3) and his feelings in order to show the degree. For this they are designing the Many with 5 faces, the Very with 4 faces, the Little with 3 faces, the Very little with 2 faces, the Very much little with 1 face. Finally, in the fifth part of the questionnaire, students were asked to list the courses they have wanted to be examine in June, September and February. In this part of questionnaire, they'll write the listing the courses with the discrimination as: - courses with a small difficulty in studying and put the numbers from the scale from (1-3), designating a face who smile, - courses with a middle-grade difficulty and put the numbers from the scale from (4-6) designating a face who does not smile, - courses with a great difficulty in studying and put the numbers from the scale from (7-9) designating a face who is does not smile and is heavy. In this part, self-observation comments were requested next to each lesson, capturing what they feel (1) and what they are thinking about the lesson (2).

In order to establish membership of the groups and set up each group, criteria were set. They were required to enrol with a code in the e-class course and choose to collaborate with those who had a common interest in a particular topic of individual and micro-study. Participants were also asked to identify their three closest friends on the basis of how often they collaborated choosing one from the phrases "most days", "at least once a week".

Also, the members from the SHCS have created a video through their participation whenever they could be presented their study work. So, the students of the SHCS chose and shared roles by creating and participating in video presentation of their work, such as:

(1) a student coordinator who shares with the members the sub subjects of their group work, draws up evaluations and delivers in paper and electronic form the group work on the day of the examination according to the instructions of the professor.

(2) a student who has the role of the educational observer - complements the hetero-observations and comments, according to the second phase of Targeted, Individual, Structured, and Integrated Program for the Special Educational Needs (TISIPfSEN) (Drossinou-Korea, 2017 a, pp. 385-465).

(3) a student who has the role of designer the teaching intervention and describe the differentiations to the task-goals, the task analysis, step by step, the pedagogical materials with variations using a shoebox or a folder according to the third and fourth phase of (TISIPfSEN) (Drossinou-Korea, 2017 a, pp. 307-338).

(4) a student who has the role of a classmate with the common interest to speech and language interactions e.g. favourite group, favourite TV series, favourite singer,

(5) a student who has the role of parent of a student with learning difficulties of disabilities discusses in front the school stuff about his child diagnosis and the routine of personal learning.

(6) a student who has the role of the researcher the bibliography from only one category of the special educational needs by collecting the basic points from the pedagogical issues theory and the psychological learning theories. The purpose of this study is the support of teaching in the inclusive class without distinction with emphasis the specialized knowledge in the creation of differentiated texts.

(7) a student who has the role of the person with learning difficulties.

(8) a student who has the role of the identified a theoretical promoter who has studied a certain learning theory and doing the Informal Pedagogical Assessment (IPA) of the learning difficulties - according the second phase of (TISIPfSEN) (Drossinou-Korea, 2017 a, pp. 307-338).

2.4. Data processing and Analysis

The professor's assessment of student behaviour was based on previous studies and was used in this study appropriately adapted. For this, also was used a five-point scale where "5" is almost always indicated and "1" never and the "5" very high or always to provides information from all the students on eight factors: social exclusion, emotional behaviour aggression, sovereignty and enforcement, hyperactivity (Drossinou

Korea. & Manikioti 2019), anxiety, social anxiety and sociability (Drossinou, 2010). In the table (2) recorded the average from the five-point scale.

Table 2: Assessment of student behaviour speech and language interactions. Students, with SEN/ Disabilities

Students, with SEN/ Disabilities, N = 70 (1-5)	School of Humanities and Cultural Studies (SHCS), N=20	Agricultural University of Athens (AUA), N=50
Social exclusion	4	5
Emotional behaviour	5	2
Aggression	3	3
Sovereignty and enforcement	5	5
Hyperactivity	3	5
Social anxiety	5	5
Sociability	4	3

Measures of "social acceptance by fellow students" and "accepting work" were calculated for each participant with SENs and or Disabilities by dividing the number of smiling faces they had received from the total number of students who had responded that they liked what they chose to do in small group class work. A similar process was followed for the measures of "social rejection by fellow students" and "working with rejection" using the number of bored persons declared by each student for each course of study.

Also, three variables came from the question that asked students to recognize their friends on the basis of how often they collaborated "most of the time", "at least once a week", "never". The answers to the question about the frequency of cooperation with individual class members provided a measure of "substantive contact with fellow students" based on the average score mentioned. The term "noun" here was used to imply the intentional and authentic interactions. First, the number of candidate friends who were searched for in the first place; secondly, the number of applications received as unilateral friendship was searched in the responses "at least once a week", and is also considered as another indicator of acceptance; and thirdly, mutual friendship was sought on the "most days" criterion. Mutual friendship is considered to be the most accurate way of identifying the existence of friendship with or without SEN.

Answers to the question about roles and their verbalisation in groups were analysed using social cognitive analysis of groups to identify.

3. RESULTS

Data analyses showed a major effect on the statements of SEN students including those who received special education support and were rated significantly lower on social acceptance and work acceptance measures (table, 3).

There were also key implications of the SEN status with regard to friendships and participation in working groups. Students with SEN received fewer candidates for friendship, made fewer candidates as friends, and had fewer mutual friends. They also participated in groups with fewer members, while avoiding or not taking a role so their groups were considered less central to the class.

Table 3. Students and the frequency of cooperation with individual class members

Students, with SEN/ Disabilities, N = 70	School of Humanities and Cultural Studies (SHCS), N=20	Agricultural University of Athens (AUA), N=50	Total, 70, 20%
"social acceptance by fellow students"	10	30	40, 57%
"accepting work"	10	20	30, 42%
"most of the time"	4	20	24, 34%
"at least once a week"	10	20	30, 42%
"never"	6	10	16, 22%

The students with SEN/ Disabilities N = 70 20% (SHCS, N = 20 and AUA, N = 50) who are supported with individual counselling sessions (Drossinou-Korea, 2017 b) according the special education and training had significantly pointed and levels of effective contact with classmates. So, the "social acceptance by fellow students" and the "accepting work had increased significantly levels of effective contact to students with SEN and it is measured 57% and 30,42%. With other words, those students who had diagnoses were significantly more likely to have higher levels of social contact with speech and language interactions with others. The SEN students compared to non-SEN students, is underlined that SEN students had lower levels of admission in the group, fewer mutual friendships, and were less integrated into the study groups.

According the sociometric questionnaires provided students with the importance of language interactions in six months and were rated by the student group coordinators of the study groups. Compared to non-SEN students, SEN students had lower levels of admission in the group, fewer mutual friendships, and were less integrated into the study groups. The frequency of cooperation with individual class members (table,3) measured with the declarations of students with the phrase at least once a week" show the need who they had for a big contact with speech and language interactions, so it has the highest percentage of rank 30, 42%. The following is a phrase "most of the time" which it is show also the need who some of them have for limited communication with speech and language interactions, with a percentage of the order 24, 34%. Finally, from the 70 students with SEN declare with the only one word as "never" that they could not communicate with speech and language interactions, a percentage of the order 16, 22%.

These findings demonstrate the crucial role of effective social interaction with the students' interactive interactions in classrooms as well as with group discussions and collaborations with fellow students in the group study.

4. CONCLUSIONS

This study sought to address these issues regarding the relationships (Amando, 2004) between students with special educational needs and disabilities in the University and the importance of effective contact and communication with speech and language interactions with others. They are the fellow students and have been examining the links between a number of factors related to endogenous criteria of students' behaviour in the lecture hall.

In sum, we estimate that student relationships go beyond the simple as usual acceptance by fellow students and reflect peer consensus towards the individual who has SEN or Disabilities. Although this is important, there is not clear what to you means for everybody. So, there is a need to consider other aspects of student relationships with students in order to better understand the social participation of students with SEN. Dimensions that represent different types and levels of social participation, such as friendship and group membership, also provide critical implications for adaptation to the university, feelings of academic participation and future psychosocial adaptation (Bagwell, & Schmidt, 2011, Drossinou Korea; Kalamari; Kaldi, & Romana, 2017). That is, the students who has SEN or Disabilities and they have in their life friends

are less likely to suffer from internal problems and loneliness unless they are rejected by the members of the group to which they belong and work for the study (Hamm, & Faircloth, 2005).

The friendships are important frameworks for socialization and development (Hartup, 1996) as they provide opportunities for companionship and social, cognitive and emotional development (Ministry of Education and Pedagogical Institute, 2009). Keeping friendship shows a level of social competence beyond acceptance. But the development of friendship requires opportunities to interact effectively with the time we spent together (Bagwell, & Schmidt, 2011). The main determinants of friendship are proximity, contact and the similarity of interest (Christakis, 2011) but in cases where students spend some time in the lecture hall, or have no physical presence in the classes, it is likely that the students will choose to become friends with other fellow students who are immediately available.

Their participation in working groups is also related to social adaptation, academic engagement and achievements (Kinderman, & Gest, 2011). While friendships are private and forensic relationships, small-study groups are more easily recognized by the public, resulting from the participation of fellow students in common activities in lessons. It is important that participating as a key member as a team coordinator can enhance the feelings of participation. Some surveys show that primary school pupils with SEN are considered by others as part of the teams (Avramidis, 2010), but few studies have examined social participation and equal placement in study groups. Avramidis examined relationships with friendships to more than 500 students, including those with SEN. The findings reflected past results but also showed that many had friendship and participated in peer groups. We confirm with this work, Avramidis' conclusion, that for effective contact and interaction with fellow students, as may not be a determining factor for social exclusion or isolation.

The communication and the peer relations between students of students with special educational needs in university it is another open problem which it reflects all the meanings of school and social inclusion. So, under this sociological and cultural aspects the present paper is tried to underline the importance of speech and of the language interactions with others and special with the colleagues in the universities. The integration policy (Norwich, 2014) for Students with SEN/ Disabilities, with specific learning difficulties (dyslexia) (Markakis & Drossinou- Korea, 2000), with difficulties in communication and language interaction, with physical and sensory special needs and also with social emotional and mental health, is based on the concept of contact (UNESCO, 2015). Which emphasizes that more positive attitudes and relationships are structured with greater understanding and acceptance, because this makes sense and serves common goals. Modern policies and research evidence further support this view for universities as well. However, it is often observed that students with SEN integrate into the classroom environment but are not fully included (Terzi, 2011).

Students with SEN spend a lot of time outside the classes of lectures outside the classroom, and for some of them, it is very likely that they develop oral interactive interactions (Drossinou Korea, 2015 a, b) with fellow students and are much more likely to work in support roles, something relevant as they are the teaching assistants.

As observed in non-SEN students collaborating with their SEN scholars, low-achieving students rarely experienced success in these mixed groups. This relative social isolation was attributed to the continued presence of a supportive professor from secondary parallel supports. Classroom organization and pedagogical decisions may inadvertently or intentionally restrict opportunities for meaningful interaction with everyone (Bagwell, & Schmidt, 2011, Christakis, 2012).

REFERENCES

- Amando, A. (2004). Lessons learned about promoting friendships. *TASH Connections*, 30(1/2), pp. 4-12.
- Armstrong, F. (2017). Wicked problems in special and inclusive education. *Journal of Research in Special Educational Needs*, 17(4), pp. 229-236.
- Asher, S., & McDonald, K. (2011). The behavioural basis of acceptance, rejection and perceived popularity. In W. B. K. Rubin, *Handbook of Peer Interactions, Relationships and Groups*. New York: Guilford Press.
- Avramidis, E. (2010). Social relationships of pupils with special educational needs in the mainstream primary class: peer group membership and peer-assessed social behaviour. *European Journal of Special Needs Education*, 25(4), pp. 413-429.
- Bagwell, C., & Schmidt, M. (2011). *Friendships in childhood and adolescence*. New York: Guilford.
- Bryan, K. Freer, J., & Furlong, C. (2007). Language and communication difficulties in juvenile offenders. *International Journal of Language & Communication Disorders*, 42(5), pp. 505-520.
- Chatzitheochari, S., Parsons, S., & Platt, L. (2015). Doubly disadvantaged? Bullying experiences among disabled children and young people in England. *Sociology*, 50(4), pp. 695-713.
- Christakis, K. (2011). *Behavioral problems in school age*. Athens: Diadrasi, in greek.
- Christakis, K. (2012). *The child and the teenager in the family and school*. Athens: Grigoris, in greek.
- Drossinou Korea M. (2015 a). Adults Students with Dyslexia at Work: an Experience from Inclusion with Information Technology (IT). *Conference Proceedings. New Perspectives in Science Education*, (pp. 165-168). Firenze.
- Drossinou Korea M. & Manikioti Ath. (n.d.). Learning Difficulties And Addiction On The Internet: The Case Of A Student With Adhd In Junior High School . *Eurasian Journal of Social Sciences*, 7(2), pp. 1-11.
- Drossinou- Korea, M. (2015 b). Cognition, Behaviour, Learning, Speech And Language: The Study Of Students With Mnemonic Difficulties. *5th International Conference on Fundamental and Applied Aspects of Speech and Language*, (pp. 114-120). Belgrade.
- Drossinou Korea, M., Kalamari, A., Kaldi, P., and Romana, I . (2017). External factors in supporting of adult students with dyslexia in Greece . *Journal of Regional Socio-Economic Issues, JRSEI*, 7(3), pp. 42-51.
- Drossinou, M. (2010). The Foreign Language and its Management by Students with Special Learning Difficulties (Dyslexia): A longitudinal study at the Agricultural University of Athens. Athens: Greek Society of special Education, in greek.
- Drossinou-Korea, M. (2017 c). Mini-group workshops on mnemonic techniques and the individual method of student study. *Proceedings of the 3rd International Conference. A*, pp. 1131-141. Larissa: Scientific Association for the Promotion of Educational Innovation, in greek.
- Drossinou-Korea, M. (2017 a). Educational tools and pedagogical methodologies. Targeted, individual, structured, and integrated program of special education (TISIPfSEN). In *Special education and training. The special education proposal for children and young people with special needs* (pp. 385-465). Patra: Opportuna, in greek.
- Drossinou-Korea, M. (2017 b). Supported teaching and study habits of special education and training courses. *Proceedings of the 3rd International Conference* (pp. 1114-1124). Larissa: Scientific Association for the Promotion of Educational Innovation, in greek.
- Frederickson, N. (2010). Bullying or befriending? Children's responses to classmates with special needs. *British Journal of Special Education*, 37(1), pp. 4-12.
- Gallardo, L.O., Barrasa, A., & Guevara-Viejo, F. (2016). Positive peer relationships and academic achievement across early and midadolescence. *Social Behaviour and Personality: an international Journal*, 44(10), pp. 1637-1648.
- Gest, S.D., Graham-Bermann, S.A., & Hartup, W.W. (2001). Peer experience: Common and unique features of number of friendships, social network centrality, and sociometric status. *Social Development*, 10, pp. 23-40.
- Hamm, J.V. & Faircloth, B.S. (2005). *The role of friendship in adolescents' sense of school belonging. New Directions for Child and Adolescent Development*. San Francisco, CA: Jossey-Bass.
- Hartup, W.W. (1996). The company they keep: Friendships and their developmental significance. *Child Development*(67), pp. 1-13.
- Hirschfield, P.J., & Gasper, J. (2011). The relationship between school engagement and delinquency in late childhood and early adolescence. *Journal of Youth and Adolescence*, 40 (1), pp. 3-22.

- Jones, A., & Fredrickson, N. (2010). Multi-informant predictors of social inclusion for students with autism spectrum disorders attending mainstream school. *Journal of Autism and Developmental Disorders*, 40(9), pp. 1094-1103.
- Kinderman, T., & Gest, S. (2011). Assessment of the peer group: Identifying naturally occurring social networks and capturing their effects. In W. B. K. Rubin, *Handbook of peer interactions, relationships and groups* (pp. 100-120). New York: Guilford Press.
- Markakis E. & Drossinou- Korea, M. (2000). Experimental Curriculum for Special Learning Difficulties (Dyslexia). In *Children with Special Needs in Primary School: Theoretical and practical approach* (pp. 321-350). Athens: Atrapos, in greek.
- Ministry of Education and Pedagogical Institute. (2009). *Activities of Learning Readiness: Oral Speech, Psychomotricity, Mental Capacities, Emotional Organization. Book for the Special Educational Teacher* (pp. 13-27). (M. Drossinou, Ed.) Retrieved 8 11, 2017, from Pedagogical Institute, Department of Special Education, Athens, in greek: http://www.pi-schools.gr/download/lessons/drast_math_etoimotitas/vivlio_ekp/vivlio.pdf
- Neal, J., & Neal, Z. (2012). The multiple meanings of peer groups in social cognitive mapping. *Social development*, 22(3), pp. 580-594.
- Norwich, B. (2014). Changing policy and legislation and its effects on inclusive and special education: a perspective from England. *British Journal of Special Education*, 41(4, 14), pp. 403-425.
- Ochoa, S. &. (1995). Meta-analysis of peer rating sociometric studies of pupils with LD. *Journal of Special Education*, 29, pp. 1-19.
- Schwartz, D., Gorman, A.H., Dodge, K.A., Pettit, G.S., & Bates, J.E. (2008). Friendships with Peers Who are Low or High in Aggression as Moderators of the Link between Peer Victimization and Declines in Academic Functioning. *Journal of Abnormal Child Psychology*, 36(5), pp. 719-730.
- Terzi, L. (2011). *Special Educational Needs: A New Look* (Second ed. ed.). London: Continuum.
- UNESCO. (1994). *The Salamanca Statement and the Framework for Action on Special Needs Education*. Paris: UNESCO.
- UNESCO. (2015). *The Right to Education for Persons with Disabilities*. Paris: United Nations Educational, Scientific and Cultural Organisation.

On the Basic Mechanisms of Language Strategies in Childhood

Olga B. Sizova

Center for social adaptation for children with severe speech disorders
35 Zakharyevskaya Street, Saint-Petersburg 191123, Russia
osizova@yandex.ru

ABSTRACT

Traditional hypothesis about mechanisms of analytical and synthetic language strategies suppose their support by functions of left and right hemispheres, respectively. Verification of this hypothesis revealed its inconsistency. A study explores of relationship of language strategies with basic mechanisms of movement provided by kinetic and somatosensory cortex.

SLI preschoolers of analytical cognitive strategy with primary kinetic dysfunction (PKD), and children of synthetic cognitive strategy with primary somatosensory dysfunction (PSD) were investigated.

Methods of longitudinal observations, testing of analytical and synthetic language processing; testing of manual praxis and repetition of sequential movements were applied. All results were statistically verified by t-test and Pearson correlation coefficient.

In younger children group was revealed, that the more accurate the repetition of sequential movements, the better linguistic processing. In children with PKD, accuracy of praxis determines success of language analysis, but not synthesis. In PSD, this relationship is correct for phonemes discrimination, because it is processing of units of motor and language levels. Primary dysfunctional praxis doesn't ensure success of synthesis and word differentiation, because words processed as sound sequence.

In middle-aged children group was revealed, that the more pronounced somatosensory dysfunction in PSD and kinetic dysfunction in PKD, the more disturbed both analytical and synthetic processing. In children with PSD, degree of intactness of somatosensory cortex determines language processing. In PKD group, development of language centers weakens biological functions of dominant hemisphere at this age. Better language processing is correlated with reliance on subdominant hemisphere in motor tasks. Respectively, between success of praxis and language processing there is inverse relationship.

Thereby, in younger preschoolers, linguistic processing is more conditioned by successive processes (kinetic cortex); in middle-aged preschoolers, it is more dependent on the accuracy of movement (somatosensory zones). In younger age, interdependence is revealed between basic motor functions and nature of task: accuracy of each movement determines the analysis; sequence organization determines synthesis. In middle age, groups are differentiated not by success of analytical or synthetic processing, but by reliance on movement mechanisms, which are basic for each linguistic strategy.

Key words: linguistic and cognitive strategies, cortical mechanisms of language acquisition, specific language impairment

1 INTRODUCTION

Verification of the hypothesis about the support of analytical and synthetic language strategies on the functions of the left and right hemispheres revealed its failure (Sizova, 2019). According to the data obtained, an analytical strategy is formed for persons demonstrating an earlier choice of a dominant (not necessarily right) hand and, accordingly, the relatively earlier formation of the dominant hemisphere and interhemispheric asymmetry. Carriers of a synthetic / holistic strategy are prone to bimanual reactions and probably biologically basic activation of the cortex of both hemispheres more time during development. Nevertheless, the existence of two cognitive strategies (Bates, Dale, and Thal, 1995) implies the presence of various underlying cortical mechanisms that ensure the formation of each of the strategies.

The study justifies the version of the relationship between linguistic / cognitive strategies with the basic mechanisms of movement provided by the kinetic and somatosensory cortex. The joint functioning of the kinetic and somatosensory cortex provides the implementation of purposeful activity: kinetic cortex provides switching in the process of organizing sequential purposeful movements, somatosensory cortex ensures the accuracy of each element of the implemented sequence by providing reverse afferentation and matching of actual muscle configuration with sensory prototype (Бернштейн, 1997, Лурия, 2000).

2 STUDY DESCRIPTION

Hypothesis

The main hypothesis of the study intend the identification the relationship between the state of language functions and the characteristics of the two main cortical mechanisms of purposeful movement in children implementing analytical and synthetic strategies for linguistic and cognitive development. Supposed to confirm

1. the presence of direct relationship between
 - the state of analytical language processing and the functions of the somatosensory cortex, providing accuracy of each movement, in children of analytical strategy,
 - the state of synthetic language processing and the functions of the kinetic cortex, providing functions of sequential organization of movement, in children of synthetic strategy;
2. the presence of inverse relationship between
 - language processing and indicators of kinetic cortical dysfunction in children of an analytical strategy,
 - language processing and indicators of somatosensory cortical dysfunction in children of a synthetic strategy.

In accordance with the verified hypothesis, the formation of an analytical strategy is associated with primary kinetic dysfunction (hereinafter PKD) and relying on the functions of the somatosensory cortex, the implementation of the synthetic strategy is due to primary somatosensory dysfunction (hereinafter PSD) and reliance on the functions of the kinetic cortex.

Alternative hypothesis: language processes are formed within the framework of an isolated specific language module, closed to the effects of general biological mechanisms of the lower level, therefore, it is impossible to identify a regular relationship between the state of language processing and movement mechanisms.

Methods and informants

Research methods included longitudinal observation of children in free and educational activities in a preschool educational institution, testing of manual praxis (conventional gestures, single movements, repetition of manual signs) and serial organization of movements (reproducing a series of 2-3 simple movements). The state of language processes was investigated: analytical language processing: word & phonemic differentiation for younger children, word differentiation & phonemic analysis for middle-aged children; synthetic language processing: syllable synthesis for younger children; phonemic synthesis for middle-aged children.

Further, the presence of significant relationships between the state of language processes and mechanisms of movement through the application of statistical methods was revealed (t-test, Pearson correlation coefficient).

Informants: 21 Russian preschoolers with SLI (specific language impairment), implementing analytical or synthetic / holistic strategies for linguistic and cognitive development.

3 RESULTS

Younger children group

Table 1: Correlations between motor and language functions in younger group
(Pearson correlation coefficient, t-test)

		Analytical Language processing		Synthetic language processing
		Word differentiation	Phonemic differentiation	syllable synthesis
reproduction of movements series	Kinetic cortical dysfunctions	PKD $r=-0,81$ $p<0,01$ PSD $r=-0,64$ $p<0,05$	ns	ns
	Exact reproduction of a series	PKD $r=0,83$ $p<0,01$ PSD $r=0,63$ ns	ns	ns
manual praxis	Single movement accuracy	PKD $r=0,5$ ns PSD $r=-0,31$ ns	PKD $r=0,38$ ns PSD $r=0,58$ ns	PKD $r=-0,11$ ns PSD $r=-0,56$ ns

In the group of younger preschoolers (3-4 year) significant correlations were revealed in groups with PKD and PSD between the results of an analytical language task (word differentiation) and indicators of kinetic cortex dysfunction (perseveration and stereotyping in performing motor tests). For the PKD group, this inverse relationship is more pronounced, as it was expected. Accordingly, the success of the same analytical task (word differentiation) is directly related to the exact reproduction of movements series (kinetic task), but it is significant again only for children of the PKD group, in which this motor function is supposedly primary defective. Thus, the state of the kinetic cortex in children with PKD significantly affects language processing, but the dysfunction of the kinetic departments partly affects the language functions in younger children with PSD.

There were no significant correlations between the success of the functions of the somatosensory cortex (in tests for manual praxis) and language functions, but interesting trends in the interaction of these indicators were found. In both groups, an inverse relationship was found between the accuracy of praxis and the success of language synthesis, in the group with PKD, a positive relationship was found between praxis accuracy and analytical processing in both language tests, in the PSD group there is a positive relationship between the functions of the somatosensory cortex and one of the analytical language tasks (phonemic differentiation). Thus, analytical language processing, implying the processing of language units, is probably interconnected with the accuracy of single movements processing. Synthetic language processes as processing language sequences, are inversely related to the indicators accuracy of single movements, accordingly.

It is important to note that in the PSD group (synthetic strategy), the word differentiation indicators (analytical task) demonstrate a negative relationship with praxis indicators and a more pronounced positive relationship with success indicators of exact reproducing a series of movements (kinetic cortex function). Probably, the differentiation of words in PSD is not based on an analysis of their differential attributes, but on the processing of words as articulatory, i.e. motor sequence. Thus, the analytical task is solved based on the sequential series processing mechanism that is more intact in the PSD group, and not on the basis of a primary dysfunctional mechanism for working with units. Consequently, the tendency to choose a method for solving the problem in accordance with the dominant strategy is detected already in the younger preschool age.

- at a younger age, the intactness of kinetic processes that ensure the programming of a sequence in time, has a more significant impact on language processing than accuracy of units reproducing

- trends to the relationship between the essence of the task (analytical) and the method of its solution (analytical based on the function of precise processing of units) are revealed, these trends are especially consistent in the group of children of the analytical strategy; this finding confirms the relationship of analytical language processes and the basic unit processing function provided by the somatosensory cortex

- signs of a tendency towards the choice of a method for solving an analytical task in accordance with the dominant strategy (synthetic based on the sequence processing function) are revealed in children of PSD group.

Middle-aged children group

Table 2: Correlations between motor and language functions in middle-aged group
(Pearson correlation coefficient, t-test)

		Analytical language processing		Synthetic language processing
		Word differentiation	Phonemic analysis	Phonemic synthesis
reproduction of movements series	Kinetic cortical dysfunctions PKD>PSD (0,58>0,25 ns)	ns	PKD $r=-0,85$ $p<0,01$ PSD $r=1$ $p<0,05$	PKD $r=-0,4$ ns PSD $r=0,98$ $p<0,05$
	somatosensory cortical dysfunctions PSD>PKD (0,75>0,25 $p<0,1$)	ns	PKD $r = 0,46$ ns PSD $r=-1$ $p<0,05$	PKD $r=0,007$ ns PSD $r=-0,98$ $p<0,05$
manual praxis	Single movement accuracy	PKD $r=-0,63$ $p<0,05$ PSD $r=0,3$ ns	PKD $r=-0,18$ ns PSD $r=0,83$ ns	PKD $r=-0,3$ ns PSD $r=0,91$ $p<0,05$

Comparison of correlations between indicators in the PSD and PKD groups give a strictly mirror picture. In the PSD group, praxis success correlates directly with the success of language synthesis; it correlates with the success of language analysis also directly, but does not reach significant values. In the PKD group, praxis success is inversely related to the success rates of language analysis and synthesis, although only the relationship with the success of word differentiation reaches a significant level. It is important to note that in middle age did not reveal a negative effect of the kinetic cortex (perseverations, stereotypes) on the results of praxis tests, all failures are caused by dysfunction of the somatosensory cortex (replacements, inaccurate movements) (Sizova, 2018). Thus, the success of the function of the somatosensory cortex, which is basically dysfunctional in the PSD group and intact in the PKD group, determines the success of language analysis and even more advanced synthesis in the PSD group. In the PKD group, on the contrary, praxis success (somatosensory cortex) correlates with deterioration in the results of language tests, especially in tasks for language analysis, more intact in PKD.

The indicators of the relationship between the success of reproducing a sequence of movements (the function of the kinetic cortex) and the language processes in both groups are also strictly mirror. Analysis of indicators of kinetic dysfunction (perseveration, change of order of movements) and somatosensory / gnostic dysfunction (replacement and omission of movements) in tests for reproduction of the sequence of movements revealed the following:

1. The share of kinetic dysfunction indicators in the PKD group is more than 2 times higher than in the PSD group, although these differences do not reach the level of significant, indicators of somatosensory dysfunction are significantly more pronounced in the PSD group than in children with PKD

2. In the PSD group, indicators of less pronounced kinetic dysfunction directly and significantly correlate with the success of the analysis and synthesis; indicators of the somatosensory / gnostic dysfunction, which is characteristic for group, demonstrate an inverse relationship with indicators of language analysis and synthesis.

3. In the PKD group, on the contrary, the indices of the kinetic dysfunction, which is characteristic of the group, are inversely proportional to the success of language analysis and synthesis. Wherein, the indicators of somatosensory / gnostic dysfunction directly, although insignificantly, correlate with the success of the analysis and almost do not correlate, but still show a tendency to direct correlation with the success of the synthesis. These results are comparable with data on the inverse relationship between praxis success (somatosensory cortex function) and language processes in the PKD group. In other words, the better the indices of somatosensory cortex functions in PKD, the worse the language processes. The more pronounced somatosensory dysfunction in children of the PKD group, the better the language processes. This inverse relationship is more pronounced for analytical language processes.

4 DISCUSSION

- results characterizing the functions of the kinetic and somatosensory cortex, are consistent in independent tests for praxis and repetition of the sequence of movements;

- in middle preschool age the intactness of somatosensory cortex functions, ensuring the accuracy of reproduction of units, has a greater effect on language processing than kinetic functions, providing sequence programming in time;

- in the PSD group (synthetic strategy), the basic motor dysfunction of the sensory cortex determines the success of all types of language processing

- in the PKD group (analytical strategy), the basic motor dysfunction of the kinetic cortex determines the success of analytical language processing;

- differentiation between middle-aged groups is not based on success indicators of analytical or synthetic language processes, but is based on the success of reliance on one of two basic general biological mechanisms of movement: single movement accuracy (somatosensory cortex) or motor sequence organization (kinetic cortex);

- inverse interdependence between success of praxis and language processing in children with PKD (analytical strategy) confirms earlier conclusions (Sizova, 2019) that at middle age, the development of language centers probably weakens the general biological motor-spatial functions in the same dominant hemisphere. Therefore, the better language processing is related to reliance on the subdominant hemisphere in motor tests (reflected in the performance of the test by subdominant hand) (Sizova, 2019). In the same study, it was shown that it is children with PKD who earlier formed the hand domination and, accordingly, more often used dominant hand. Success of language processes suppresses success of praxis controlled by the dominant hemisphere, but just such cortical mechanism of praxis organization is more frequent for children with PKD, who use the dominant hand more actively. Accordingly, successful language processing (predominantly analytical processes) is correlated with deterioration of praxis tests results in middle-aged children.

5 CONCLUSION

- the success of language processes at a younger age is more influenced by the processes of successive deployment of a series provided by the kinetic cortex; in middle preschool age, they are more affected by the accuracy of reproduction of units provided by the somatosensory cortex; probably these data indicate that at the initial stages of the formation of motor or speech action, a more important characteristic is its implementation as a purposeful sequence, the accuracy of the realization of its constituent units becomes significant at the next stage of development;

- at a younger age for children of analytical strategy, significant interdependencies between the nature of language processing (analytical) and the tendency to rely on movement mechanisms, ensuring the accuracy of the realization of single elements, units (the analytical component of the motion system) are revealed, which confirms part 1 of the main hypothesis;

- in middle age, significant relationships were found between the severity of primary motor dysfunction (somatosensory for children of synthetic strategy, kinetic for children of analytical strategy) and the state of language processing, which confirms part 2 of the main hypothesis;

- evidence has been obtained in favor of the hypothesis of a weakening of the motor-spatial functions of the dominant hemisphere during the maturation of specific linguistic analytical zones of the cortex in children of analytical strategy, who are characterized by an earlier formation of interhemispheric asymmetry and the allocation of a dominant hemisphere.

The results obtained can contribute to the creation of methods of language acquisition in childhood based on appealing to the relationship of movement mechanisms and linguistic processing.

REFERENCES

- Bates E., Dale P., Thal D. (1995). Individual differences and their implications for theories of language development. *Handbook of child language*. 1–55.
- Sizova O.B. (2018). Language and motion: isolated modules or interconnected levels? 2nd International Workshop NEUROBIOLOGY OF SPEECH AND LANGUAGE. St. Petersburg.: Skifiya-print, Proceedings, p. 49
- Sizova O.B. (2019). Language processing strategies and hand dominance: How do they really correlate? 3rd International Conference NEUROBIOLOGY OF SPEECH AND LANGUAGE. St. Petersburg.: Skifiya-print, Proceedings, pp. 99-100
- Бернштейн Н.А. (1997). *Биомеханика и физиология движений*. М.: Институт практической психологии
- Лурия А.Р. (2000). *Высшие корковые функции человека и их нарушения при локальных поражениях мозга*. — М.: Акад. проект

Perception of Speech Sounds' Pronunciation Quality Based on The Acoustic Features

Silvana Punišić^{1, 2}, Ružica Bilibajkić², Milan Vojnović², Miško Subotić²

¹The Institute for Experimental Phonetics and Speech Pathology, Belgrade

²Life Activities Advancement Centre, Belgrade

silvanapunisic@hotmail.com

ABSTRACT

For many years, scientists from the field of phonetics have been trying to detect the connection between articulation and acoustic features of pronounced speech sound. Complex dependence, including nonlinear effects, makes this connection unambiguous, so the variation field of pronounced speech sounds is multidimensional in the acoustic domain and its boundaries are not defined. One way of researching the variation field of pronounced speech sounds is the analysis of acoustic characteristics of typical and atypical speech sounds' production. The aim of this study was to analyze the acoustic measures for deviation identification and its role in deviation recognition. Sample consisted of 30 speakers with typical (E group) and 105 speakers with atypical pronunciation (C group). Following speech sounds have the highest frequency of atypical production: /c/, /č/, /dž/, /š/, /ž/, /r/, /l/, which was the criterion for the inclusion into the acoustic analysis. The analysis of deviations' acoustic correlates in the spectral domain showed that deviations by the sigmatism type (interdental, alveolar and strident sigmatism) and the friction intensity (weak and strong friction) can be recognized in the spectral domain and it is possible to define the criteria for differentiation of typical and atypical pronunciation for mentioned deviations. The existence of more objective criteria for assessing the speech sounds' articulation quality, based on the determination of clear articulation-acoustic indicators of pronunciation deviation, would contribute to a more reliable classification and categorization of vectors of multidimensional acoustic space in which pronounced speech sounds are realized.

Keywords: acoustic correlates, perception, pronounced speech sounds, speech sounds variational field, distortion

1 INTRODUCTION

The basic feature of a speech signal that discriminates it from other acoustic (non-speech) signals is the content of the information it carries. Apart from the articulatory ones, speech possesses certain characteristics called acoustic characteristics, which, from a linguistic point of view, are important for the identification of a particular phoneme and for interphonemic discrimination. In the acoustic domain, speech segment is a speech sound that manifests itself as a signal that has three dimensions: intensity, frequency and duration (Jovičić, 1999). Duration and intensity are the inherent acoustic characteristics of each speech sound, significant in the realization of continuous speech communication from a linguistic and paralinguistic point of view, and belong to the speech sounds' variable characteristics (Lehiste & Ivić, 1986; Rosa, 2017). Research related to the measurement and analysis of acoustic features in the field of speech sound pathology, in relation to typical/atypical features, is rare in the Serbian literature (Jovičić, Kašić & Punišić, 2008; Jovičić, Kašić & Punišić, 2010; Punišić, Jovičić & Golubović, 2010; Punišić, Jovičić & Subotić, 2011; Punišić, Kašić, Golubović & Jovičić, 2013). The acoustic characteristics of each speech sound are directly correlated to the position of the articulatory organs, which can cause variations in pronunciation during speech. If they move within the standard articulation-acoustic limits set for each speech sound, we are talking about a typical realization (Miletić, 1952; Stevanović, 1981). However, if the variations at the level of movement of the speech organs or acoustic features are such that they come out of the standard set frames, this represents an atypical realization. Distortion is produced by retaining the

character of a given speech sound but with altered articulatory and/or acoustic quality, while substitution by another voice results in an atypical pronunciation called substitution. Both phenomena represent the domain of speech pathology designated as Speech Sound Disorder (SSD). According to DSM-5 (APA, 2013), SSD is diagnosed if there is a difficulty in speech sound production that may interfere with communication (NIDCD, 2010). SSD is a deficit in expressive speech that excludes other deficits such as neurological, cognitive etc. (Morgan, Bonthrone & Liegeois, 2016) and is considered to be the most common speech disorder in the general population of children (Luders et al., 2017).

Atypical pronunciation from the distortion spectrum can be expressed in many different forms, but for the purposes of this experimental study, articulatory deviation by type of sigmatism (interdental and adental) and acoustic deviation in intensity (weak and strong frictions) are shown.

Interdental sigmatism is caused by the interposition of the tongue during pronouncing speech sounds, whereby the direction of the air current is good but it spills over the entire upper surface of the tongue because there is no longitudinal tongue groove. The tongue is in a horizontal position and the pronunciation of speech sounds is shifted to the outside of the dental space. This feature is common in the pronunciation of fricatives and affricates and is always pathological. Adental sigmatism is a hallmark of atypical pronunciation primarily of dental speech sounds, although it can also affect other speech sounds which are formed in the anterior oral space. Speech sounds, which should be spoken by pressing the tongue on the inside of the incisors, are pronounced away from them as the tongue is moved away and pulled into the oral cavity. This position of the tongue increases the anterior resonator so that the speech sounds are not only articulatory but also acoustically altered.

The weak/strong friction feature is the most common in fricatives (especially / š / and / ž /) marked as atypical. They are perceived as softened, non-expressive, articulatory imprecise, "loose" in the case of weak friction, and overemphasized and sharp in the case of strong friction. The tongue is in the right place, but the strap is altered in shape and volume. The fact that the fricatives / š / and / ž / show the highest incidence of atypical production in their group and that the cause of such production lies in the quality of frictions (weak or strong frictions), has been shown by research aimed at finding those articulatory features in the group of fricatives that most often characterized by their atypical pronunciation (Punišić, Subotić, & Čabarkapa, 2009).

Previous studies of deviations from the typical pronunciation in the Serbian language speakers are most often based on one of the criteria: articulatory or auditory (perceptual), while the objectified acoustic approach is most often missing (Vojnović, Punišić & Subotić, 2010; Subotić, Šarić, Bilibajkić, Jovičić & Punišić, 2015). Unlike articulatory analysis, the result of which is a dynamic description of speech sounds from the anatomical point of view, namely, the description of all anatomical details that directly participate in the generation of a speech sound, whether it is typically or atypically spoken, the result of acoustic analysis is the description of speech sounds in the spectral-time-intensity domain, ie. description of each speech sound with a set of acoustic features that correlate with the position and function of the articulatory organs.

Thanks to multidisciplinary knowledge and the application of knowledge, methods and techniques from various scientific fields (speech therapy, acoustics, phonetics), this paper presents an attempt to analyze acoustic measures of identification of speech sounds and their role in recognition. An analysis of acoustic measures of speech sounds' deviation identification (spectral domain) has been shown to be a convenient way to characterize speech sounds (Punišić, pantelić, Subotić & Đoković, 2006; Punišić & Jovičić, 2010; Subotić, Vojnović & Punišić, 2010; Vojnović & Punišić, 2011; Punišić, Jovičić & Subotić, 2011) necessary in studies aimed at differentiating and describing differences between typically and atypically pronounced speech sounds.

2 AIM OF THE STUDY

The aim of this study was to analyze the acoustic measures for deviation identification and their role in deviation recognition.

By finding the acoustic correlates of the deviation of the speech sounds in the spectral domain, an attempt was made to determine the articulatory-acoustic indicators of the deviation in the speech sounds' pronunciation.

3 METHODOLOGY

The analysis of acoustic measures of identification of deviation of speech sounds was preceded by two procedures: 1) analysis of articulatory features of pronunciation, which was realized by applying the Global Articulation Test (GAT) and the Test for Analytical Evaluation of Serbian Speech Sounds (AT) (Kostić, Vladislavljević, & Popović, 1983) and 2) measurement, ie. determining the variational field of intensity and duration based on the characteristics of their distributions. These two procedures are described in detail in a monographic study by Punišić (2016).

The basis of this research is an experimental method and the steps in obtaining the results were: 1) choosing a speech stimulus database (speech corpus) - selection of stimulus words (GAT), containing each of 30 speech sounds; 2) choosing of speakers (respondents): 30 speakers with typical (E group) and 105 speakers with atypical pronunciation (C group). They were all native speakers of Serbian language, with an automated articulation base, neat intellectual and hearing status, and neat anatomo-morphological status of the speech organs; 3) speech quality assessment was performed according to the standard GAT procedure, which includes assigning grades from 1 to 7 for pronounced speech sound in each stimulus word, immediately after pronunciation, audio-visual assessment; 4) recording - each spoken stimulus is recorded simultaneously in a soundproof space (quiet room) and memorized in the form of wav files for each stimulus; 5) stimulus processing - from the E group's speech base, stimuli that contained the highest frequency of atypicality, rated with 5 or 6 were selected. A group of 7 speech sounds (/š/, /č/, /dž/, /š/, /ž/, /r/ and /l/) was singled out, which showed the highest frequency of atypical production, by the type of distortion; 6) all stimuli were subjected to a segmentation method using the Praat software package. The pronunciations of the segmented speech sounds of interest were evaluated by the corresponding characteristics of the AT method of perceptual (auditory) analysis, whereby a set of acoustic-articulatory features was obtained for each of the seven speech sounds. Finally, acoustic studies were conducted on the basis of atypically spoken speech sounds in terms of finding acoustic correlates of deviations in the spectral domain.

For this occasion, spectral manifestations of atypical forms of pronunciation for affricate / c / and fricative / š / in the following physical domains will be presented and analyzed: spectral (interdental and adental sigmatism) and intensity (weak or strong frictions).

4 RESULTS

The acoustic structure of atypical speech sound pronunciation may be quite different from the typical structure, and these changes in the spectrum can be manifested in the following physical domains: time (shortened or extended frictions), intensity (weak or strong frictions) and spectral (various forms of sigmatism) (Bilibajkić, Šarić, Jovičić, Punišić, & Subotić, 2016). Some discrepancies may occur in only one domain, but the most common occurrence is their spread across multiple domains (Punišić et al., 2009; Jovičić et al., 2010).

The analysis of deviations' acoustic correlates in the spectral domain showed that deviations by the sigmatism type (interdental, adental and strident sigmatism) and the friction intensity (weak and strong

friction) can be recognized in the spectral domain and it is possible to define the criteria for differentiation of typical and atypical pronunciation for mentioned deviations.

The analysis is comparative in terms of comparing spectral characteristics in typical and atypical speech sounds' production with the aim of attempting to define the boundaries of the "typical-atypical" discriminatory fields and thereby contribute to the objectification of the diagnostic procedure.

The example of spectral analysis of interdental sigmatism in speech sound / c /

In this analysis, long-term averaged spectra (LTAS) of speech sound / c / from stimulus word / cica / determined on the basis of 43 speech stimuli of C and E group were used.

LTASs were determined as it follows: first, for each pronounced speech sound / c /, the long-term spectrum was determined (by averaging the short-term spectra over the entire duration of the speech sound), then the long-term spectra of the speakers were normalized in the sense that the total speech sound intensity was 0 dB and finally, all long-term spectra within the C group are averaged. The same procedure was repeated in the E group.

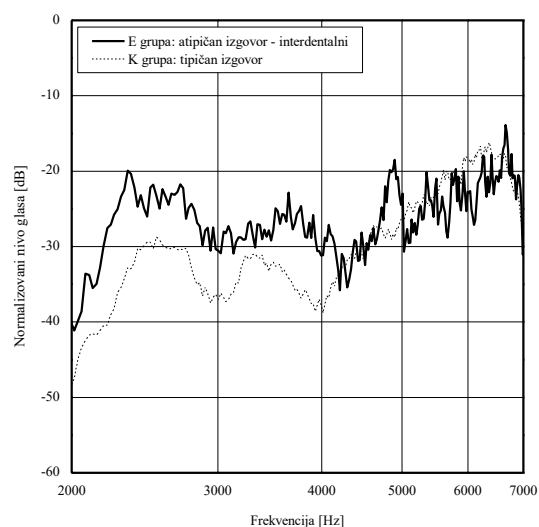
The normalization of the spectra enabled a direct comparison of the LTAS between the C and E group. Figure 1 shows the LTAS of the initial affricate / c / from the word / cica / for the E group (solid line) and C group (dashed line).

A typical pronunciation of affricate / c / is characterized by three energy concentrates located around the 2500, 3500, and 6500 Hz. The levels of the first two energy concentrates are lower by about 13 dB than the levels of the third energy concentrate.

The first characteristic of the spectrum in interdental pronunciation is the considerable alignment of the spectrum, ie. significantly reduced dynamics of spectral concentrates. Consequently, the basic feature of the friction of affricate / c / is lost, which is a pronounced concentrate at high frequencies of about 6500 Hz.

Another feature is the change of position of the first two energy concentrates. The changes are such that the first energy concentrate moves to lower and the second to higher frequencies; therefore, the two energy concentrates are being separated.

All these changes are the result of irregularly formed resonant spaces, the shape and size of which in this case dictates the position of the language.

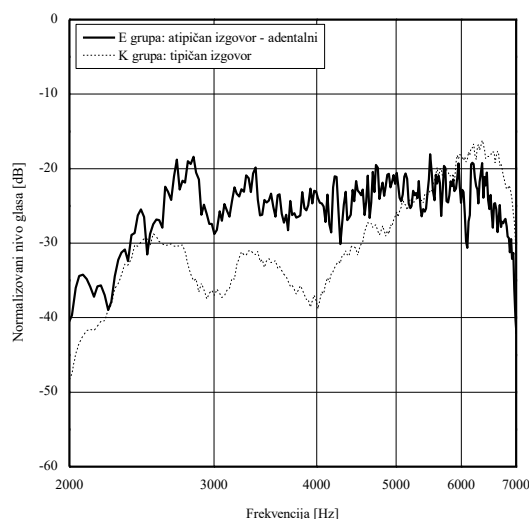


Graph 1. LTAS of affricate /c/ in typical and atypical (interdental) pronunciation

The example of spectral analysis of adental sigmatism in speech sound / c /

In this analysis, long-term averaged spectra (LTAS) of speech sound / c / from stimulus word / cica / determined on the basis of 44 speech stimuli of C and E group were used.

The main feature of the adental pronunciation of speech sound / c / is the almost complete alignment of the spectrum so that the spectral concentrates are lost, as well as the shift of the first and second energy concentrates so that they converge, thus opposite to the results for interdental pronunciation (Graph 2).



Graph 2. LTAS of affricate /c/ in typical and atypical (adental) pronunciation

Criteria for interdental and adental pronunciation of affricate /c/ can be expressed in following way:

1. the position of the first two energy concentrates changes,
2. the first two energy concentrates are shifted by about 200 Hz by moving away at interdental pronunciation and by approaching at adental pronunciation by the same amount,
3. there is a change in the energy ratio in the LF and HF band - the LTAS becomes more flattened (the limit for defining the LF and HF band is about 4000 Hz).

A change in the energy ratio in the LF and HF range, where the LTAS becomes “flattened”, will also appear in the case of weak frictions, the description of which follows, indicating that interdental and adental pronunciations are similar to those with weak frictions, but additionally, there is a shift in energy concentrates. Namely, improper placement of the frictional barrier leads to a decrease in the quality of the generated friction, making it weaker, which is why the LTAS is “flattened” as in the case of the *weak friction*.

The fact that changing the position of the friction barrier’s generating site (interdental and adental pronunciation) leads to a change in the shape of the vocal tract and the shifting of energy concentrates has also been confirmed in the simulation procedure, which will be described.

The example of spectral analysis of weak friction of affricate / c /

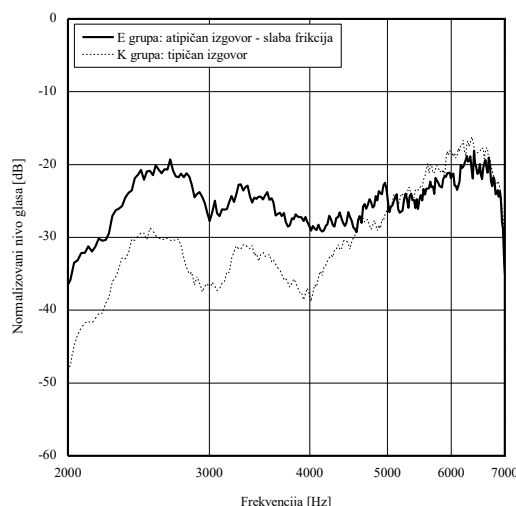
In this analysis, we used LTASs of speech sound /c/ from stimulus-word /cica/ based on 85 speech stimuli of C and E group.

The feature of weak friction was most commonly detected while pronouncing affricate /c/. Figure 3 shows the spectra, of typically (dashed line) and atypically-weak frictions (solid line) pronounced affricate /c/ where the presence of energy concentrates in the vicinity of frequencies: 2500, 3500 and 6500 Hz is visible, but a difference is observed between them in the ratio of HF and LF components.

The division into high and low spectral components is conditional and in this particular case the cut-off frequency is 4000 Hz. Above this frequency, the area is declared as HF and below is the LF.

According to Figure 3, in typical friction of speech sound / c /, the speech sound level in the HF band is about 13.5 dB higher than in the LF band. In the atypical pronunciation of affricate /c/, the difference in energy levels in the HF and LF bands is smaller and is about 6,5 dB.

The criterion for weak friction of affricate /c/ can be expressed in following way: in pronunciation of affricate /c/, friction is weak if the difference in speech sound level in HF (4000 to 7000 Hz) and LF range (2000 to 4000 Hz) is less than 6 dB.



Graph 3. LTAS of affricate /c/ in typical and atypical (weak friction) pronunciation

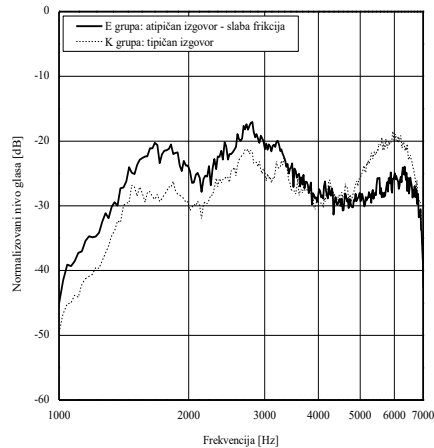
The example of spectral analysis of weak and strong friction of fricative /š/

In this analysis, we used long-term averaged spectra (LTAS) of speech sound / š / from stimulus-word / šuma / determined on the basis of 57 stimuli for the weak and 44 for the strong frictions of the C and E groups.

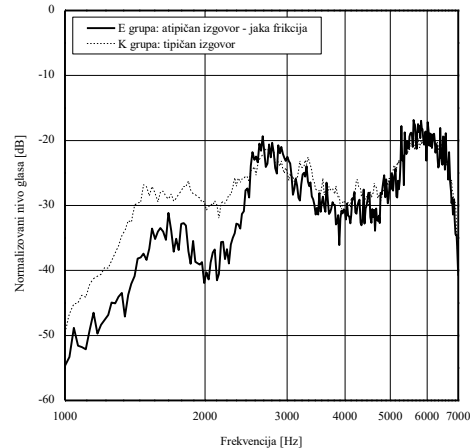
Both spectra, for weak and strong friction, show an energy imbalance in the upper - HF part of the spectrum relative to the lower - LF part of the spectrum compared to the spectrum of typical frictions (Graph 4 and Graph 5).

In the case of weak friction, the ratio of the levels of spectral components of speech sounds above (HF) and below (LF) the frequency of 4500 Hz is essential for proper objective assessment of the quality of the friction seal. In typical pronunciation of fricative / š / the ratio of the total level of HF and LF components of the speech sound is about 2,7 dB, while in the case of weak friction this ratio is -5,9 dB. The criteria for weak friction of fricatives / š / can be expressed in following ways: weak friction occurs if the ratio of the total level of HF and LF components is -5 to -6 dB (Graph 4), with a decrease in intensity in the area of HF components. The difference of HF/LF ratio for typical and weak friction of over 8 dB is sufficient.

In the case of strong friction of fricative / š /, the imbalance of the spectrum, compared to the typical spectrum, occurs around the threshold frequency of 2200 Hz. In typical pronunciation of fricative / š / the ratio of the total level of HF and LF components of the speech sound is, in this case, around 12,4 dB, while in the case of weak friction this ratio is 20,1 dB. The criteria for strong friction of fricative / š / can be expressed in following ways: strong friction occurs if the ratio of the total level of HF and LF components is about 20 dB (Graph 5), with the intensification of the intensity in the area of HF components. The difference of HF/LF ratio for typical and strong friction of about 7,5 dB is sufficient for quality discrimination.



Graph 4. LTAS of fricative /š/ in typical and atypical (weak friction) pronunciation



Graph 5. LTAS of fricative /š/ in typical and atypical (strong friction) pronunciation

5 CONCLUSION

Nowadays, expert or trained listening is most commonly used in assessing the quality of speech sound pronunciation, and it provides the "establishment" of a discriminatory line between typical and atypical pronunciation of Serbian language speech sounds. This is a disadvantage of speech therapy practice, because the analysis of speech sounds, especially atypical ones, can only be conducted by experienced speech therapists with a well-trained auditory perception of the mother tongue phonemes and the detection of the type and degree of features that contribute to their atypicality. An additional disadvantage is that there are no standardized spoken bases of atypical pronunciation for the Serbian language so that speech therapists can "train" their auditory perception during education.

Sound changes in the atypical speech sound realization that the speech therapist perceives are also present in the spectral domain, but finding suitable spectral parameters for the pronunciation quality evaluation was needed. By finding the acoustic correlates of deviations in the spectral domain, an attempt was made to determine the articulatory-acoustic indicators of deviations in speech sound pronunciation. Comparative analysis of spectral characteristics of typical (C group) and atypical (E group) speech sound production defines the boundaries of the "typical-atypical" discriminatory fields in order to objectify the diagnostic procedure. Research has shown that spectral changes that contribute to atypical speech sound pronunciation can be manifested in: time (shortened or extended frictions), intensity (weak or strong frictions) and spectral domain (various forms of sigmatism). The best approach to the analysis of these deviations has been the comparison of long-term averaged spectra (LTAS) of typically and atypically pronounced speech sounds, which enabled the definition of discrimination criteria for distinguishing typically from atypically pronounced speech sounds.

Determining the appropriate spectral parameters for assessing the quality of the pronunciation would contribute to the objectification of atypical features of the speech sound pronunciation, which could have the effect on improving the diagnostic and therapeutic procedure in speech therapy.

Acoustic research has shown that there are correlates in the acoustic domain that can be used to define discrimination criteria for typical of atypical pronunciation, even up to the level of determining the type of pathological pronunciation.

The existence of a more objective criterion for assessing the speech sound articulation quality, based on the determination of clear articulatory-acoustic indices of pronunciation deviation, would contribute to a more reliable classification, categorization of vectors of multidimensional acoustic space in which spoken speech sounds are realized.

Defining the unit vectors of the multidimensional acoustic field of pronounced speech sounds and their relationship with the phonemes correlates in the perceptual domain is one of the directions of the scientific research work that this research has contributed to. This research has shown that by combining subjective and objective measures in the analysis of acoustic correlates of speech sounds, it is possible to develop objective systems for the articulation assessment.

ACKNOWLEDGMENT

The research was partly financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia, within the projects No. 178027 and No.32032.

REFERENCES

- American Psychiatric Association [APA] (2013). *Diagnostic and Statistical Manual of Mental Disorders*, (5th ed., text rev. DSM-5). Washington, DC: Author.
- Bilibajkić, R., Jovičić, S., Šarić, Z., Punišić, S., & Subotić, M. (2013). Automatic detection of speech pathology - toward the expert system. In M. Sovilj & M. Subotić (Ed.), *Proceedings Speech and Language 2013*, 4th International Conference on Fundamental and Applied Aspects of Speech and Language, (pp. 340-346). Belgrade: LAAC & IEPSP.
- Bilibajkić, R., Šarić, Z., Punišić, S., Subotić, M., & Jovičić, S.T. (2013). Automatic evaluation of stridence in speech based on the auditory model. In S.T. Jovičić & M. Subotić (Ed.), *Verbal communication quality, Interdisciplinary Research, II* (pp. 111-128). Belgrade: LAAC & IEPSP.
- Bilibajkić, R., Šarić, Z., Jovičić, S.T., Punišić, S., & Subotić, M. (2016). Automatic detection of stridence in speech using the auditory model, *Computer Speech & Language*, ISSN 0885-2308, March 2016, Advance online publication. DOI: <http://dx.doi.org/10.1016/j.csl.2015.08.006>, Volume 36, p. 122–135.
- Boersma, P., & Weenink, D. (2010). Praat: *doing phonetics by computer [Computer program]*, Version 5.1.34, retrieved 31 May 2010. from <http://www.praat.org/>
- Jovičić, S., Kašić, Z., & Punišić, S. (2008). Trajanje frikativa /š/: analiza u izolovanim rečima, *XVI Telekomunikacioni forum - TELFOR*, Beograd, 715-718.
- Jovičić, S. (1999). *Govorna komunikacija: fiziologija, psihoakustika i percepcija*, Nauka, Beograd.
- Jovičić, S., Kašić, Z., Punišić, S. (2010). Production and perception of distortion in word-initial friction duration. *Journal of Communication Disorders* 43/5., DOI:10.1016/j.jcomdis.2010.04.007.
- Kostić, Đ., Vladislavljević, S., & Popović, M. (1983): *Testovi za ispitivanje govora i jezika*. Zavod za udžbenike i nastavna sredstva, Beograd.
- Lehiste, I., & Ivić, P. (1986). *Word and Sentence Prosody in Serbocroatian*. MIT.
- Luders, E., Kurth, F., Pigdon, L., Conti-Ramsden, G., Reilly, S., Morgan, A.T. (2017). Atypical Callosal Morphology in Children with Speech Sound Disorder, *Neuroscience*, doi: <https://doi.org/10.1016/j.neuroscience.2017.10.039>
- Miletić, B. (1952). *Osnovi fonetike srpskoga jezika*. Znanje, Beograd.
- Morgan, A., Bonthron, A., Liegeois, F. J. (2016) Brain basis of childhood speech and language disorders: are we closer to clinically meaningful MRI markers? *Curr Opin Pediatr* 28:725-730.
- National Institute on Deafness and other Communication Disorders - NIDCD (2010). Statistics on Voice, Speech, and Language.
- Punišić, S., Pantelić, S., Subotić, M., & Đoković, S. (2006). Karakterizacija glasovnih odstupanja u Globalnom artikulacionom testu. *Zbornik radova L Konferencije ETRAN*, Beograd, 450-453.
- Punišić, S., Subotić, M., Čabarkapa, N. (2009). Stability of articulatory-acoustic characteristics in fricatives of the serbian language. *Speech*, vol. XXVI-br. 2. Zagreb.
- Punišić, S., & Jovičić, S. (2010). Artikulaciono-akustičke karakteristike glasa /c/. *Zbornik radova 54. Konferencije za ETRAN*, D. Milanovac, AK4.4-1-4.
- Punišić, S., Jovičić, S., Kašić, Z., & Golubović, S. (2010). Analiza trajanja i intenziteta zvučnih glasova /dž, ž, r, l/ u tipičnoj i atipičnoj produkciji. *DOGS - Digitalna obrada govora i slike VIII*, Iriški Venac, A 1.4.1-A1.4.4.
- Punišić, S., Jovičić, S., & Subotić, M. (2011). Analysis of duration and intensity of voiceless affricatives and fricatives in typical and atypical pronunciation. In M. Sovilj, M. Skanavis & V. Bojanova (Ed.), *Third European Congress on Early Prevention, Detection and Diagnostics of Verbal Communication Disorders. Proc.* (pp. 72-79). Belgrade.

- Punišić, S., Jovičić, S., Subotić, M., Šarić, Z., & Bilibajkić, R. (2012). Stridens-spektralna distorzija glasova: auditivna i akustička analiza. *DOGS - Digitalna obrada govora i slike, IX*, Kovačica, 60-64.
- Punišić, S., Kašić, Z., Golubović, S., & Jovičić, S. (2013). Characteristics of perceptive identification of level of duration deviation for fricative /ʃ/ in trained and untrained listeners. In M. Sovilj & M. Subotić (Ed.), *Proceedings Speech and Language 2013, 4th International Conference on Fundamental and Applied Aspects of Speech and Language*, (pp. 100-110). Belgrade: LAAC & IEPSP.
- Punišić, S. (2016). Analiza atipičnog izgovora sa artikulacionog, akustičkog i perceptivnog aspekta. [Articulation, acoustic and perceptive aspects in analysis of pathological pronunciation]. *Monography*, Beograd: CUŽA, IEPFG.
- Rosa, E. da. (2017). Linguistic Variation in English. *R. Letras, Curitiba*, v. 19, n. 25, p. 35-50.
- Subotić, M., Vojnović, M., & Punišić, S. (2010). Spektralne karakteristike afrikcije glasa /c/. *Zbornik radova, LIV Konferencije ETRAN-a*. Donji Milanovac, AK4.3-1 - AK4.3-4.
- Subotić, M., Šarić, Z., Bilibajkić, R., Jovičić, S.T., & Punišić, S. (2015). Objective approach to the acoustic characteristics of stridence. *Speech and language 2015, 5th International Conference on Fundamental and Applied Aspects of Speech and Language*, Belgrade, pp. 65-90.
- Stevanović, M. (1981). *Savremeni srpskohrvatski jezik I*, Naučna knjiga, Beograd.
- Vojnović, M., Punišić, S., & Subotić, M. (2010). Spektralne karakteristike afrikcije i frikcije u tipičnom i atipičnom izgovoru glasova srpskog jezika, Konferencija i zasedanje na Komisijata za fonetiku i fonologiju pri Međunarodniot slavistički komitet, 28-29. oktombri, JNU IMJ "Krstе Misirkov", Skopje, Makedonija, str. 3.
- Vojnović, M., & Punišić, S. (2011). Atipičan izgovor frikativa /ʃ/ kod dece. *Zbornik radova, XVIII Telekomunikacioni forum TELFOR*, Beograd, 1075-1078.

The Importance of Preschool Hearing Screening

Tatjana Adamović^{1,2}, Slavica Maksimović^{1,2}, Milan Vojnović²

¹ Institute for Experimental Phonetics and Speech Pathology “Djordje Kostic”, Belgrade, Serbia;

² Institute for Research and Development “Life Activities Advancement Centre” Belgrade, Serbia

ABSTRACT

Child's auditory function during the preschool period, should be controlled on several occasions. The reason for this are hidden hearing deficits, even the most discreet ones, that can be a disruptive factor in the adoption of specific skills at school such as reading and writing. Hearing loss often gradually progresses from slight to more serious during early childhood, and sometimes even into school age years. The aim of this paper was to examine the reliability and feasibility of transient otoacoustic emission (TEOAE) as a screening method in the assessment of hearing loss (HL) in preschool children. In a sample of N = 54 children, aged 5.0 to 5.4 years, the auditory function (AF) was tested by TEOAE, tympanometry and audiometry. The hearing function in five-year-olds was tested twice. The first time on the whole sample of children, and the second time only on the part that failed at the initial testing. After the child was cured and monitored over a period of 6 months, a control test was conducted to confirm or deny the existence of a suspected hearing deficit. Assessment of speech and language development was additionally carried out. The obtained results indicated that 94.40% of the sample has a proper auditory function, 3.70% bilateral conductive hearing loss and 1.9% bilateral sensorineural hearing impairment. Results confirmed the high degree of positive correlation ($r_t = +0.81$, on the level 0.01) between tympanometry and TEOAE responses, indicating the sensitivity of the TEOAEs methods in the detection of both sensorineural and conductive hearing impairments. Introduction of systematic programs for preschool hearing screening can play an important part in promoting early intervention for childhood hearing loss and minimizing the negative consequences for children. Otoacoustic emissions offer the most promising option for systematic hearing screening of the preschool population.

Key words: conductive hearing loss, child, otoacoustic emission, screening, pre-school age

1 INTRODUCTION

Hearing impairment is a relatively common phenomenon in children, predominantly conductive hearing impairment due to various inflammatory processes of the middle ear (Babac, 2010). According to Yin et al. (2009), normal hearing in pre-school children is a key factor of speech, language and social-emotional development. The same authors point out that the TEOAE screening test is a fast, efficient and easily feasible technique that needs to be applied in preschool institutions for assessing the hearing function.

An increased number of authors has been interested in the influence of pathological disorders of the middle ear on the otoacoustic emissions (Ho et al., 2002; Margolis, 2000). Babac et al. (2010), conducted a study to examine the reliability and feasibility of otoacoustic emissions in the assessment of hearing in children, in the assessment of the frequency and type of hearing impairment and in defining the etiological factors that led to the aforementioned impairment. The study examined 133 children, aged 2 to 7.5 years, in both ears by the method of transient (TEOAE) and distortion (DPOAE) otoacoustic emissions. The obtained results confirmed a *high* degree of correlation between tympanometry findings and results of selective testing for TEOAE and DPOAE, indicating that the tests of TEOAE and DPOAE are reliable, non-invasive, easy and quick methods of examining hearing in children.

Working on early detection of hearing loss in children up to five years of age, Ho et al. (2002) compared the results of tympanometry screening and transient otoacoustic emissions. They concluded that

the TEOAE method is reliable in the detection of both sensorineural and conductive hearing impairments. Otoacoustic emissions can be registered in the regular function of the middle and the inner ear, while they are otherwise absent or reduced in the impaired cochlea and/or the middle ear, even of a milder degree.

In view of the fact that middle-ear diseases are the most common cause of hearing impairment in childhood, the idea was launched of attempting to apply otoacoustic emissions in an adult group of children aged 1 to 7 (Babac et al., 2010; Van Cauwenberg et al, 1999). The same author emphasized high sensitivity of the results of the TEOAE testing and tympanometry examination. The chronic secretory otitis is the most frequent cause of hearing impairment in children and the most frequent indication for surgical intervention. Untreated or inadequately treated, these pathological processes can lead to irreversible damage to the middle or the inner ear. For these reasons, there is a need for the earliest detection possible to ensure adequate and timely therapy.

Children with mild hearing loss have greater difficulties than their peers with normal hearing ability. There is evidence that fine speech perception skills are critical for language development and learning, and weakness in auditory discrimination of speech sounds is one of the most common causes of poor reading. Such findings suggest that academic success largely depends on a person's ability to receive and discriminate the differences between spoken words (Maltby, 2000).

2 AIM

The aim of this paper was to examine the reliability and feasibility of transient otoacoustic emission (TEOAE) as a screening method in the assessment of hearing loss (HL) in preschool children.

3 RESEARCH METHODOLOGY

The testing of auditory function was conducted on a sample of $N = 54$ children, of calendar aged from 5.0 to 5.4 years, of which $N = 29$ were male and $N = 25$ were female. Hearing testing using transient otoacoustic emission (TEOAE), tympanometry and tonal liminary audiometry was performed at the Djordje Kostic Institute for Experimental Phonetics and Pathology of Speech (IEFPG), and at the Center for the Advancement of Life Activities (CUŽA) in Belgrade. With each of these three techniques, the hearing of a five-year-old was examined twice. For the first time on the whole sample of children, and for the second time only on the part of the sample which, due to failure to pass the initial testing, was referred for a detailed audiological examination. Following the healing and follow-up of the children for a period of 6 months, control testing was conducted to confirm or deny the existence of a hearing deficit. The results of TEOAE imaging, tympanometry, and tonal audiometry were interpreted by audiologists at IEFPG.

To test cochlear function of children aged 5, we used the COCHLEA device (Subotić, 2013), constructed by the expert team at the IEPSP and developed within the technological project of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Technological project No. IT108.0239.B/2, patent II528/03). The literature on factors that could impair the quality of the TEOAE-2 responses, such as external and internal noise (Mikić et al., 2005), prompted us to record cochlear function in both ears in the tested sample of children by the COCHLEA device, in a soundproofed room where the sound pressure level (SPL) of ambient noise was $\text{SPL}=30\text{dBA}$. At the same time, we chose an adequate probe extension in relation to the diameter of the external auditory canal to prevent an additional loss of the deep spectrum frequency of the stimulus.

The course of examination was followed on the display. Each test started with the calibration, automatically followed by the phase of stimulation and the registration of the corresponding TEOAE responses. The result of the TEOAE test was displayed in two categories, as PASSED or FAILED (Adamović and Sovilj, 2013).

The regularity of the middle ear function in the tested sample of five-year-olds, was examined by tympanometry. The impedancemeter Maico MI 24 device was used for this purpose. Once the tympanometer was turned on, the calibration procedure preceded the beginning of measurement. If the

calibration was regular, the tympanometer probe with an adequate rubber tip was carefully placed in the child's external ear canal, completely closing it. The rubber tip and the part of the probe placed in the subject's ear were cleaned by alcohol, which was an important part of the procedure during the tympanometry measurement. In the assessment of the results, the type A tympanogram was considered as a regular finding of the middle ear function and the passed test (the pressure between -100dPa and +50dPa). In contrast, the flat type B tympanogram and the negative pressure in the middle ear – the type C tympanogram (with the pressure from – 100 to – 200 dPa or even higher than – 200 dPa), indicated the disorder of the middle ear function and the failed test (Babac, 2010; Adamović, 2015). Children with impaired middle ear function were directed to a detailed ORL and audiological examination. When the child was cured, control tympanometry was scheduled to confirm or deny hearing impairment of the conductive type.

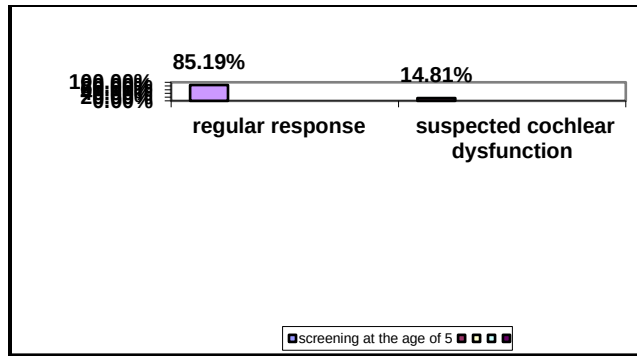
The hearing sensitivity of five-year-olds was examined by the method of tonal liminal audiometry. Audiometer Maico M53 was used for that purpose. Subjects with a decrease in hearing sensitivity or a registered hearing threshold, were examined for both airborne and bone conduction. Masking of the untested ear was necessary in all bone conductivity measurements to avoid the effect of transmitting sound through the bones of the head to the other side. In accordance with the World Health Organization classification, the degree of hearing impairment was ranked by the classification criterion of pure tone hearing threshold at the frequencies of 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz.

For the assessment of speech-language development (SLD) of five-year-olds included in this study, the test or subscales were used (test for the assessment of SLD) within the standardized Scale for the assessment of psychophysiological abilities of a child aged 0-7, by the author Neda Subota (Adamovic, 2015). This scale is an integral part of the IEPSP battery of tests and enables relatively quick and accurate evaluation of overall abilities of a child compared to its calendar age. Depending on the achieved level of SLD of five-year-olds and their chronological age, the test performance is assessed in percentage in relation to 100%. The number of positively assessed questions is calculated in relation to 100%, so the deviations for the given age can be clearly noted.

Statistical data processing was conducted using the SPSS (Statistical Program for Social Sciences) package, version 20.

4 RESULT AND DISSCUSION

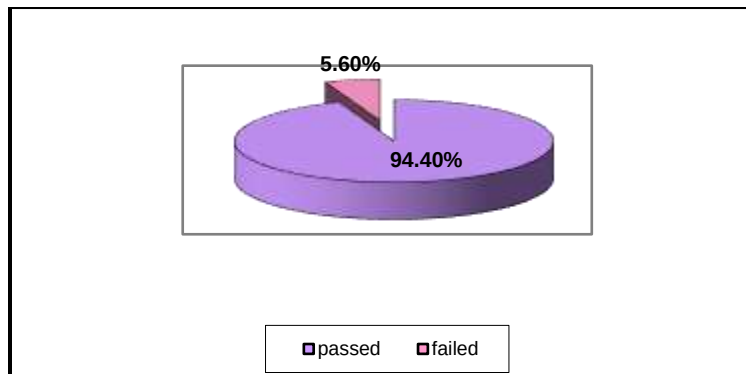
Examining cochlear function by the TEOAE was carried out in both ears in 54 children - 29 boys and 25 girls. An average calendar age of subjects during the TEOAE test was from 5.0 to 5.4 years. The TEOAE test in five-year-olds was carried out twice. The first time – on the whole sample of children, and the second time – only on the part of the sample that was subjected to the control TEOAE testing.



Graph 1 – The preliminary results of the TEOAE test at the age of 5

Graph 1 indicates that in 85.19% of children (46 out of 54 subjects) the test results of the inner ear function were bilaterally regular. On the other hand, 14.81% of the sample (8 out of 54 subjects), were referred for the otoscopic examination and the additional audiological testing due to suspected cochlear dysfunction (5 subjects failed the test bilaterally, 2 in the right ear, and only in 1 child the absence of the cochlear response was registered on the left side).

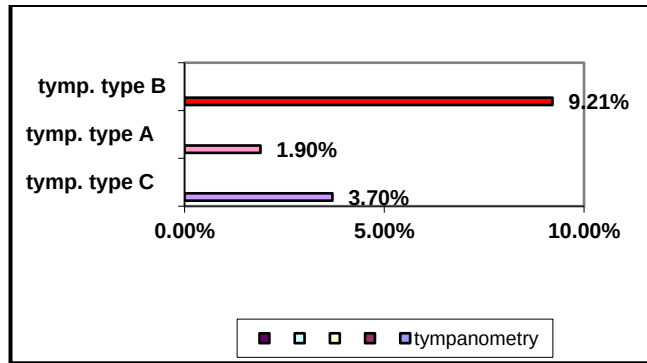
After removal of cerumen, adequate medicament and surgical therapies and monitoring children during the period of 6 months, the control TEOAE testing was carried out in all 8 subjects in both ears, to deny or confirm the suspected cochlear dysfunction.



Graph 2 – The confirmed results of the TEOAE test

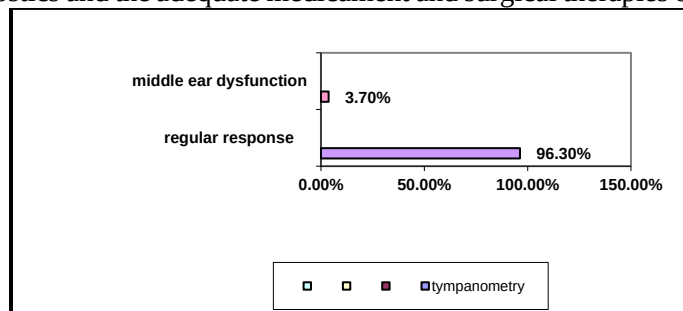
The final results of the TEOAE test, shown in Graph 2, indicate that the total of 3 children or 5.6% of the examined sample failed the test bilaterally, while 51 children or 94.4% of the sample passed the test both on the left and the right side.

Out of 14.81% of the sample (8 out of 54 subjects) with the suspected hearing impairment after a selective TEOAE test who were referred to the otoscopic examination and additional audiological diagnostics, 9.21% of the sample or 5 five-year-olds had type B tympanogram, 3.70% or 2 subjects had type C tympanogram, while only 1 subject or 1.90% of the sample had a regular type A tympanogram (Graph 3).



Graph 3 - Tympanogram type and its representation in five-year-olds who were referred to the additional audiological diagnostics

Graph 4 shows the results of the control tympanometric measurement, carried out after detailed ORL and audiological diagnostics and the adequate medicament and surgical therapies over a period of 6 months.



Graph 4 – The confirmed results of the tympanometry test

The final results of tympanometry showed that 96.3% of the examined sample or 52 children, had bilaterally regular type A tympanogram which indicates a normal function of the middle ear, in 2 subjects or 3.7% of the sample had a dysfunction on the level of the middle ear with type B tympanogram (also bilaterally).

The results shown in Table 1 indicate that in 20.4% of children aged 5 the lowest hearing threshold was registered in the right ear, which is 15dB, i.e. in the left ear in 33.3% of children. At the same time, the maximum value of an elevated hearing threshold of 58.75dB in the right and 73.75dB in the left ear, was recorded in 1.9% of the examined sample i.e. in 1 child.

Table 1 - The basic results on the hearing threshold in five-year-olds

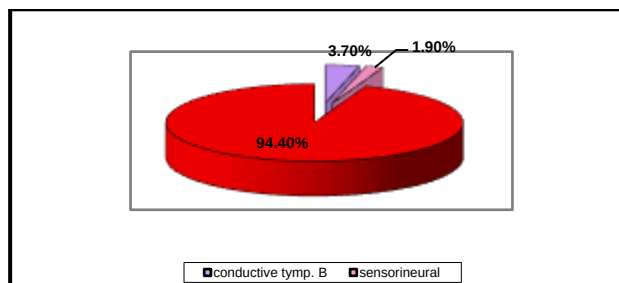
	min.	max.	AM	SD	N
right	15,00 (20,4 %)	58,75 (1,9 %)	20,95	7,12	54
left	15,00 (33,3 %)	73,75 (1,9%)	21,41	9,10	54

The correlation coefficient is $r=+0.97$ and is significant on the level of 0.01. It can be concluded with 99% confidence that there is a *very high* degree of positive correlation between the hearing threshold in the right ear and the hearing threshold in the left ear of five-year-olds in our research.

Table 2 - Correlation of the audiometric results in the left and in the right ear

	audiometry right
audiometry left	$r = + 0,97$ (level 0,01)

Children with a lower hearing threshold in one ear, also have a lower hearing threshold in the other and vice versa, five-year-olds with a higher hearing threshold in one ear, also have a higher hearing threshold in the other (Table 2).



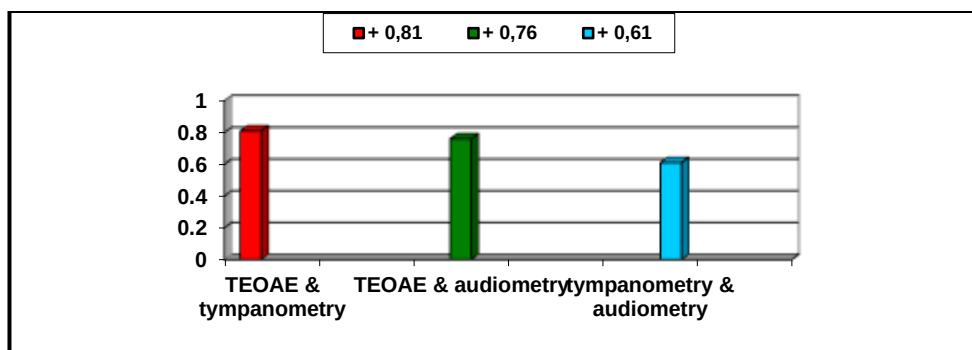
Graph 5 – Confirmed hearing impairment by summarizing the TEOAE, tympanometry and tonal audiometry results (N=54)

After the second i.e. control examination of auditory function in the examined sample of five-year-olds, considering the results of the TEOAE-2 test, tympanometry and audiometry, it was found that 94.40% of the sample or 51 children had a regular hearing function, while 5.6% of the sample or 3 subjects had a hearing impairment (Graph 5).

Table 3 – Type and representation of confirmed hearing impairment after complete audiological diagnostics

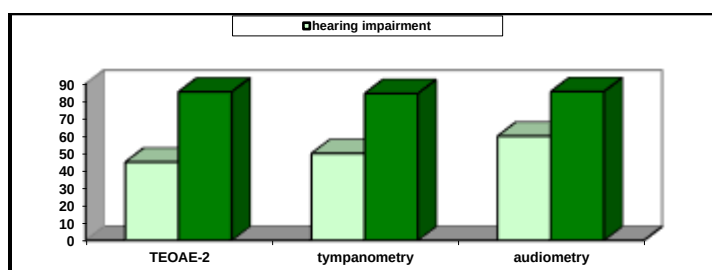
	Type of hearing impairment		total
	Conductive n (%)	Sensorineural n (%)	n (%)
Bilateral	2 (3,70%)	1 (1,9%)	3(5,6%)
Unilateral	0 (0,00%)	0 (0,00%)	0 (0,00%)
total	2 (3,70%)	1 (1,9%)	3 (5,6%)

The results shown in Table 3 indicate that 2 children or 3.70% of the examined sample had bilateral conductive hearing impairment, while 1 subject or 1.9% of the sample also had sensorineural hearing impairment in both ears. Conductive hearing impairment with type B tympanogram was the consequence of the chronic secretory otitis in both cases, while the use of ototoxic drugs during neonatal infection period was the most probable cause of bilateral sensorineural hearing impairment recorded in 1 subject, as indicated by detailed anamnestic data. In case of the sensorineural impairment, the function on the level of the middle ear was preserved as confirmed by the tympanometry finding with type A tympanogram.



Graph 6 - The correlation between the TEOAE-2, tympanometry and audiometry

The results shown in Graph 6 indicate a very high degree of correlation between the results of the TEOAE-2 test and tympanometry i.e. the results of the function of the middle ear and the results of the function of the middle ear in children aged 5. The tetrahoric correlation coefficient is $r_t = +0.81$ and is significant on the level of 0.01 so it can be concluded with 99% confidence that children with an impaired cochlear function also have an impaired function on the level of the middle ear in a significantly higher percentage, i.e. all children with the normal condition of the inner ear also have the normal condition of the middle ear.



Graph 7 – SLD, SMD and SEB in children with regular and impaired hearing function

Observing the results of SLD, SMD and SEB in the group of children with hearing impairment compared to the group of children with regular hearing function, the visible differences were found in favor of children with normal auditory function (Graph 7).

5 CONCLUSIONS

- 94.40% of the sample has a proper auditory function, 3.70% bilateral conductive hearing loss and 1.9% bilateral sensorineural hearing impairment
- The high degree of positive correlation ($r_t = +0.81$, on the level 0.01) between tympanometry and TEOAE responses, as well as between audiometry and TEOAE responses ($r_t = +0.76$, on the level 0.01) indicating the sensitivity of the TEOAEs methods in the detection of both sensorineural and conductive hearing impairments.
- TEOAE is a reliable and easily to perform screening method for assessing conductive hearing impairment in preschool children. Otoacoustic emissions offer the most promising option for systematic hearing screening of the preschool population.

ACKNOWLEDGMENT

Research is supported by the Ministry of Education, Science and Technological development of the Republic of Serbia within the project no. 178027.

REFERENCES

- Adamović, T., Sovilj, M.: (2013). Auditory disfunction in children. *Beogradska defektološka škola*, ISSN 0354-8759, Association of Defectologists of Serbia and Faculty of Special Education and Rehabilitation, Belgrade, UDK 372.76, br. 55, vol 19 (1) : 1-20. (in Serbian)
- Adamović, T.: (2015). Correlation of vestibular and cochlear responses in children in the prelingual period and at the age of 3 to 5 years. *Doctoral dissertation*, University of Belgrade. (<http://nardus.mpn.gov.rs/handle/123456789/2712>, in Serbian)
- Babac S., Petrović-Lazić M., Tatović M., Kamberović-Stojanović V., Ivanković Z. (2010). Otoacoustic emissions in hearing assessment in children. *Military Medical Review*, ISSN: 0042-8450, UDC: 616.28-072.7:616-053.2; 67 (5): 379-385.
- Ho V., Daly K.A., Hunter L.L., Davey C. (2002). Otoacoustic emissions and tympanometry screening among 0-5 year olds. *Laryngoscope*, 112: 513-9
- Maltby, M. (2000). A new speech perception test for profoundly deaf children, *Deafness and Education International*, 2, 2, 86-101
- Margolis, R. H. (2002). Influence of Middle Ear Disease on Otoacoustic Emission. In Glatke & Robinette (eds.) *Otoacoustic Emissions: Clinical Applications*. Thieme, New York, Stuttgart
- Mikić, B., Đoković, S., Sovilj, M., Pantelić, S. (2005). Otoacoustic emission in neonatus, children and adults. *Monograph Otoacoustic emission-theory and practice*, IEPSP, P.A.L.O., Belgrade, 5: 122-142.
- Subotić M. (2013). Impact of acoustic and biological noise on the quality of otoacoustic emission signal measurement. *Doctoral dissertation*, Faculty of Electrical Engineering, University of Belgrade. (in Serbian)
- Yin L., Bottrell C., Clarke N., Shacks J., Poulsen M.K. (2009). Otoacoustic emissions: a valid, efficient first-line hearing screen for preschool children. *J Sch Health*, doi: 10.1111/j.1746-1561.2009.00383.x.; 79 (4): 147-152.
- Van Cauwenberg P, Watelet JB, Dhooge I. (1999). Uncommon and unusual complication of otitis media with effusion. *Int J Pediatr Otorhinolaryngol*, (49): 119-25.

Detection of Lateral Sigmatism using Support Vector Machine

Ružica Bilibajkić, Milan Vojnović and Zoran Šarić

Life Activities Advancement Center

Gospodar Jovanova 35, Belgrade, Serbia

r.bilibajkic@add-for-life.com, vojnovicmilan@yahoo.com, sariczoran@yahoo.com

ABSTRACT

Sigmatism or lisp is an articulation disorder characterized by defective articulation of sibilant sounds. Lateral sigmatism is a form of lisp which occurs when the air stream is forced over the sides of the tongue instead of being directed through the centre of oral cavity. Traditionally, the existence and severity of these types of articulation disorders are determined by trained professionals - speech therapists by the means of audiovisual assessment. This paper proposes a method for automatic detection of lateral sigmatism. The proposed method is based on SVM (Support Vector Machine) as a binary classifier and its ability to distinguish between normal and pathological speech. Speech samples of simulated lateral sigmatism and normal speech are collected for stimuli words that contained phonemes /c/, /s/ and /z/. This speech database is used for SVM training and testing. The results show that it is possible to achieve significant level of correspondence between the results of automatic detection and real classes.

Key words: lateral sigmatism, SVM, articulatory disorders

1 INTRODUCTION

The advancements in the field of speech technologies and signal processing have enabled the development of computer programs and systems that could be used as a useful tool in speech therapy and diagnosis (Chen et al., 2016; McKechnie et al., 2018). Although these tools have become increasingly appreciated among patients and speech language pathologists (SLPs), it is necessary to invest further efforts in order to form efficient and reliable computer-based speech diagnostic tools. In this paper, we proposed a method for automatic detection of one form of speech disorder - lateral sigmatism.

Sigmatism, also called lisp, is a speech disorder in which sibilant sounds are misarticulated. Sigmatism is one of the most common types of speech disorders found in children (Punisić, 2012). It is possible to differentiate between interdental, lateral, nasal, strident and palatal sigmatism. Each of the sigmatism types is characterized by specific articulation pattern i.e. position of the articulators and affects the articulation of all or only a subset of sibilant sounds. In lateral sigmatism, an airflow which normally goes through the center of the mouth cavity during the production of sibilants is redirected to flow laterally, over the sides of the tongue, resulting in faulty articulation.

Most of the studies regarding the sigmatism mainly focus on articulatory movements and acoustic correlates of misarticulations (Daniloff, Wilcox & Stephens, 1980; Baum & McNutt, 1990; Weismer & Elbert, 1982; Suzuki et al., 1995; Vojnović & Jeličić, 2015). The perception of lateral sigmatism is explored by Akagi, Suzuki, Hayashi, Saito and Michi (2001) for Japanese and found that spectral envelope peaks differ in the case of lateral sigmatism compared to the normal speech.

Only a few of the studies have addressed algorithms for computer-aided diagnosis of lateral sigmatism, while most of the studies focus on the evaluation of the correct/incorrect articulation of the phoneme, not on the identification of the particular sigmatism type.

Mujunen, Leinonen, Kangas and Torkkola (1993) used Kohonen self-organizing maps and short-time FFT spectra to detect the misarticulation of phoneme /s/. The results showed that self-organizing maps are suitable for the extraction and measurement of acoustic features that correspond to psychoacoustic classification.

Another system for sigmatism detection is proposed by Benselama, Guerti, and Bencherif (2007). This system is developed for the Arabic language. The authors use MFCCs as features and HMM combined with Gaussian Mixture Models (GMM) for speech segmentation. The Artificial Neural Network (ANN) is used for phoneme evaluation. The classifier was trained with data from TIMIT corpus, as well as with the data from their own speech database. They obtained 89 % classification accuracy.

Botinhao, Noeth, Hornegger, and Maier (2009) investigated classification of normal speech and samples with lateral and interdental sigmatism using the different feature sets (Mel frequency cepstral coefficients - MFCC, Modified MFCC, energy) and three classifiers from WEKA toolbox (Witten & Frank, 2005) : Naïve Bayes, logistic and VIAregression. The best classifier resulted in 67 % of recognition rate.

The database of simulated misarticulations which included interdental, lateral and dentalized sigmatism and database of normal speech is used by Valentini-Botinhao et al. (2012) to train a classifier in order to distinguish between mispronounced and correct sibilant sounds. They used several features including MFCC, energies in specific bandwidths of the spectral envelope, and the so-called supervectors. Recognition results were calculated at a phone, word and speaker level for both the simulated database and for a database of real pathological speech. The recognition rates of up to 86 %, 87 % and 94 % at a phone, word and speaker level are achieved for the simulated database.

Miodonska, Kręcichwost and Szymańska (2016) developed a system for the classification of sibilant [Z] that was trained with data from 60 preschool children (5 and 6 years old) from Poland. Their model uses the first 13 MFCCs, together with the frequencies and amplitudes of three fricative formants, and also the first four normalized spectral moments. They use the Fisher linear discriminant analysis to reduce the dimensionality of the features. The feature sets have been classified using the Support Vector Machine with a linear kernel. The best-obtained accuracy of the classification is 94.48 %.

The detection of sigmatism in consonant /z/ is analyzed by Bodusz, Miodonska and Badura (2017) and it was based on spectrogram analysis in the form of image processing used for feature extraction and classification. Five features (image centroid, average centroid crossing ratio, entropy, standard deviation, and average gray level) are extracted, and the classification is performed using the SVM. The database consisted of 140 speech recordings with 50 normal and 90 pathological samples. The authors reported accuracy of 85.7 % in binary classification on normal/pathological speech.

Krecichwost, Miodonska, Badura, Trzaskalik and Mocko (2019) proposed the method for the detection of lateral stigmatism. The acoustic signal is acquired using the microphone array mounted on the acoustic mask. Two different feature vectors containing MFCC and fricative formants are evaluated in terms of classification. They used SVM as a classifier. The results show that the multichannel speech signal processing supported by beamforming has a positive impact on the detection of lateral sigmatism. The proposed model showed 80 % accuracy in distinguishing between normal and pathological class.

One other approach to sigmatism detection for the Portuguese language was proposed by the Anjos et al. (2018). The isolated sibilant sounds recorded from 145 children were modeled using the MFCC. The SVM was used as a classifier and the false-negative rate was used as a measure of phoneme distortion. About 66 % of the samples that were automatically detected as distortions were confirmed by an SLP as having some sort of distortion or are perceived as being the production of a different sound.

The method proposed in this paper is based on the binary classification on normal and pathological speech sound in the form of lateral sigmatism. The SVM is used as a classifier and MFCCs as features. The speech database contained recordings of three Serbian words, each with one sibilant sounds. The speakers recorded normal speech and simulated misarticulations – lateral sigmatism. Section 2 of this paper is dedicated to the methodology of data collection, data pre-processing and classification. The results are given in section 3. The conclusions and discussion on the further development of the algorithm are given in section 4.

2 METHOD

Training and testing of the classifier were performed using the database of simulated pathological speech and normal speech. All speech samples needed to be pre-processed in terms of manual segmentation, annotation and feature extraction. The SVM is used as a classifier since it gives good results even in the case of high-dimensional data and a relatively small sample size.

Data collection

A group of 14 speech language therapists (13 female and 1 male) was recorded in the quiet room using the ZOOM H4n Handy recorder speaking the Global Articulation Test stimuli, a Serbian test commonly used in speech therapy. Data were sampled at 44.2 kHz with 16-bit quantization. At the time of recording, all participants were employed as speech language pathologists at the Institute of Experimental Phonetics and Speech Pathology “Djordje Kostic”, and none of them reported having the speech disorder. Therefore, all of them were able to produce normal speech as well as to simulate lateral stigmatism. The participants were asked to simulate mispronunciation of lateral stigmatism in initial phonemes of the words /zima/ and /seka/, and phoneme /c/ in the initial and inter vowel position in the word /cica/.

Data pre-processing

Each word is manually segmented from the recordings, and all phonemes in all words are manually annotated. Segmented words are normalized by the maximum absolute amplitude within the word.

The analyzed phonemes were divided into 20ms frames with 10ms overlap. Each frame is parametrized by a set of 24 Mel Frequency Cepstral Coefficients (MFCCs) used as feature vector. The MFCCs are widely used in speech processing. They are calculated through several steps few steps. In the first step, spectrum of the speech segment is filtered by Mel filter bank. In the second step, logarithm of the obtained result is calculated. In the third processing step, discrete cosine transform (DCT) is used to obtain MFCC coefficients. Mel filter bank consisted of 40 filters, covering the frequency range from 113Hz to 6854 Hz.

Classification

The input speech is classified into normal class or pathological class using the Support Vector Machine (SVM). Support-vector machines (SVMs) (Vapnik, 1998; Cortes & Vapnik, 1995) are a set of supervised learning methods used for classification and regression. SVMs use learning algorithms in order to analyze training data and build a hyperplane in multidimensional space that best separate classes.

When provided with the labelled training data which are marked to belong to one of the two classes, an SVM algorithm finds the optimal hyperplane which classifies classes correctly and maximizes the margin between two classes (Figure 1). The closest values to the classification margin are known as support vectors. The SVM's goal is to maximize the margin between the hyperplane and the support vectors. Support vectors are the data points nearest to the hyperplane, which, if removed, would alter the position of the dividing hyperplane. They are essential because they provide a compact description of the learned model.

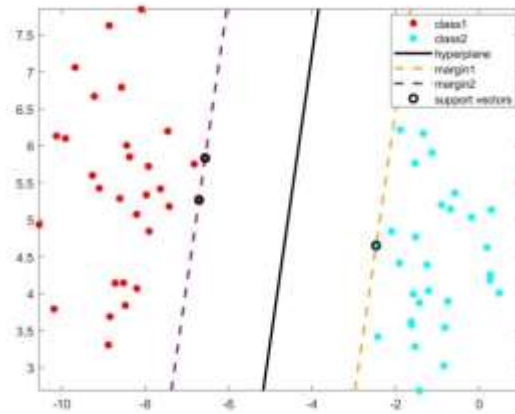


Figure 1: Classification of linearly separable classes using SVM

If the training data are not linearly separable a soft margin SVM can be used. This form of SVM defines a hyperplane that correctly classifies the majority of data but allows for some data to be incorrectly classified (Figure 2). This results in a wider margin and greater error on the training set but in turn, improves generalization and/or enables a linear separation of data that is not linearly separable. The SVM uses the slack parameter to control the trade-off between the width of the margin and the classification accuracy.

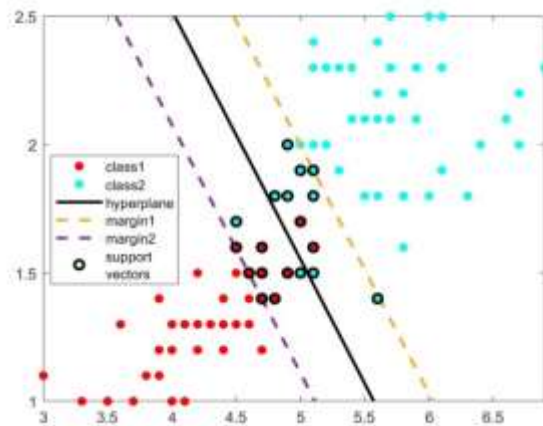


Figure 2: Classification of linearly inseparable classes using soft margin SVM

In addition to linear classification, SVMs can also perform non-linear classification. This is achieved using the technique called “kernel trick” which maps the data that are not linearly separable from original feature space into higher-dimensional feature space (Figure 3.), in which they could be linearly separated. The kernel function defines an inner product in the transformed space. There are three commonly used kernel functions:

- Polynomial kernel: $G(x_1, x_2) = (x_1 * x_2 + 1)^p$
- Radial Basis Kernel $G(x_1, x_2) = e^{-\gamma(x_1 - x_2)^2}$
- Sigmoid Kernel $G(x_1, x_2) = \tanh(\eta x_1 * x_2 + \nu)$

where x_1 , and x_2 are the samples from the data set, p is the adjustable parameter which defines the order of the polynomial kernel; γ is the adjustable parameter of Radial Basis Kernel which defines the shape of the decision boundary; η is the slope and ν is the intercept constant both adjustable parameters of Sigmoid Kernel.

In this paper, we used the second-order polynomial kernel for the detection of lateral sigmatism.

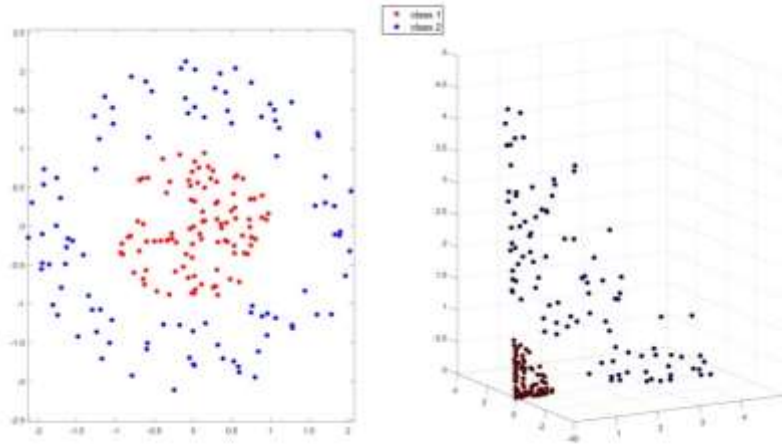


Figure 3: Mapping from the 2-dimensional feature space to 3-dimensional feature space using the second-order polynomial kernel

3 RESULTS

The results are determined at the phoneme level. A separate set of models is used for each of the three words/phonemes of interest (/cica/, /zima/ and /seka/). Training and testing are performed using the Leave One Out Cross Validation (LOOCV). The recording that is to be tested is removed from the set of recordings and the rest of the recordings are used as a training set. Since the phoneme consists of multiple frames, the decision about the presence or absence of pathology is made based on the majority class of its frames. In the subsequent subsections, the results are given for each of the words that were tested.

Results for the word /cica/

For the word /cica/, the proposed algorithm correctly classified 41 out of 42 normal (97.6 %) and 49 out of 52 (94.2 %) mispronounced phonemes. One of the normal phonemes is incorrectly classified as mispronounced and this corresponds to 1.1 % of all 94 phonemes in the data. Similarly, 3 of the mispronounced phonemes are incorrectly classified as normal and this corresponds to 3.2 % of all data. Overall, 95.7 % of the classifications are correct and 4.3 % are wrong (Table 1).

Table 1: Classification for word /cica/

word	True positive	True negative	Overall accuracy	Error
/cica/	94.2 %	97.6 %	95.7 %	4.3 %

Results for the word /zima/

For the word /zima/, the proposed algorithm correctly classified 18 out of 20 normal (90 %) and all 28 mispronounced phonemes (100 %). Two of the normal phonemes are incorrectly classified as mispronounced which corresponds to 4.2 % of 28 phonemes in total. The overall accuracy is 95.8 %. (Table 2.) The two misclassified words belonged to the same speaker.

Table 2: Classification for word /zima/

word	True positive	True negative	Overall accuracy	Error
/zima/	100 %	90 %	95.8 %	4.2 %

Results for the word /seka/

For the word /seka/, the proposed algorithm correctly classified all 20 normal (100 %) and 28 out of 29 (96.6 %) mispronounced phonemes. Only one of the mispronounced phonemes is classified as normal which means that the total classification error is 2 % and that the overall accuracy is 98 % (Table 3.)

Table 3: Classification for word /seka/

word	True positive	True negative	Overall accuracy	Error
/seka/	96.6 %	100 %	98 %	2 %

4 CONCLUSION

The high overall accuracies of 95.7 % for word /cica/, 95.8 % for word /zima/ and 98 % for word /seka/ obtained in this experiment suggest that the proposed algorithm could be successfully used for classification of pathological and normal speech. The good results are obtained even though we were dealing with a limited amount of data. In order to improve and further develop the algorithm for classification of normal speech and lateral sigmatism, future work should include the expansion of the simulated and normal speech corpus. Besides that, significant efforts should be invested in the collection of speech samples from patients with lateral sigmatism in order to form a real lateral sigmatism speech database. Also, detailed acoustic analysis of lateral sigmatism speech samples will enable more efficient feature engineering. It is desirable to investigate the process of lateral sigmatism perception and to determine which characteristics/features in temporal, frequency and intensity domains are responsible for perceptions of this type of misarticulation.

ACKNOWLEDGMENT

This research was supported by grants OI178027 and TR32032 from the Ministry of Education, Science and Technological Development of the Republic of Serbia.

The authors would like to express their gratitude to the SLPs from the Institute of Experimental Phonetics and Speech Pathology “Djordje Kostic” for participating in the experiment.

REFERENCES

- Akagi, M., Suzuki, N., Hayashi, K., Saito, H., & Michi, K. I. (2001). Perception of lateral misarticulation and its physical correlates. *Folia phoniatrica et logopaedica*, 53(6), 291-307.
- Anjos, I., Grilo, M., Ascensão, M., Guimarães, I., Magalhães, J., & Cavaco, S. (2018, November). A Model for Sibilant Distortion Detection in Children. In *Proceedings of the 2018 International Conference on Digital Medicine and Image Processing* (pp. 42-47). ACM.
- Baum, S. R., & McNutt, J. C. (1990). An acoustic analysis of frontal misarticulation of /s/ in children. *Journal of Phonetics*, 18, 51-63.
- Benselama, Z. A., Guerti, M., & Bencherif, M. A. (2007). Arabic speech pathology therapy computer aided system. *Journal of Computer Science*, 3(9), 685-692.
- Bodusz, W., Miodońska, Z., & Badura, P. (2017, October). Approach for spectrogram analysis in detection of selected pronunciation pathologies. In *Conference on Innovations in Biomedical Engineering* (pp. 3-11). Springer, Cham.
- Botinhao, C., Noeth, E., Hornegger, J., & Maier, A. (2009). Speech classification for sigmatism in children. In *Proceedings of the 5th Russian-Bavarian Conference on Biomedical Engineering* (pp. 151-153)
- Chen, Y. P. P., Johnson, C., Lalbakhsh, P., Caelli, T., Deng, G., Tay, D., Erickson, S., Broadbridge, P., El Refaie, A., Doube, W. & Morris, M. E. (2016). Systematic review of virtual speech therapists for speech disorders. *Computer Speech & Language*, 37, 98-128.
- Cortes, C., & Vapnik, V. (1995). Support-vector networks. *Machine learning*, 20(3), 273-297.
- Daniloff, R. G., Wilcox, K., & Stephens, M. I. (1980). An acoustic-articulatory description of children's defective/s/productions. *Journal of Communication Disorders*, 13(5), 347-363.
- Krecichwost, M., Miodonska, Z., Badura, P., Trzaskalik, J., & Mocko, N. (2019). Multi-channel acoustic analysis of phoneme/s/mispronunciation for lateral sigmatism detection. *Biocybernetics and Biomedical Engineering*, 39(1), 246-255.
- McKechnie, J., Ahmed, B., Gutierrez-Osuna, R., Monroe, P., McCabe, P., & Ballard, K. J. (2018). Automated speech analysis tools for children's speech production: A systematic literature review. *International journal of speech-language pathology*, 20(6), 583-598.
- Miodońska, Z., Kręcichwost, M., & Szymańska, A. (2016, June). Computer-aided evaluation of sibilants in preschool children sigmatism diagnosis. In *Conference of Information Technologies in Biomedicine* (pp. 367-376). Springer, Cham.
- Mujunen, R., Leinonen, L., Kangas, J., & Torkkola, K. (1993). Acoustic Pattern Recognition of /s/ Misarticulation by the Self-Organizing Map. *Folia Phoniatrica et Logopaedica*, 45(3), 135-144.
- Punišić, S. (2012). Articulation-acoustic and auditory aspect of sound deviation in pathological pronounciation (Doctoral dissertation, University of Belgrade).
- Suzuki, N., Wakumoto, M., Michi, K., Dent, H., Gibbon, F., & Hardcastle, W. J. (1995). Cross-linguistic study of lateral misarticulation using electropalatography. *International Journal of Language & Communication Disorders*, 30(2), 237-245.
- Valentini-Botinhao, C., Degenkolb-Weyers, S., Maier, A., Nöth, E., Eysholdt, U., & Bocklet, T. (2012). Automatic detection of sigmatism in children. In *Third Workshop on Child, Computer and Interaction*, 1-4
- Vapnik V. (1998). *Statistical Learning Theory*, Wiley, New York.
- Vojnović, M., & Jeličić, Lj. (2015). Manifestation of lateral sigmatism in spectral domain, In *Proceedings of the Speech and Language 2015, 5th International Conference on Fundamental and Applied Aspects of Speech and Language* (pp. 252-261).
- Weismer, G., & Elbert, M. (1982). Temporal Characteristics of "Functionally" Misarticulated /S/ in 4-to 6-Years-Old Children. *Journal of Speech, Language, and Hearing Research*, 25(2), 275-287.
- Witten, I. H., & Frank, E. (2005). *Data Mining: Practical machine learning tools and techniques* 2nd edition. Morgan Kaufmann, San Francisco.

Specific Protocol for Hearing Assessment in Preterm Babies

Mikić Branka, Nikolić Mina, Jotić Ana

Center for Hearing and Speech
FASPER, University in Belgrade
Clinic for ENT&MFS, Clinical Center of Serbia
e-mail: branmi@gmail.com

ABSTRACT

Hearing impairment is frequently met in preterm babies as compared to well baby population. Incidence of congenital and perinatal hearing loss in prematurely born children is 2-4% and in case of extreme prematurity (less than 32 GW) it could reach 6 %. It could be caused by extreme immaturity of the newborn baby as well as by multiple risk factors (gestational age, extremely low birth weight, hypoxia, hyperbilirubinaemia, infection, ototoxic medication, prolonged NICU stay, mechanic ventilation) Procena stanja sluha kod prevremeno rođenog deteta je izuzetno složena, a tumačenje dobijenih rezultata zahteva veliko iskustvo i poznavanje miljokaza i složenosti razvoja u ovoj populaciji. Pored kohlearnog oštećenja sluha često se mogu javiti i retrokohlearni problemi usled auditivne neuropatije i disnhronije, ali i nezrelosti centralnih auditivnih puteva. Hearing screening in prematurely born babies should not be restricted to otoacoustic emission testing (OAE), but automated auditory brainstem response (AABR) is mandatory for detection of retrocochlear pathology which is frequently seen in those babies. In case of several negative OAE tests baby should be referred for further audiology evaluation. Interpretation of audiology test results is complex and dependent on the degree of prematurity, age at the time of testing and comorbidities. Type and timing of eventual intervention is determined by the degree of the hearing impairment and other developmental disorders. It should be kept in mind that one third of babies identified as significant hearing loss in the first months of life, later on could achieve normal hearing thresholds through maturation process. It is essential to monitor development of these children closely at least during first two years of life in order to adjust type of amplification and habilitation of hearing and speech.

Keywords: preterm babies, hearing loss, hearing assessment

1 INTRODUCTION

Preterm birth

Preterm birth, before 37th week of pregnancy can occur for many reasons. Many vital functions in those babies are not mature enough requiring intensive care and support in order to provide survival and prevent further damage. According to the national health statistics in 2018, out of 63955 newborns in Serbia, 4500 were born preterm, which comprises 6.8%. The babies that were born extremely premature or with serious health problems have been referred to the Institute of neonatology in Belgrade. One thousand preterm babies are treated in that hospital each year. The percentage of premature births in Serbia is similar to UK statistics from the year 2015, with 53209 registered preterm babies (7.7%) and 3014 babies (0.4%) born before 28th gestational week or extremely premature (Cook, 2019). The percentage of prematurely born babies is on the constant rise all over the world due to better survival rates. However, there are still numerous issues regarding their morbidity and further development.

Incidence of hearing impairment

Occurring in 1-2 out of 1000 babies born at full term, hearing loss is the most frequent sensory impairment in newborn. The incidence of hearing impairment in premature babies is much higher due to their immaturity and various risk factors. The rate of hearing loss in preterm babies comprises 2-4% and in extremely premature (born before 32nd GW) it could be 6%.(Wroblevska-Seniuk K. et al, 2017). Better survival rates and improved methods in intensive care could lead to decrease in the incidence of various sequels to 1% with hearing or vision impairment (Pierrat V., 2017)

Risk factors for hearing impairment

Joint Committee on Infant Hearing (JCIH) has defined the risk factors that can contribute to the occurrence of hearing impairment in infants. Those factors are likely to induce hearing impairment 20 times more than in general population. However, one half of the infants diagnosed with hearing loss do not have any of those factors in their medical history. The list of those factors has been revisited and extended on several occasions. According to the newest revision in 2007. The list of the risk factors for hearing loss is as follows:

RISK FACTORS FOR HEARING IMPAIRMENT (JCIH, 2007)

- Familial deafness
- Extremely low birth weight <1500 g
- Intrauterine infection (toxoplasmosis, rubella, CMV, herpes, HIV,)
- Asphyxia (APGAR score 0-3)
- Extreme hyperbilirubinemia
- Head or neck congenital anomalies
- Neonatal bacterial meningitis
- Mechanical ventilation >2 days
- Neonatal intensive care >5 days
- Ototoxic medication

The longitudinal study on auditory development in preterm babies treated in the Institute of neonatology in Belgrade from 2014 to 2016 has revealed that most of those babies had 3 or more risk factors from JCIH list, but only a small number of them have been diagnosed with hearing loss eventually. The multiple risk factors imply that prematurely born babies should be referred for audiology diagnostics and their auditory development should be monitored carefully (Nikolić M, 2014).

Early hearing detection and intervention (EHDI)

Congenital or early postnatal hearing loss seriously affects speech and language development in children thus compromising their cognitive capacity and educational perspective. Early diagnosis and intervention for hearing impairment (EHDI) is essential for achieving optimal outcome, because of the plasticity of central nervous system in infants. The current timeline of EHDI considers that the neonatal hearing screening should be done before 1 month of age, complete audiology diagnostics before 3 months of age and intervention for hearing loss before age of 6 months.

According to the recent publication by C. Yoshinaga –Itano (2017) it might be not good enough. She had found that verbal score of hearing impaired children from EHDI at the age of 30 months is 82, which is still inferior to normal hearing children (VS-100), but considerably better than of VS of lately diagnosed hearing impaired children (VS-70, 10th percentile). Therefore she has suggested that EHDI timeline should be shifted to earlier age, so that the screening should be done before 1 month, diagnosis at 2 month and intervention at 3 month of age. Although it could be ideal from the maturational point of view, it might not be realistic in the majority of the countries. When premature babies are considered the EHDI timeline is not met in the majority of the cases due to multiple health issues in that population. Regardless of the failed

hearing screening, comprehensive audiology diagnostic should be postponed until baby is not well enough and in case of the diagnosed hearing impairment, planning of the intervention should be coordinated with other rehabilitation priorities.

2 DIAGNOSTIC PROCEDURES IN AUDIOLOGY

Hearing screening in newborn babies is the corner stone of every EHDI program. By this easy procedure babies with suspected hearing loss are recruited for further audiology diagnostic procedures in order to confirm the degree of hearing impairment and commence rehabilitation procedure. Early diagnosis and treatment provide for optimal outcomes, thus minimizing deleterious impact of congenital hearing loss on the development of speech and language in the affected child.

Neonatal hearing screening

Neonatal hearing screening could be organized as universal, when all the babies born in certain country are screened right after the birth or sporadic, with some of the hospitals screening the hearing in babies (hospital based) or reserved for special population of newborns, such as babies from neonatal intensive care units (NICU graduates) or prematurely born babies. Screening which does not cover at least 95% of the population is not working efficiently. It is usually performed by otoacoustic emissions, using either TEOAE or DPOAE modality. This screening method is insufficient for NICU graduates and preterm babies because of the possible retro cochlear pathology, which could be overlooked by otoacoustic emissions. Combination of OAE and automated auditory brainstem (AABR) screening is recommended for this population of newborns. Two-step screening using OAE or combination of OAE and AABR is the way to decrease the referral rate and overall number of babies who need further audiology diagnostics.

National program for universal hearing screening with proper tracking and follow-up is the best guarantee that the majority of the children should be diagnosed with hearing loss soon after birth. It is also the most economic and cost effective regarding the cost of the screening per baby (7-13 euro) or the cost per infant diagnosed with hearing loss is 8000 euro (Brockow et al 2018).

Unlike well babies, born at full term, who are screened on second or third day after birth, timing of the hearing screening in preterm babies should be determined in accordance with general health of the baby. Prematurely born babies could fail hearing screening on several occasions even if further audiology diagnosis confirms normal hearing function. However, preterm babies frequently require comprehensive audiology diagnostic due to numerous risk factors for possible hearing impairment and general immaturity of the central nervous system (Nikolić M, 2014).

Behavioral methods in pediatric audiology

The initial step of hearing assessment in babies and infants begins with conditioned orientation reflex (COR) and behavior observation audiometry (BOA), thus depicting their reaction to sounds of different pitch and intensity. In babies older than 6 months visual reinforcement audiometry (VRA). In older infants and toddlers play conditioned audiometry (PCA) could be appropriate. Pure tone audiometry requires full cooperation of child and several days of conditioning is usually needed in order to obtain precise hearing threshold. Masking of the contralateral ear could not be applied in children younger than 6 years because of the immaturity of central nervous system and hearing function. That could affect the proper measurement in case of unilateral or asymmetric hearing loss.

Objective methods in audiology

Considering the fact that infants and toddlers could not cooperate in hearing threshold measure (TEOAE) or distortion products (DPOAE). They could be registered in very young babies and it makes them convenient for neonatal hearing screening. They are the part of the comprehensive audiology test battery in fully diagnostic mode as well. In order to avoid false negative screening results OAE screening should not be performed immediately after birth, on the first day of because of the immaturity of OAE mechanism. Starting OAE screening from the second day after birth diminishes the referral rate (Mikić, 2005).

Auditory brainstem evoked potentials (ABR or BERA) measurement is an important tool for the assessment of hearing threshold in babies and infants as well as in subjects who do not cooperate in subjective audiometry tests. The stimulus used for BERA could be click or frequency specific. Accuracy of the threshold measurement is much better in high frequency range. Unstable electric activity of the brain (EEG), as well as asynchronous activity along auditory pathways (auditory neuropathy-dis-synchrony) could affect the results.

Auditory steady state response (ASSR) is another objective test used in pediatric audiology, especially useful for the diagnosis of severe to profound hearing loss.

Cortical evoked potentials are no longer used for determination of hearing threshold due to poor accuracy, but they are widely used for evaluation of maturation of central auditory system.

The best way to achieve exact evaluation of hearing threshold and auditory maturation in pediatric audiology is to use the full test battery, combining subjective and objective measurements as well.

ment, audiology diagnostic requires a number of electrophysiology tests, aka objective measurements.

Acoustic impedance measurements include tympanometry and acoustic reflex. Tympanometry depicts mobility of the tympanic membrane and middle ear ossicles and the content of the tympanic cavity. It could reveal possible conductive hearing loss. Acoustic reflex threshold and decay could be helpful in diagnosing sensori-neural hearing impairment.

Otoacoustic emissions are useful for the assessment of inner ear functioning. They could be either spontaneous or evoked. Evoked otoacoustic emissions could be represented as transient

3 HEARING ASSESSMENT IN PRETERM BABIES

Considering the fact that hearing loss could be 20-30 times more frequent in preterm babies than in well baby newborns, it is of utmost importance to assess the hearing function as soon as possible. Babies born before 28th GW are at the greatest risk for developing hearing loss.

Preterm babies, especially those born extremely premature, are usually vitally endangered and critically ill, so that hearing screening could not be done immediately after birth.

General health condition, comorbidities and maturity of the prematurely born baby are the main determinants of the timing for comprehensive audiology testing.

In some cases hearing loss could be progressive and that requires prolonged audiology monitoring of prematurely born babies. Progressive or delayed onset of hearing loss could be genetically determined, caused by cytomegalovirus infection (CMV), ototoxic medication, severe hypoxia, etc. Those babies could pass initial newborn hearing screening but develop hearing loss later on. Repeated audiology testing and continuous surveillance is required at least in the first two years of life and later on if necessary.

Hearing screening methods

TEOAE screening is not always enough in the population of preterm babies, because of the high probability of retro-cochlear (or central) hearing pathology. Besides the immaturity of central nervous system, there could be intracranial bleeding or other CNS pathology as a cause of retro-cochlear hearing impairment. TEOAE could be normal in some cases and screening using only this method could lead to false positive results (Akinpelu et al, 2014). Therefore the use of automated ABR (AABR) screening is a must in this population.

On the other hand, TEOAE screening in preterm babies is frequently negative and should be repeated on several occasions, before the baby is referred to audiology department for comprehensive hearing assessment. False negative result of OAE hearing screening could be caused by a fluid in the ear canal or middle ear, as well as by negative pressure in tympanic cavity.

Behavioral assessment

Behavioral assessment of hearing function and choice of behavioral test depends of the age and maturity of an infant. In case of the preterm birth corrected age (the difference between the expected and real birth date) is always used for assessing developmental milestones and maturation of certain functions, such as hearing and speech. Corrected age should be used for at least two years after birth.

Test method should be chosen in accordance with corrected age, general health and maturity of the baby or infant. In older children cognitive level, maturity and general health affect the choice of audiometry type.

In case of developmental delay, associated neuropathology or grave illness, the degree of hearing loss could be overestimated. On the other hand, it is essential not to attribute the poor reaction to sound to kid's general delay or neuropathology and miss the diagnosis of hearing impairment. In those cases high frequency hearing loss could be easily overlooked. It is very important to define hearing threshold precisely in order to choose adequate hearing aid or hearing implant and provide speech and hearing rehabilitation thus stimulating overall development of a child.

Combination of subjective and objective measurements is necessary for the most precise diagnosis of hearing impairment.

Longitudinal follow-up is necessary because auditory function in preterm babies can improve over time due to maturation of central nervous pathways and synapses. On the other hand there is a possibility of development of acquired or progressive hearing loss in babies who initially have passed hearing screening. Continuous audiology surveillance is mandatory for at least first two years of life and longer if necessary.

Objective aka electrophysiology methods

Since preterm babies have low or extremely low birth weight the volume of the external ear canal remains extremely small for quite a long time. It is important to know that in those cases tympanometry ought to be done with high frequency probe (1000 Hz) in order to avoid faulty recordings obtained by 220 Hz probe.

Acoustic reflex measurements in prematurely born babies could be negative in the beginning due to extreme central nervous system immaturity or extensive brain lesions (intracranial hemorrhage, hypoxic-ischemic encephalopathy, etc).

Registration of auditory brainstem evoked potentials (ABR or BERA) could be affected not only by hearing impairment, but dominantly by central nervous system pathology and maturity. Synchronous propagation of the signal through auditory pathways is required for obtaining good waveform, absolute and inter-peak latencies. Pre- or postsynaptic dis-synchrony affects BERA morphology and could be mistaken for hearing loss (Silva, 2015). If normal auditory function is assumed by behavioral tests, BERA should be

performed with 40 and 70 dB click stimulus, followed by tone burst of 4 kHz at 40 dB, according to NHS protocol in UK. On the other hand, in case of suspected hearing loss based on behavioral methods, BERA should be done both click and tone burst at 0.5, 1, 2 and 4 kHz to determine hearing threshold. This is not always easy task in premature baby because of neurological comorbidities and immaturity (Hof, 2015).

Combination with auditory steady state response (ASSR) could be helpful in determining the degree of hearing impairment.

Using complete audiology test battery and cross check principle (J. Jerger, 1976) is the only way to achieve the precise diagnosis in pediatric audiology, especially when prematurely born babies are concerned.

Parent's questionnaires designed for follow up of infant's hearing are useful tool for monitoring auditory development in early years. There are several of them such as LittleEARS, CHILD or PEACH. Information gathered from parents on auditory behavior of child in everyday situations could improve comprehensive diagnostic process. (Schaefer et al, 2013)

Flaws and obstacles

Hearing assessment in babies and infants born prematurely could be very challenging because of the numerous prenatal and perinatal risk factors. Extremely preterm babies born before 28th week of gestation are especially endangered to develop hearing loss.

It is not always possible to perform complete audiology assessment due to poor general health and severe comorbidities. Neonatal hearing screening should be done as soon as possible and repeated on several occasions if necessary, but comprehensive audiology testing should be postponed until preterm baby is not well enough and capable for it.

Two types of errors could occur. Hearing impairment could be overlooked or underestimated if infant's poor reaction to sound is attributed to general developmental delay or associated neuropathology. It could unnecessarily postpone amplification and speech therapy thus affecting final outcome.

On the other hand if the degree of the hearing loss is overestimated hasty intervention, such as early cochlear implantation could possibly do a lot of harm (Coenrad et al, 2011) There have been numerous records of auditory function recovery through the maturation process of preterm babies in the first and second year of life. Hof et al. (2013) have reported that one third of 14 preterm babies diagnosed with severe to profound hearing loss in the first months has shown complete recovery of the auditory function within a year following diagnosis. We have encountered partial or full recovery of hearing in preterm babies occasionally as well.

It is therefore necessary to monitor auditory development and maturation in prematurely born children for at least two years of life and later if needed.

4 CONCLUSION

Hearing assessment in preterm neonates and infants is considerably different and quite complicated as compared to babies born at full term. Incidence of hearing impairment in premature babies is 20 to 30 times higher than in well baby population because of extreme immaturity of sensory organ and central auditory pathways. Preterm babies have elevated risk for developing hearing impairment. They usually have 3 or more risk factors from defined by Joint Committee on Infant Hearing.

Otoacoustic emissions are not sufficient for neonatal screening in preterm neonates, because retro-cochlear pathology could be easily overlooked. Combination of OAE and AABR is required for hearing screening in this population. Timing of screening depends on general health and maturity of the baby and should be postponed until baby is fit for screening. In case of repeated failure on screening procedures, baby should be referred for comprehensive audiology diagnostics. Complete test battery combining behavioral and objective measurements should be used for obtaining most accurate hearing assessment.

However, due to immaturity of all systems and multiple comorbidities hearing loss could not be always properly diagnosed. It could be overlooked or underestimated, thus leading to delayed intervention and poor outcome. On the other hand, it could be overestimated in young babies. Considerable number of preterm babies diagnosed with severe to profound hearing loss in the first months of life could restore hearing through maturation process. It is therefore important to adjust the intervention mode to such possibility and to avoid early cochlear implantation in preterm infants. Continuous audiology monitoring and repeated hearing and speech assessment is mandatory for at least first two years of life and longer if needed.

REFERENCES

- Akinpelu OV, Peleva E, Funnell WR, Daniel SJ. Otoacoustic emissions in newborn hearing screening: a systematic review of the effects of different protocols on test outcomes. *Int J Pediatr Otorhinolaryngol.* 2014;78(5):711-7. doi:10.1016/j.ijporl.2014.01.021
- Bagatto, M. P., Brown, C. L., Moodie, S. T., & Scollie, S. D. (2011b). External validation of the LittleEARS® Auditory Questionnaire with English-speaking families of Canadian children with normal hearing. *International journal of pediatric otorhinolaryngology*, 75(6), 815-817.
- Bagatto, M. P., Moodie, S. T., Seewald, R. C., Bartlett, D. J., & Scollie, S.D. (2011a). A critical review of audiological outcome measures for infants and children. *Trends in Amplification*, 15(1-2), 23–33. doi: 10.1177/1084713811412056
- Bagatto, M.P., Moodie, S.T. & Scollie, S.D. (2010). Beyond matching targets: an approach to outcome evaluation in pediatric hearing aid fitting. A sound foundation through early amplification: International pediatric audiology conference, Nov 8-10 2010, Chicago, USA,
- C. Franck, W. Vorwerk, A. Kohn et al: Prävalenz, Risikofaktoren und Diagnostik von Hörstörungen bei Frühgeborenen Published: 01 June 2017 in Endoscopy <https://doi.org/10.1055/s-0043-109512>
- Coninx, F., Weichbold, V., Tsiakpini, L., Autrique, E., Bescon, G., Tamas, L.,... & Brachmaier, J. (2009): Validation of the LittleEARS® auditory questionnaire in children with normal hearing. *International journal of pediatric otorhinolaryngology*, 73(12), 1761-1768.
- Hof, J. R. (2015). Hearing loss in young children : challenges in assessment and intervention. Maastricht: Maastricht University
- Inken Brockow *, Kristina Söhl and Uta Nennstiel: Newborn Hearing Screening in Bavaria—Is It Possible to Reach the Quality Parameters? *Int. J. Neonatal Screen.* 2018, 4(3), 26; <https://doi.org/10.3390/ijns4030026>
- Jerger, J. F., & Hayes, D. (1976). The cross-check principle in pediatric audiometry. *Archives of otolaryngology*, 102(10), 614-620.
- JR Hof, RJ Stokroos, E Wix, M Chénaul - TAuditory maturation in premature infants: a potential pitfall for early cochlear implantation
- K Schaefer, F Coninx, T Fischbach LittleEARS auditory questionnaire as an infant hearing screening in Germany after the newborn hearing screening *International journal of pediatric otolaryngology* 2019 - Taylor & Francis
- Mikić, B., Arsović, N., Ostojić, S. & Mirić, D. (2006) Validation of littleears questionnaire for Serbian language in hearing children under age of two. *Abstracts of 9th International Conference on Cochlear Implantation Vienna.* 156(Suppl.119), 164.
- Nikolić, M., Ostojić-Zeljko, S., Slavnić, S. (2017). Auditory development of preterm babies: early age evaluation criteria. *Early Childhood Intervention: For meeting sustainable development goals of the new millennium*, 175-185. October 6-8th, 2017, Belgrade, Serbia.
- Nikolić, M., Sekulović, G., Ostojić, S. (2016). Učestalost faktora rizika za nastanak oštećenja sluha kod prevremeno rođene dece. *Specijalna edukacija i rehabilitacija*, 15(2), 173-189. UDK: 616.28-008.13-053.32. doi: 10.5937/specedreh15-10664 Pages S105-S111
- S.CoenraadA.GoedegebureL.J.Hoeve: An initial overestimation of sensorineural hearing loss in NICU infants after failure on neonatal hearing *International Journal of Pediatric Otorhinolaryngology screening* Volume 75, Issue 2, February 2011, Pages 159-162
- Schäfer, K. (2013): Screening mit dem LittleEARS®(MED-EL)-Hörfragebogen - Eine empirische Untersuchung zur Möglichkeit eines zweiten Hörscreenings für Kinder im Alter von 10-12 Monaten im Rahmen der

- Früherkennungsuntersuchung U6. PhD thesis, Universität zu Köln. Dostupno na (08.08.2013.):<http://kups.ub.uni-koeln.de/5235/>
- Silva Dd, Lopez P, Mantovani JC. Auditory brainstem response in term and preterm infants with neonatal complications: the importance of the sequential evaluation. *Int Arch Otorhinolaryngol*. 2015;19(2):161–165. doi:10.1055/s-0034-1378137
- Sophie Cook: NIHR's research signals in The BMJ *BMJ* 2019; 364 doi: <https://doi.org/10.1136/bmj.l513>
- Teresa Y. C. Ching, Harvey Dillon, Greg Leigh & Linda Cupples  "Longitudinal outcomes of children with hearing impairment (LOCHI): 5 year data." *International Journal of Audiology*, 2018, 57(sup2), pp. S1–S2
- Veronique Pierrat et al., *BMJ* 2017;358:j3448
- Wasser J: Ari-Even Roth D^{2,3}, Herzberg O^{2,4}, Lerner-Geva L^{5,6}, Rubin L^{7,8}. Assessing and monitoring the impact of the national newborn hearing screening program in Israel. *Isr J Health Policy Res*. 2019 Mar 11;8(1):30. doi: 10.1186/s13584-019-0296
- Wroblewska-Seniuk K, Greczka G, Dabrowski P, Szyfter-Harris J, Mazela J. Hearing impairment in premature newborns-Analysis based on the national hearing screening database in Poland. *PLoS One*. 2017;12(9):e0184359. doi:10.1371/journal.pone.0184359
- Микић, Б. (1995). Утицај ране рехабилитације на евоциране потенцијале деце са тешким оштећењем слуха (докторска дисертација). Универзитет у Београду: Медицински факултет.
- Микић, Б. (2014). Савремени алгоритам за рану дијагностику оштећења слуха. У Ј. Карић, С. Остојић, & М. Радић Шестић (Ур.), Специфичност оштећења слуха. (стр. 31-44). Београд: Факултет за специјалну едукацију и рехабилитацију.
- Микић, Б., Ђоковић, С., Совиљ, М., Пантелић, С. (2005). Отоакустичка емисија код неонатуса, деце и одраслих. У С. Јовичић, М. Совиљ (Ур.): Отоакустичка емисија – теорија и пракса, 122-140.
- Николић, М., Остојић, С., & Мирић, Д. (2014). Примена упитника за родитеље у процени аудитивних способности глуве и наглуве деце. Зборник радова VIII међународног скупа Специјална едукација и рехабилитација – данас. 7.-9. новембра 2014. Београд, 65-72. ISBN 978-86-6203-057-3
- Николић, М. (2017). Специфичност аудитивних способности код превремено рођене деце. Београд: Универзитет у Београду – Факултет за специјалну едукацију и рехабилитацију.
- Николић, М., Остојић, С. (2016). Утицај фактора ризика на резултате неонаталног скрининга слуха. Специфичност оштећења слуха – нови кораци, 23-37. Универзитет у Београду, Факултет за специјалну едукацију и рехабилитацију, издавачки центар. ISBN 978-86-6203-081-8

Sleep - a Multifunctional Phenomenon: Memory Consolidation and Protective Effect with Respect to Psychosomatics

Tijana Bojić¹, Zoran Matic², Stefan Mandić-Rajčević³, Ivan Soldatović⁴, Ljiljana Čvorović⁵, Zorica Rašić Milutinović⁶, Aleksandra Vucković⁷, Aleksandar Kalauzi⁸

¹Laboratory for molecular genetics and radiobiology, Institute of Nuclear Sciences Vinča University of Belgrade, P.O. Box 522, Mike Petrovića Alasa 11-14, 11000 Belgrade, Serbia
tijanabojić@vin.bg.ac.rs

²Biomedical engineering and technologies, University of Belgrade, Studentski trg 1, 11000 Belgrade, Serbia

³Innovation Centre of the Faculty of Technology and Metallurgy University of Belgrade, Karnegijeva 4, 11000 Belgrade, Serbia

⁴Institute for Medical Statistics and Informatics, School of Medicine University of Belgrade, Doktora Subotića 1, 11000 Belgrade, Serbia

⁵Clinical Center of Serbia, School of Medicine, University of Belgrade, Dr Subotica 9, 11000 Belgrade, Serbia

⁶Clinic of Internal Medicine, University Hospital Zemun, University of Belgrade, Vukova str. 9, 11080 Zemun, Belgrade, Serbia

⁷University of Glasgow, School of Engineering, Glasgow, UK

⁸Department for Life Sciences, Institute for Multidisciplinary Research, University of Belgrade, Kneza Višeslava 1, 1030 Belgrade, Serbia

ABSTRACT

Sleep is a universal physiological necessity whose precise mechanisms and function(s) are still unknown (Huber, 2004, Donlea, 2018). The most known attempt to describe its role by Allan Hobson “Sleep is of the brain, by the brain and for the brain” (Hobson, 2005) is slowly but inevitably extended by “...and for the organism”. On the basis of electroencephalographic and electromyographic activity sleep is defined as the approx 8 hour cyclic successive alteration of Non REM (or Quiet Sleep) and REM sleep (or Active Sleep) (Rechafen & Kales, 1968). Duration, sleep quality and harmonic alteration of Non REM and REM sleep play essential role in memory consolidation which is consequently of paramount importance for the new vocabulary learning (Batterink, 2017), motor skills learning (Cipolli, 2005) and the learning process in general. Non REM and REM sleep have specific physiology both on neurophysiological and molecular levels (Kryger, 2017) that drive restorative processes of the cardiovascular (Zoccoli, 2001, Silvani, 2003, Bojić, 2014), respiratory (Harper, 2017), immune (Opp, 2017) and endocrine system (Van Cauter, 2017) all the way to the genetic restorative processes (Fuller, 2019). Thus, healthy sleep contributes to healthy functioning of the organism and assures higher abilities like mental attention, mindfulness, insightfulness (Wagner 2004), creative (constructive), focused/unscattered and vivacious oral communication and social high quality self-regulation and cooperation. In the era of information revolution where the only limitations are the individual's cognitive and memory capacities, the importance of healthy sleep regime must be recognized and taken as a priority with respect to short term benefits of stress-driven learning coupled with sleep deprivation. Consequently, sleep deprivation, a novel phenomenon of 24/7 society is becoming a notable circumstance of the general human psychophysical health.

Key word: sleep, memory, speech

1 INTRODUCTION

Sleep as an active state

Traditionally, until the late '50s of the last century, sleep was considered a passive state, the general opinion also shared by the great scientists like Charles Sherrington, Sigmund Freud and Ivan Petrovich Pavlov (Hobson, 2009). This opinion was finally refuted by the seminal work of Aserinsky and Kleitman (1953) where specific patterns of EEG and eye motility in Quiet Wake (QW), Slow Wave Sleep (SWS) and Rapid Eye Movement Sleep (REMS) were observed and described. Physiological findings were backed up by psychological sleep research, identifying psychophysiological patterns of three basic states of consciousness (QW - the state of vivid sensation, externally generated perception, logical progressive thought; SWS - the state of dull or absent sensation and perception and logical perseverative thought and REMS - the state of vivid sensation and internally generated perception). Finally, the conclusive facts were added by brain metabolism studies which reported only 20% reduction of SWS brain metabolism with respect to QW, while, surprisingly, REMS brain metabolism was scoring increases, up to 20% above the values of QW.

Sleep is though fascinating, active state, unexpectedly abundant with physiological and psychological processes whose (multiple?) teleological role(s) are just about to be revealed.

Sleep and memory: Hippocampal neocortical dialog during SWS

One of the most intriguing psychological properties of sleep is memory consolidation. Different forms of memory (declarative, procedural) and different aspects of the memory processing (consolidation, integration with existing memory) are reinforced during the sleep, with SWS and REMS specific roles. Studies based on declarative and procedural memory tasks applied over early and late nocturnal sleep, as well as wakefulness controlled conditions, have been shown that declarative memory improves more during early sleep (dominated by SWS) while procedural memory during late sleep (dominated by REM sleep).

Physiological background of SWS specific memory effects was recently conceptualized as “Hippocampal neocortical dialog” (Peigneux, 2015)

The hippocampal neocortical dialog refers to the very structured interactions during SWS between groups of neurons in the hippocampus and neocortex. Sharp wave patterns (SPW) dominate the hippocampus during SWS and neuron populations in the hippocampus participate in organized bursts during this phase. This is done in synchrony with state changes in the cortex and coordinated by the slow oscillations in cortex. These observations, coupled with the knowledge that the hippocampus plays a role in short to medium term memory whereas the cortex plays a role in long term memory, have led to the hypothesis that the hippocampal neocortical dialog might be a mechanism through which the hippocampus transfers information to the cortex. Thus, the hippocampal neocortical dialog is said to play a role in memory consolidation.

Hippocampus, considered to hold information only temporarily and in fast-learning rate, passes the information to neocortex, related to long-term storage and slow-learning rate. This dialogue between hippocampus and neocortex occurs in parallel with hippocampal sharp-wave ripples and thalamo-cortical spindles, synchrony that drives the formation of spindle-ripple event which seems to be a prerequisite for the formation of long-term memories.

REMS, its duration and intensity are associated with consolidation of procedural memory (Cipolli, 2005). Still, some aspects of sleep mediated effects on memory, like acoustically cued memory in targeted memory reactivation paradigm (TRM), can be explained only by joined, compatible and cooperative action of SWS and REMS mechanisms (Batternik, 2017).

Sleep transition phases

Cyclic alteration of sleep-wakefulness phases is continual, not discrete. For that reason, there is a particular interest for sleep transition phases and their psychophysiological dynamics. Significant insights could be gained from examination of electrophysiological characteristics of the state of drowsiness. State of drowsiness, or hypnagogic state is the transitional state between wakefulness and sleep. Physiologically, state of drowsiness is characterized by the decrease of sensory signal detection and the decrease of the motor reaction time (Ogilvie and Wilkinson, 1984). Psychologically, it is characterized by the decrease of the attention level and dream like mentation (Nielsen et al., 2005). State of drowsiness, on the basis of electroencephalogram, was described as a nine-stage state (Hori et al., 1990). The first four stages were shown to be the most correlated to the decrease of attention level (Nielsen et al., 2005) and they are characterized by the dominance of EEG alpha activity (8-12 Hz) and its gradual decrease towards deeper drowsiness stages (1-4). This period was the focus of our investigation.

2 METHODS AND RESULTS

Each oscillation process, as we did with alpha neural oscillations, can be characterized by its amplitude A and phase φ :

$$U(t) = A \sin(\omega t + \varphi) \quad (1)$$

In our first work (Bojić et al., 2010) we analysed the relation of alpha amplitude to the fractal dimension (FD), measure of the EEG signal complexity, in order to take into account both linear and nonlinear neuronal dynamics. We examined and compared topographic distribution of EEG FD between states of relaxed wakefulness and drowsiness, as well as FD differences. In our second work (Kalauzi et al., 2012) we studied changes in alpha phase shifts occurring during the wake-to-drowsy transition. We defined four measures in order to investigate the dynamical interrelationship of EEG signals at different electrodes: 1) Alpha carrier frequency (ACF) - a mathematical concept developed to overcome the FFT limitations for calculating the leading oscillatory component of the signal; 2) Alpha carrier frequency phase shift was defined as the difference in ACF phases between two electrodes; 3) ACF phase potential is the characteristics of one electrode - defined as an average value of ACF phase shifts of all electrode pairs, where that electrode was positioned as the first in the pair; 4) ACF phase locking as the feature of two electrodes and the measure of their synchronicity - calculated as the reciprocal value of the standard deviation of ACF phase shifts.

In order to establish the relationship between changes of the FD and the degree of alpha activity, a series of simulations were performed and a four parameter mathematical model was developed. Coefficient of nonlinear correlation between the simulated and measured EEG data was 0.682. (for detailed description an interpretation please see Bojić et al., 2010). Relatively large size of the two ensembles of FD values (in the wake and drowsy states) allowed us to study EEG FD as a random variable by plotting its probability density estimate (PDE). Number of peaks of FD PDE distribution decreased from 4 to 2 when shifting from wake to drowsy. Four groups of EEG regions could be distinguished in wakefulness: occipital (O2O1); temporoparietal (T6P4T5P3); centrofrontal (C3F3F4C4F8F7); temporal (T4T3), while in drowsiness FD values increased and regrouped to two (O2O1P3T6P4T5; C3C4F4F3F8T4T3F7). We also observed the topographical distribution of EEG FD differences between wake and drowsy state. The analysis pointed to the electrodes F7, O1 and F3 as the positions with the greatest FD changes.

In our second work (Kalauzi et al., 2012) we calculated and tested the accuracy of our proposed model of alpha carrier frequency phase shift and it turned out as the most accurate estimation of phase shift, with respect to all other Fourier components phase shifts. The greatest change in phase shifts during the transition occurred in four frontal regions. Regarding ACF phase potentials, in the wake state two groups

of channels arranged in antero-posterior direction could be observed: frontal, central and temporal were characterized by small, while temporoparietal and occipital had large values of phase potential. This difference was statistically confirmed. Regarding ACF phase locking, we plotted channels with above-than-average synchronous phase locking of channel pairs, and we deduced that these channels were different in the two states. Wake state had two separate regions: anterior, with numerous intraregional connections, and posterior with less developed intraregional network. In the drowsy state these two regions merged into one, spreading in antero-posterior direction (for detailed description and interpretation of the results please see Kalauzi et al., 2012).

3 CONCLUSION

Our research presented here introduces a new way of analysis of EEG oscillations by treating them as stable carrier frequency signals. This model is particularly adequate for studying alpha states of the brain. We found that EEG channels can be differently coupled in the two states, synchronized in wake and less synchronized in drowsiness. Our data suggest that first uncoupling of synchronized activity was in frontal regions - which is in a line with the fact that drowsiness is accompanied by the reduction of the highest cognitive functions (Nielsen et al., 2005) and by increase of motor reaction time (Stuss et al., 2005). Our hypothesis is that increased alpha phase locking in the frontal and fronto-temporal regions might be a necessary condition for the presence of alertness during full wakefulness. Alpha phase potentials speak for the presence of a contraphase of alpha oscillations between anterior and posterior regions in wakefulness; while in drowsiness we registered the emergence of new alpha clusters in the anterior brain regions, speaking in favour of existence of diffuse alpha generators. Results obtained for ACF phase locking may be interpreted as correlating with the distribution of specific transient neuronal assemblies (Dehaene et al., 1998; Jann et al., 2009): two assemblies in wake integrating into one in the drowsy state.

Perspectives of this study. This new method gives a new insight into the phenomenon of drowsiness, having a high potential both in basic and clinical research. Drowsiness, with its specific dynamical transition of externally oriented awareness (QW) to internally oriented awareness (SWS) might be crucial for understanding psychophysiological phenomena of Alzheimer disease, vegetative state and autism. Finally, regarding the issue of memory consolidation (and retrieval?) traditional sleep quality measures should be expanded for the quality of cycling QW-SWS-REMS functional units with new, extended research into the psychophysiological properties of sleep transition phases. Reaffirmation of the importance of healthy sleep, combined with healthy diet and regular moderate physical activity can represent a physiologically based revival of traditional wisdoms for hale and creative longevity.

ACKNOWLEDGEMENT

We would like to thank the Ministry of Education, Science and Technological Development of the Republic of Serbia (project III 41028).

REFERENCES

- Batterink, L.J., Westerberg, CE., Paller, KA. (2017). Vocabulary learning benefits from REM after slow-wave sleep. *Neurobiol Learn Mem.* 144:102-113. doi:10.1016/j.nlm.2017.07.001.
- Bojić T. (2014). Nesanica kao faktor rizika za kardiocerebrovaskularne bolesti. *Engrami časopis za kliničku psihijatriju psihologiju i granične discipline*, 36 (1-2), 31-34.
- Bojić, T., Vuckovic, A., Kalauzi, A. (2010). Modeling EEG Fractal Dimension Changes in Wake and Drowsy States in Humans-a preliminary study. *Journal Theor Biol*, 262(2), 214-222.
- Cipolli C. (2005). Sleep and memory. In: *Physiological Nature of Sleep*. Parmeggiani P and Veluti RA. Imperial College Press, 2005, pp. 601-615.

- Dehaene, S., Kerszberg, M., Changeux, J.P. (1998). A neuronal model of a global workspace in effortful cognitive tasks. *Proceedings of the National Academy of Sciences of the United States of America*, 95, 14529–14534.
- Donlea, J.M., Pimentel, D., Talbot, C.B., Kempf, A., Omoto, J.J., Hartenstein, V., Miesenbock, G. Recurrent circuitry for balancing sleep need and sleep. *Neuron*, 97, 378-389.
- Fuller, P.M., Eikermann, M. (2019). Genomic consequences of sleep restriction: the devil is in the details. *Anaesthesia*, 74 (4), 417-419. doi: 10.1111/anae.14479.
- Harper, R.M., Verrier, R.L. (2017). Cardiovascular physiology and Coupling with Respiration: Central and Autonomic Regulation. In: Principles and Practice of Sleep Medicine. Ed. Kryger, M., Roth, T. Sixth Edition, Philadelphia, PA, Elsevier, 132-142.
- Hobson, J.A. (2005). Sleep is of the brain, by the brain and for the brain. *Nature*, 437 (7063), 1254-1256.
- Hori, T., Hayashi, M., Morikawa, T. (1990). Topography and coherence analysis of the hypnagogic EEG. In: *Sleep '90*, J. Horn (ed.). Pontenagel Press, Bochum, 10–12.
- Huber, R., Ghilardi, F., Massimini, M., Tononi, G. (2004). Local sleep and learning. *Nature*, 430, 78-81.
- Jann, K., Dierks, T., Boesch, C., Kottlow, M., Strik, W., Koenig, T. (2009). BOLD correlates of EEG alpha phase locking and the fMRI default mode network. *Neuroimage*, 45, 903-916.
- Kalauzi A, Vuckovic A, Bojić T (2012). EEG alpha phase shifts during transition from wakefulness to drowsiness. *Int J Psychophysiology*, 86(3):195-205.
- Kryger, M., Roth, T., Dement, W.C. (2017). Principles and Practice of Sleep Medicine. Sixth Edition, Philadelphia, PA, Elsevier 2017.
- National Sleep Foundation (2012) Sleep in America® poll. <http://www.sleepfoundation.org/article/sleep-america-polls/2005-adult-sleep-habits-and-styles> (accessed November 18th 2019).
- Nielsen, T., Stenstrom, P., Takeuchi, T., Saucier, S., Lara-Carrasco, J., Solomonova, E., Martel, E. (2005). Partial REM-sleep deprivation increases the dream-like quality of mentation from REM sleep and sleep onset. *Sleep*, 28 (9), 1083–1089.
- Ogilvie, R.D., Wilkinson, R.T. (1984). The detection of sleep onset: behavioral and physiological convergence. *Psychophysiology*, 21, 510–520.
- Opp, M.R & Krueger, J.M. (2017). Sleep and Host defense. In: Principles and Practice of Sleep Medicine. Ed. Kryger, M., Roth, T. Sixth Edition, Philadelphia, PA, Elsevier, 193-202.
- Silvani, A., Bojic, T., Cianci, T., Franzini, C., Lodi, C.A., Predieri, S., Zoccoli, G., Lenzi, P. (2003). Effects of acoustic stimulation on cardiovascular regulation during sleep. *Sleep*, 26(2), 201-5.
- Stuss, D.T., Alexander, M.P., Shallice, T., Picton, T.W., Binns, M.A., Macdonald, R., Borowiec, A., Katz, D.I. (2005). Multiple frontal systems controlling response speed. *Neuropsychologia*, 43, 396-417.
- Van Cauter, E. & Tasali, E. (2017). Endocrine physiology in Relation to Sleep and Sleep Disturbances. In: Principles and Practice of Sleep Medicine. Ed. Kryger, M., Roth, T., Sixth Edition, Philadelphia, PA, Elsevier, 202-220.
- Wagner, U., Gais, S., Haider, H., Verleger, R., Born, J. (2004). Sleep inspires insight. *Nature*, 427(22), 352-355.
- Zoccoli, G., Andreoli, E., Bojić, T., Cianci, T., Franzini, C., Predieri, S., Lenzi, P. Central and baroreflex control of heart rate during the wake-sleep cycle in rat. *Sleep*, 24(7), 753-758.

Perinatalni rizikofaktori u disharmoničnom razvoju i u razvoju komunikacije

Juhász Ibolya

Eszterházy Károly Univerzitet, Doktorska Škola, Eger, Mađarska
juhaszibolya-unieszterhazy@gmail.com
Perinatalno Razvojno Psiho-pedagoško Savetovanište, Budimpešta

SAŽETAK

Perinatalna psihologija ističe koliko je važno detetovo rano iskustvo, iskustvo u maternici i za vreme porođaja, isto tako i deca dolaze na svet, sa raznim „kompetencijama”. Naučnici ističu, da sve se pamti od najranijeg doba i kao neki razvojni modeli očituju se kasnije u normativnim krizama i u toku razvoja kod struktura i funkcija. Adaptacija i učenje nosi na sebi obrazac, kako smo se rodili odnosno kako smo startali u život. Prenatalni rizici i intervencije za vreme začeća, trudnoće i porođaja nagoveštavaju specifične razvojne poremećaje. U ovom radu prikazujemo prenatalne, perinatalne rizikofaktore koji najviše utiču na razvoj komunikacije, razvoj razumevanja i ekspresivnog govora. Naši ispitanici su deca i porodice koji su potražili Ranu Ambulanciju za ranu intervenciju i prevenciju od 0-6 godina. Dolazili su zbog poteškoća u razvoju i/ili razvojnih poremećaja ili zbog problema govorne nerazvijenosti. Dobijeni rezultati podvlače važnost potreba za neometanom trudnoćom i porođajem kao i kompetencijama roditeljstva. Dete i njegova porodica su u središtu intervencije. To nam pokazuje smerice rane terapije.

Ključne reči: perinatalna psihologija, perinatalna komunikacija, perinatalni rizici

1 UVOD

Naučnici se u zadnjih 50 godina sve više bave prenatalnim razdobljem. Sve više znamo o prenatalnim i perinatalnim rizikofaktorima, koji imaju značajan uticaj na opšti razvoj te na razvoj komunikacije i govora. Zadnjih decenija ogroman napredak je očigledan u medicinskim, psihološkim, sociološkim i informatičkim naukama, koje pomažu da rana intervencija i prevencija budu uspešnije.

Sve što se doživi, pamti se, već od prvih začetih ćelija. Pamćenje zadržava sva znanja o odnosima, o zbivanjima, o traumi koja se upisuje u ličnost, opterećujući sa tim svest o sebi i znanje o svetu. Utiče na emocionalnu vezanost majka – dete, i na ranu, postnatalnu adaptaciju. Ne zrele strukture i funkcije otežavaju i onemogućavaju dalji harmonični život. Zastoji u razvoju, smetnje u učenju, poremećaji ponašanja i psihički problemi, ponavljanja raznih aktivnosti, isto mogu biti dokaz perinatalnih trauma. Jakobson (1990) i Nyberg (2000) su našli da kod majki koje su dobijala sredstva za umirenje bolova deca u adolescenciji značajno više puta koriste sredstva za promenu svesti. Deca rođena sa epiduralnom anestezijom (EDA), više plaču i imaju emocionalne i opazajne smetnje. Deca ranije pokrenutog, tempiranog porođaja su osetljivija, ranjivija (Gaskin, 2006), više od tih porođaja se završava instrumentalno ili carskim rezom, a novorođenčadi je potrebna intenzivna nega. Oksitocinom periferijalno potpomognut porođaj utiče na ritam porođaja i kasnijeg razvoja te privrženosti majka – dete. Otežano je dojenje i serijalizacija (Insel, 1992; Varga, 2009). Istraživanja ukazuju na vezu između signifikantnosti perinatalnih intervencija i kasnije psihičkih problema (Myhrman Rantacallio, 1996; O’Callaghan and Gibson, 2000; Hidas i Raffai 2000; Orosz, 2017). Psihoterapija dece, simboli rođenja i porođaja, narativna i art terapija (Kokas, 1972) vode nas u bolje razumevanje perinatalnih tokova i tokova duše.

Ističu se periodi dualnija i trialunija. Naziv dualunion predstavlja zajednicu majka-fetus/dete, a u zadnje vreme se sve više govori o trialunionu majka-fetus/dete i otac. S time se prihvata značaj, da sve što

majka i tata doživljava za vreme trudnoće, ima uticaja i na dete. Od 1970-ih godina se u više istraživanja prikazalo, da stres, strah se prenosi preko majčine krvi, kako i ostali kemijsko-biološki sastojci utiču na razvoj za vreme trudnoće (Liebemann, 2005). Bell (1983) ističe, da imunološka komunikacija majka-dete je izuzetno važna, pa taj smisao razvija Szekeres (2003) i kaže, da odnos majka-dete usmerava razvoj komunikacije i nakon rođenja. Nasledni i socijalni učinci, kako na fizičkom, tako i psihičkom planu imaju uticaj na daljnje reproduktivno zdravlje (Varga, 2016). Uticaje obrazlažu epigenetskim pravilima (Falus, 2009; Zhang, 2011). Epigenetika istražuje genske modifikacije od ćelija do ćelija, kao i transgeneracijsko nasleđe, koje ne ide paralelno sa promenama DNS sekvencije i promenama genetskog koda. Epigenetska regulacija ima uticaja u funkcioniranju centralnog nervnog sistema (CNS) u najvećem delu, tako da se promene manifestuju kasnije i na molekularnom, ćelularnom, neuralnom području i očituju se i u ponašanju, emotivnom i kognitivnom planu (Bokkon i sr., 2014). Svako iskustvo se upisuje i prenosi na novu generaciju. Tako se prepisuju stres i trauma majki i baka (Zhang i sr., 2014). Ključni deo ima u tom prenošenju hormonski sistem. U najnovijim istraživanjima nailazimo na dokaze, da životna dob i prelazi kao krizne faze (Erikson, 1967) su normativni, prirodni. Kao jedno od najuticajnijih razdoblja ističe se perinatalno razdoblje, u kojem su prisutni događaji vremena prošlosti, sadašnjosti i budućnosti. U njemu se javljaju najčešći uzorci ponašanja (Zhang i Ho, 2014). Tu su promene na granici dobra i zla, te promene u razvoju i zastoju. Perinatalno razdoblje nosi rane i traume, kao i snagu i plodnost. Nažalost naša moderna vremena mnoge prenatalne, transgeneracijske rizikofaktore ne uzima sa dužnom obazrivošću, tako riziko ostavlja tragove čak preko 6-7 kolena. Npr. majke koje su same rođene carskim rezom češće rađaju carskim rezom. Čak su češći i ostali pre, peri i postnatalni poremećaji (Orosz, 2017). Normativne krize su povez i kasnijih antagonističkih stvari kao što su prijatno i neprijatno, sinkron i desinkron majke-dete. Normativne krize koordiniraju harmoniju zbivanja i dobrobit ličnosti. Osovina je između majka-dete ili majka-dete-otac i nosi značenje postojanja. „ja postijem“, „kako misle o meni“, „postaću kakao funkcionišem i kako me ljube“ (Erikson, 1967). U terapijama sledimo normativne krize i uticaje te organsko-psihološkim učincima pomažemo da se formiraju novi kvaliteti našega „ja“.

Duhovna dob se ostvaruje preko ranih odnosa i iskustava i utiče na harmoničan psihički i emotivni razvoj te zrelost naše ličnosti. Postoji naš korektivni duševni dob i kao kod dece prerano rođenih, računamo korektivni kalendarski uzrast, korigiramo razvojnu dob sa preostalim vremenom koliko bi još bilo do stvarnog rođenja (Juhász, 1918).

Müssing nemački analitičar (1995) kaže da razvoj CNS-a teče zajedno sa razvojem ontogenetskog evolucijskog napredovanja. Jaap der Vaal (2005) iskaže da embrij pokazuje „razvojno ponašanje“ od začeca. Preko neurona oglinda se razvija intuitivni put preverbalne komunikacije. Majke imaju mogućnost „velike sile“ odnosno da sav stres, strah i traumatu promene, eliminišu i učine da postanu snaga razvoja. Neke to čine nehotice, instiktivno, neke to trebaju učiti (Juhász, 2005). Fonagy (2008) kaže da majka-dete kominucira sa unutrašnjim narativima. Mnogi autori, kao Raffai i Hidas (2000) se pozivaju na činjenicu, da majka sa negativnim mislima može izazvati spontani abortus.

Komunikacija je interakcija odnosa, harmonizacija i privrženost. Počinje u maternici i ima veliki uticaj na kasniji razvoj i život. Zastoji razvoja, traume, problemi učenja i regulacije su znak reaktiviranih nerešenih razvojnih rizika ali i mogućnosti ozdravljenja. Obnavljanjem rizčnih perioda dobijemo novu šansu (Orosz, 2016) za reorganizaciju struktura i sposobnosti. Prva škola i prostor gde se počinje komunikacija jest maternica, prvi učitelj je majka, njeno telo, psiha i duša (Juhász, 2018). Ekspresivni govor i verbalna komunikacija se razvijaju na temelju preverbalne komunikacije koja je starija i pouzdanija. Zato kod dece često kad je u pitanju sukob između odnosa i sposobnosti oni više veruju intuitivnim osećajima, nego onom što im se govori (Emerson, 1995/96). „Ne može se ne komunicirati“ (Watzlawick, 1968). Lepe reči, stvaraju, drže nas, miluju. Lepe reči izražavaju naša osećanja, našu melodiju srca. Dobro je odrasti na lepim rečima svoje majke i oca (Juhász, 2015).

Kako tretiramo život od najranijeg doba takvo društvo gradimo. Na žalost još ne činimo sve sa svešću, možda nam trebaju pravno-etička pravila da perinatalni period učinimo radosnijim i plodnijim.

2 METODIKA

Naša pitanja su bila:

1. Kakva je povezanost između perinatalnih rizikofaktora (PRF) i razvojnih funkcija?

H.1. Predpostavili smo da kod većeg učešća PRF, veći je broj razvojnih problema. Predpostavili smo da su neke funkcije osjetljivije i neki PRF učestaliji. U našem radu zbog opširnosti istraživanja govorimo samo o komunikaciji i razvoju govora.

2. Koji PRF imaju najveći uticaj na razvoj komunikacije i govora?

H.2. Predpostavili smo da razvoj komunikacije i govora paralelno ide sa razvojem motorike i zrelošću CNS.

3. Može li se predvideti uticaj PRF na razvoja rane motorike, komunikacije, govora i kasnijeg školskog uspeha?

H.3. Predpostavili smo da rani PRF utiče na razvojne poremećaje i poteškoće u učenju.

Ispitanici

Ispitanici N=113, deca i njihove porodice, od 0-6 godine koji su dolazili u Savetovalište na ranu intervenciju i prevenciju. Uzimanje perinatalnih podataka i merenje sposobnosti sprovedeno je u dva zahvata u predškolskom i školskom razdoblju, početkom terapije i krajem školske godine.

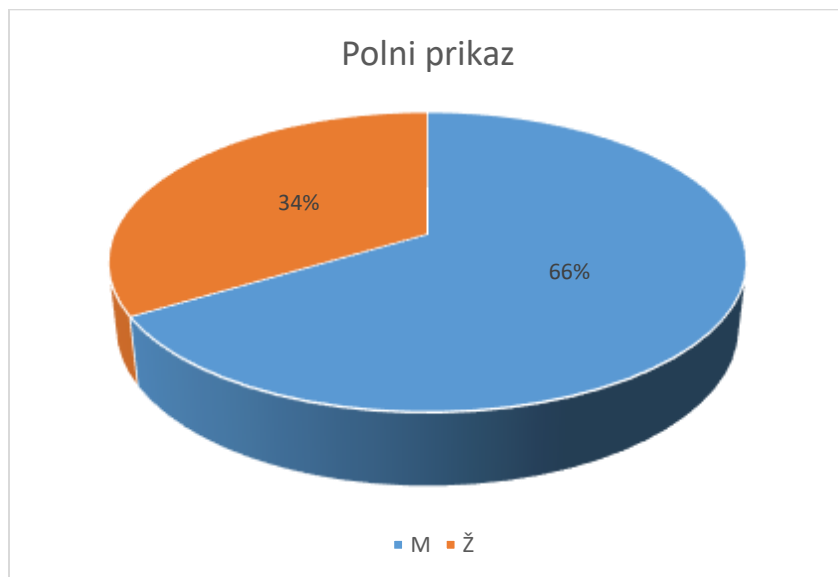
Podatke smo dobili pomoću proširenog upitnika „Perinatalna Anamneza“(PA-JI-2010) i polustrukturanog intervjua. Razvojnim testovima smo merili psiho-motorni (PM) razvoj.

Kvantitativna i kvalitativna analiza je izvršena pomoću statističkog progama SSPS 21. i Excel.

U ovom radu iznećemo samo podatke kvantitativne statistike, nećemo ulaziti u kvalitativnu analizu.

3 REZULTATI

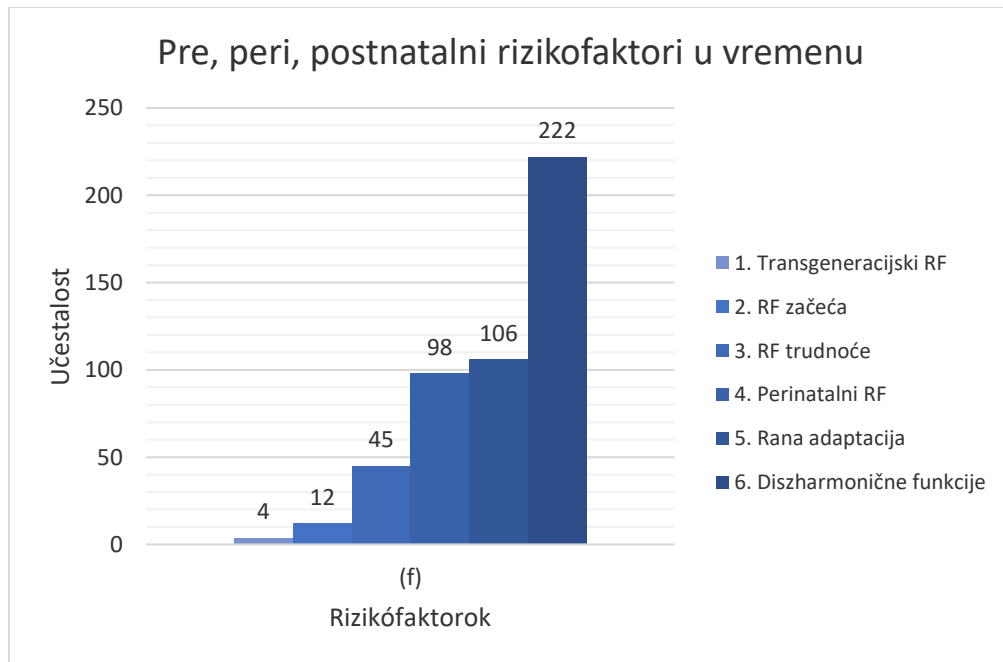
Grafikon 1 prikazuje odnos pola, od N=113 ispitanika, N=75 je muškog pola, N=38 ženskog pola.



Grafikon polnog učešća, (Juhász, 2019)

Kakav je učestalost PRF, razvojnih poremećaja, diszharmoničnog razvoja?

H.1. Naša pretpostavka opravdava, da kod većeg broja PRF nalazimo mnogo više disharmoničnog razvoja (Grafikon 2).



Grafikon 2 Vremenska raspoređenost pre-, peri-, postnatalnih rizikofaktora i razvoju disharmoničnost

Koji PRF imaju najveći uticaj na opšti razvoj i razvoj komunikacije i govora?

H.2. Predpostavili smo da kod većeg učešća PRF, veći je broj razvojnih problema, i predpostavili smo da neke funkcije su osetljivije, i neki PRF su učestaliji. Na sledećoj tabeli prikazemo učestalost PRF. (Tabela 1).

Tabela.1 Učestalost rizikofaktora, (Juhász, 2019)

Učestalost rizikofaktora N=113	f	%
Transgeneracijski RF	72	63,71
RF začeca	35	30,97
RF trudnoća	80	70,79
RF perinatalni (porođajni)	81	71,68
Prevremeno rođenje	37	32,74
Majke doživile traumu	76	67,25
Elektivni carski rez	53	46,90
Carski rez	36	31,85
pOT-periferalni oksitocin	76	67,25
Lek protiv bolova	68	60,17
EDA-epiduralna anestezija	35	30,97
Magnezijum	81	71,68
RF rane adaptacije	78	69,02
RF dojenje	71	62,83

Statistička sredina	19
f RFmin=	8
f RFmax=	30

Opšti razvoj kod dve trećine dece kasni oko godinu dana u različitim funkcijama, kod jedne trećine dece više od dve godine, a kod jedne trećine nema kašnjenja u razvoju.

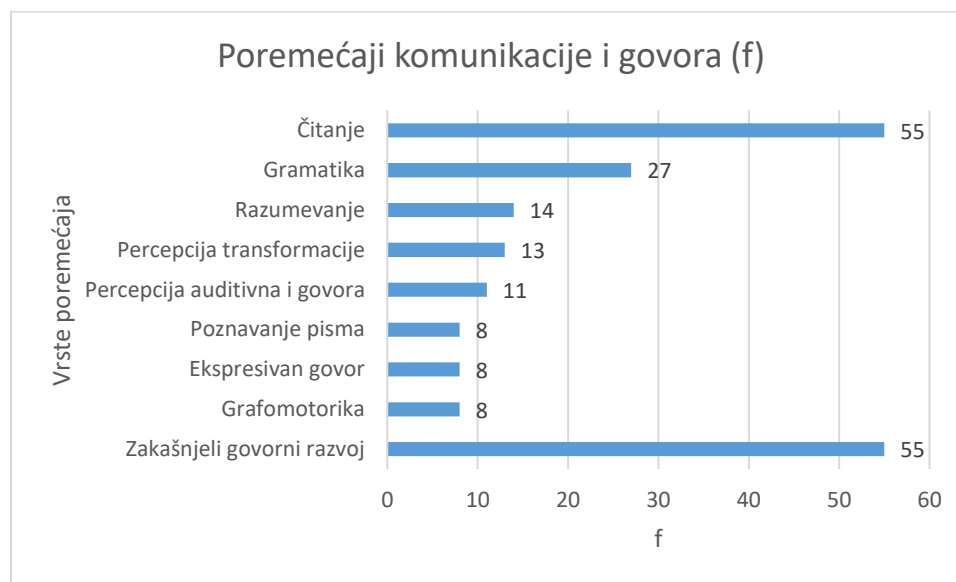
Tabela 2 Opšti razvoj i kašnjenje funkcija, (Juhász, 2019)

Opšti razvoj	f	%
Nema kašnjenja a razvoju	22	19,46
Kasni razvoj manje od godinu dana	62	54,86
Kasni razvoj više od godinu dana	29	25,66

One majke koje imaju problema začeca znatno više RF je kod dece u razvoju $f =$ preko 20 i više problema u školi preko 80% učenika imaju funkcionalne probleme. Najmanji broj učestalosti RF $f_{min} = 8$, a najveći broj $f_{max} = 30$. Statistička sredina $f_{SD} = 19$.

Govorni i motorni razvoj hodaju zajedno i najviše predstavljaju uspešnost učenja. Naša pretpostavka delimično se ispunilo. Razvoj govora ide zajedno sa razvojem motorike, ali najvećem delu sa tonusom mišića i kognitivnim razvojem (Tabela 2).

Poremećaji komunikacije i govora koji su se javili u našem istraživanju dati su u grafikonu 3.



Grafikon 3 prikazuje poremećaje komunikacije i govora (Juhász, 2019)

Pitanje: koji PRF imaju najveći uticaj na razvoj?

H.3. Pretpostavili smo da rani PRF utiče na razvojne poremećaje komunikacije i govora i poremećaje učenja (Tabela 3).

Tabela 3 Korelacija između RF i komunikacije i govornog razvoja (Juhász, 2019)

	Korelacija komunikacije i govora sa PRF	p=0,05	p=0,01
RF trudnoće	0,24	*	
Nedonišče	-0,264	*	
Tonični poremećaji	0,322		**
Razvoj motorike	0,498		**
Kognitivni razvoj	0,302		**
Senzorni razvoj	0,279		**
IR éretlen	0,244		**
Poremećaji učenja	0,522		**
Rani tretman	-0,203	*	

4 DISKUSIJA

Deca i porodice su tražili pomoć i delom su uključeni u rani tretman. U našem istraživanju, kao i kod drugih autora, dobiveno je da je u perinatalnom periodu muški spol osetljiviji od ženskog spola u omeru 2/3 : 1/3. Interesantno bi bilo daljne istraživanje da li se menja omer u toku razvoja.

Razvoj komunikacije i govora korelira najviše sa razvojem motorike, tonusom, zrelošću nervnog sistema. Razvoj u materici je izuzetno važan, a perinatalni rizikofaktori pokazuju kako je ranjivo ovo vreme.

Povećanje broja PRF povećava broj razvojnih poremećaja i probleme u učenju. Nadam se da ćemo jednom sa mnogo više osetljivošću i pažnjom pratiti život od začeca do škole.

Istraživanje nam ostavlja puno otvorenih pitanja, kao što su pitanja privrženosti, osećajnosti u najranijem periodu zivota i kasnije u učenju... Interesantno bi bilo više znati o uzrocima normativnih razvoja, i kontekstima razvojnih poremećaja da bismo koristili u planiranju kod dece sa razvojnom poremećajima.

LITERATURA

Buckley TM. (2005).A hipotalamusz-hipofízis-mellékvese (HPA) tengely és az alvás kölcsönhatásairól: normális HPA tengely aktivitás és

Bell L. D.Bell (1983) Parental validation and support in the development of adolescent daughters, Kötet 1983 , Issue 22, 1983. december, 27–42. Oldal

Bókkon István, Vas József és Császár Noémi (2014): Gondolatok a szabadakaratról az epigenetika, a transzgenerációs traumaátvitel és tudattalan folyamatok tükrében. *Magyar Pszichológiai Szemle*, 69. 4/8. sz. 797–819. cirkadián ritmus, példaértékű alvászavarok. *J Clin Endocrinol Metab*. 2005. május; 90 (5): 3106-14. Epub 2005, február 22.,Buckley TM 1 , Schatzberg AF .

Emerson, W. (1994) Trauma impacts audiotaped presentations. Seattle 1992, Petaluma 1992, and March 1993. Emerson Training Seminars.

Emerson, W. (1995/1996). Treating birth trauma during infancy: A series of five videos. Petaluma, CA, Available from Emerson Training Seminars, (707) 763-7024.

Erikson, E. Az emberi életciklus, IN. Bernáth L., Solymosi K. (1997) Fejlődéslélektan olvasókönyv, Budapest

Fonagy, G. (2003) Fonagy, P. szerk. (2006): Handbook of Mentalization-Based Treatment. West Sussex, John Wiley & Sons, 3-31.

Gaskyn I.M. (2015) Útmutató szüléshez - 3. kiadás, Jaffa Kiadó és Kereskedelmi Kft

- Hidas Gy. - Raffai J. - Vollner J. (2000): *Lelki köldökszínór–Beszélgetések a kisbabámmal*, Helikon kiadó kft., Budapest
- Jaap van der Vaal, (2005) *The Architecture of the Connective Tissue in the Musculoskeletal System—An Often Overlooked Functional Parameter as to Proprioception in the Locomotor Apparatus*, Published online 2009 Dec 7. PMID: PMC3091473, PMID: 21589740
- Jakobson, Roman at all (1990) *A nyelvről*, ISBN978-0-67463-535-7 Kiadó Cambridge, Mass.: Harvard University Press, 1990.
- Juhász, I. (2005) *A korai fejlesztés és a prenatális határán – A IX. Korai Konferencia*, előadás, Korai fejlesztők IX. Konferenciája, Pécs
- Juhász, I. (2015) *Padlock in soul – description of cases in perinatal communication: lokot na dusi... trauma prenatalne komunikacije–ptsd, pas*, Serbia, 1st international congress on psychological Trauma: Prenatal, Perinatal & Postnatal Aspects (PTPPA 2015), May 15–16, 2015., Belgrade, Serbia (2015)
- Juhász, I. (2014) *A perinatális kommunikáció*, A Magyar Gyógyneveléstudományok Egyesületének XLII. Országos Szakmai Konferenciája, A konferencia kerettémája: "Fogyatékoságügy– rehabilitáció–szociális megsegítés", Konferenciakötet, Szeged, 2014. június 21. (2014)
- Juhász, I. (2015) *Padlock in soul – description of cases in perinatal communication: lokot na dusi... trauma prenatalne komunikacijeptsd, pas*, Serbia, 1st international congress on psychological Trauma: Prenatal, Perinatal & Postnatal Aspects (PTPPA 2015), May 15–16, 2015., Belgrade, Serbia (2015)
- Juhász I., (2018) *Korrigált életkor, korrigált lelki életkor*, In: Fehérvári, Anikó; Széll, Krisztián; Misley, Helga (szerk.) *Kutatási sokszínűség, oktatási gyakorlat és együttműködések: Absztrakt kötet: XVIII. Országos Neveléstudományi Konferencia*, Budapest, Magyarország : ELTE Pedagógiai és Pszichológiai Kar, MTA Pedagógiai Tudományos Bizottság, (2018) p. 247
- Kokas, K. (1972). *Képességfejlesztés zenei neveléssel*, Budapest, Zeneműkiadó, 65 118-120p
- Lieberman, E., Davidson, K., Lee-Parritz, A., Shearer, E. (2005) *Changes in fetal positioning during labor and their association with epidural anesthesia. Obstetrics & Gynecology*, 105 (5 Pt 1), 974–982.
- Müssing, R. (1991) *Imagination und Trauma: Bilder und Träume von Müssing, R.: Familien- Selbst-Bilder. München/Basel 1991. In: Harvard Educational Review, 57/1947, S. 102ff.... - 412. p*
- Myhrman A , Rantakallio P , Isohanni M , Jones P., Partanen U. (1996) *Nem kívánt terhesség és skizofrénia a gyermekben. Br J Pszichiátria*. 1996. november; 169 (5): 637-40.
- Nyberg, K., Buka, S. L., Lipsitt, L. P. (2000) *Perinatal medication as a potential risk factor for adult drug abuse in a North American cohort. Epidemiology*, 11 (6), 715–716.
- O'Callaghan at all (2000) *Az anyák mentális betegségei és a gyermekek viselkedésével kapcsolatos problémák: ok-okozati összefüggés vagy megfigyelési torzítás? Az Amerikai Gyermek- és serdülőkorai pszichiátria akadémia lapja*, 39. Kötet, 5. Szám , 2000. Május, 592–602. 2000. Május , 592–602. p. <https://doi.org/10.1097/00004583-200005000-00013>
- Orosz, K. (2009) *Perinatális terápiák*, ELTE APIK Perinatális szaktanácsadó képzés, Budapest
- Orosz Katalin, S. Nagy Zita (2017) *A sorsformáló 9+1 hónap. A magzati kor és a születés hatása az életút alakulására*. Kulcslyuk Kiadó Kft.p.288. ISBN:9786155281518
- Szekeres, (2003), *Immunológiai párbeszéd az anya és magzata között*, Magyar Tudomány, 2003/4
- Varga, K. (2009) *Szuggesztív kommunikáció a szomatikus orvoslásban*, Cheek, 1969, *Kommunikáció a kritikus állapotú betegekkel*, 201-222, ELTE Könyvtár
- Watzlawick, P., Weakland, J. H. és Fisch, R. (2008): *Változás - A problémák keletkezésének és megoldásának elvei*. Animula Kiadó, Budapest.
- Zhang, X., és Ho, S. M. (2014): *Epigenetics meets endocrinology. Journal of Molecular Endocrinology*, 46, R11–R32.

Assessment of the Quality of Spoken Voices Using Information Technologies

Drasko Furundzic¹, Silvana Punisic², Miško Subotić²

¹Mihajlo Pupin Institute, Volgina 15, 11000 Belgrade, Serbia.
drasko.furundzic@pupin.rs

²Life Activities Advancement Center, Gospodar Jovanova 35, Belgrade 11000, Serbia.
silvanapunisic@hotmail.com

ABSTRACT

The problem of automated articulation quality assessment is primarily determined by the relevance and representativeness of a set of articulation quality feature vectors, as well as by the applied mathematical models of correspondence between feature vectors and indicators of articulation quality.

The main task of the research presented here is the modeling of the complex process of logopedic assessment of the quality of the articulation of Serbian phonemes, using "data driven" learning models. The complexity of the task determined the following steps for its fulfillment:

a) a descriptive analysis of the articulation process, as the most important and complicated aspect of the psycho-physiological process, the production of speech, in the light of the definition and analysis of its typical and atypical realizations; b) the characterization of an acoustic manifestation of the process of articulation, as phenomenon suitable for the indirect analysis through instrumental experimental acoustic methods; c) describing the process of audible perception and evaluating the quality of articulation by the expert based on a trained listening, in accordance with existing standard tests; d) the establishment of different models of algorithmic correspondence between the acoustic feature vectors and the numerical indicators of the classes of different articulation quality, based on intelligent learning predictors.

Key words: Speech pathology, artificial neural network, computer modelling, Bayesian classifier, k nearest neighbours.

1 INTRODUCTION

The current situation in the field of speech communication indicates the spread of various forms of speech pathology, which is most often manifested by a distortion of the quality of articulation, often related to the rapid technological development in the field of telecommunications, the internet and mobile telephony. In addition to its importance, modern technologies also generate a negative impacts on the health of the younger population, in particular on the development of speech. Namely, the favor of non-verbal and indirect communication at the expense of direct speech communication affects the in voice articulation quality and speech quality in general.

The existential importance of speech and language implies that properly developed speech is a necessary condition for the healthy development and quality of all aspects of a person's life. Consequently, standard methods of articulation quality assessment have already been established in speech therapy.

Computational evaluation of voice articulation, since the middle of the last century, has been the subject of several related scientific disciplines. Such an approach is conditioned by the complexity of the relationship between the neuro-physiological process of articulation and the speech signal, as its direct acoustic manifestation, on the one hand, and the complexity of the auditory process of speech signal perception. Due to the large number and very prominent variability of the voice quality carriers and the

complexity of the articulation process, no unique solution of the system for computer evaluation has been found so far.

The rapid development of artificial intelligence, the Internet and Information Technology, has generally enabled the development of efficient tools and the formation of a large number of readily available databases, including the domain of speech quality recognition and evaluation. The existing conditions provide an opportunity to design flexible computer models and software tools for objective assessment of speech quality with wide application in speech diagnosis and therapy that can also be used online. Proposed assessment of articulation quality basically refers to a fine discrimination between the attributes of a predefined and restricted set of related and similar phonemic and subphonemic structures.

Learning models have a structure that, in a given information environment, enables computer identification of the functional dependence of articulation quality on particular articulatory-acoustic features.

The performance of intelligent learning predictors, known as "data driven" models, is, by definition, determined by the quality (representativeness) and quantity (number of instances) of the databases available, as well as the degree of relevance or informativeness of representative features.

The purpose of the research

The purpose of the presented research is the determination of formal model of algorithmic correspondence between vectors of acoustic measures of voice articulation quality and the numerical indicators of their ratings, obtained by a team of speech therapists. The specific objective of this research is to prepare an adequate representative sample base, to form a reliable model of predictors of articulation quality, as ultimate goal of the whole research. The emphasized subjectivistic character, insufficient efficiency and reliability of the traditional methods for assessing the quality of articulation of the Serbian voices are the motives for simplification and objectification of this process. Previous approaches to this problem are based on partial solutions based only on the articulatory aspect or on the analysis of individual acoustic manifestations of its variability.

Starting Assumption

The general assumption of the feasibility, justification and required performance of the planned efficient computer model had to satisfy several prerequisites and go through the process of proving the following assumptions:

1. The multidimensional space of the articulatory-acoustic attributes of the spoken voices allows us reliable distinction between their typical and atypical realizations.
2. There is no significant difference in the accuracy of the articulation quality assessment between the speech therapist and the selected algorithm for the automatic articulation quality evaluation.

Methodological Aspect

The realizability of the proposed objective computer model for evaluating the quality of Serbian voice pronunciation was conditioned by the validation of the defined starting assumptions.

Of primary importance was understanding the process of voice articulation, a mechanism based on the learned paradigms of coordinated activation of speech organs and hearing senses.

Another important premise was the understanding of the mechanism of the trained perception of the quality of spoken content by speech therapists, in order to identify relevant set of features on the basis of which the speech therapist assesses the quality of speech. Articulatory-acoustic features, as correlates of the quality of speech articulation can be presented in numerical or symbolic form, which enables us a computer modeling of the articulation quality evaluation process.

The next research step concerned the selection of the type and structure of the proposed predictive mathematical models.

The accomplishment of general task implied the following methodological steps we focused on:

- a) determination and characterization of articulatory-acoustic indicators of articulation quality, definitions of their metrics and their typical deviations;
- b) analyzing and increasing the level representativeness of the selected feature vector and training sample using appropriate methods;
- c) establishment of different formal models of algorithmic correspondence between the vector of acoustic measures and numerical indicators of different classes of speech segments.
- d) selecting the optimal model through a comparative analysis of the performance of several proposed model types and structures;

The research was conceptualized and realized to ensure the collection of statistically representative data. The database was used to extract relevant phoneme features, for the segmentation of phonemic and sub-phonemic structures of analyzed words

The survey involves two groups of respondents: a control, with correct pronunciation and an experimental one with different types and levels of variance in voice pronunciation. In addition, there is also a group of trained listeners - experts, who will serve to objectify the performance of our algorithm .

The study used standard tests, **Global Articulation Test (GAT)** and **Analitycal Test (AT)** (Kostic et al, 1983; Vladisavljevic, 1981) and relevant expert knowledge. Software tools, Matlab, Praat, Microsoft Excel and Statistica were used for data processing, modeling and presentation of results.

Using the available base of sound stimuli, we form two sets of feature vectors, train and test set, and their corresponding expert evaluation values.

2 ARTICULATION QUALITY REPRESENTATION

Voice communication, which in itself is an exchange of information between the interlocutors through speech as a complex sound signal takes place successively at the following three levels of realization: neuro-physiological (articulatory and auditory) and physical (acoustic). Disruptions or interruptions at any of these levels impair the quality or interrupt the voice communication process.

The articulatory level essentially refers to the mechanism of properly encoding a message into a complex speech signal through the learned paradigms of coordinated activation of the components of the speech apparatus by the speaker.

The acoustic level is an acoustic manifestation of the process of speech articulation through the interaction of the articulated speech signal with the local environment, its transmission to the listener/s through the medium of propagation that is most often exposed to noise in real conditions.

Auditory level refers to the reception and perception of a speech signal, during which the auditory attention of the listener is directed to the structure of its acoustic attributes as carriers of the coded message in purpose of proper decoding or understanding of the message to the level of its intelligibility.

Logopedic Perception of Articulation Quality

The logopedic approach to analysing phoneme characteristics is largely determined by standard tests, namely the GAT and the AT. Both tests are based on auditory perceptual detection and recognition of the type of deviation from the typical pronunciation of the phoneme of the Serbian language. The AT test, because of the large number of variations characteristic, requires extensive speech therapist experience in shaping a general impression into a concrete assessment of the quality of the utterance. The deviations defined in the AT test are caused by the variability of the basic articulatory acoustic parameters. Since the number of these deviations is large, their detailed modelling, as a whole or individually, does not make much sense. That is why, when modelling speech evaluation, we rely entirely on the GAT test which allows the speech therapist to make a reliable judgment in the form of a global attitude on the quality of articulation.

The GAT test scores use a scale with marks from 1 to 7. Ratings 1 and 2 are correspond to adult speakers, mark 3 refers to children and average speaker and mark 7 indicates replacement or omission of phonemes. Marks 4, 5 and 6 represent the various levels of distortion of phonemes.

The oldest technique for analysing of speech quality is the auditory-perceptual assessment of speech by listening (Kasic, 2003). The essence of the method is based on the comparison of the complex general acoustic image of the analysed speech segment with its abstract paradigm formed on the basis of experience in the speech therapist's consciousness. This procedure is an initial and crucial moment in the treatment of subjects. Fundamental problems of speech articulation relate to the quality of articulation of basic speech entities, voices and syllables. A prominent feature of speech is variability, manifested by the emergence of variable values of measures of the attributes of speech segments and the variable relationship between these measures. The values of the aforementioned attribute measures define the domain of a multidimensional space of standard set boundaries into which typical realizations of a particular category of speech segments are projected. This space is known in phonetics as a variational field, whether it is in the articulatory or acoustic domain. Any projection of speech segments from the same category into a space outside this area is perceived as a certain degradation of the quality of its articulation, that is, atypicality of its realization.

Practical Aspect of Speech Quality Assessment

There is still no reliable general procedure for a comprehensive automatic assessment of the quality of Serbian voices pronunciation, although there are recent proposals for solutions to specific problems in the area. The cause of this situation lies in the complexity and insufficient knowledge of both the process of articulation and auditory perception, and their inadequate formal representations.

As an indicator of the importance of the proposed research can serve following scientific papers in the field: (Hadjitodorov et al., 2000; Manfredi, 2001; Godino-Llorente, et al., 2004). Some papers focus on the general detection of speech disorders (Wallen et al., 1996; Hadjitodorov et al., 2002) while others address specific types of pathology (Maier et al., 2009; Hossein et al., 2009). Also, the partiality of approaches in solving the problem of automatic evaluation of speech quality based on individual acoustic characteristics of speech signal is observed, both in spectral (Markaki, 2011; Bilibajkic et al. 2016) and those defined in the time domain (Markaki, 2011; Jovicic et al. 2010; Vasilakis, 2009).

The complexity of the feature extraction process indicates the great importance of the determination of a training sample of high representativeness data and optimal selection of the type and structure of the classifier as essential conditions for completing the task.

3 EXTRACTION OF CHARACTERISTIC FEATURES OF PHONEMES

The preparation of feature vectors of different phoneme articulation quality classes has three levels: separation of the effective spoken word stimulus from the silent signal, a process known as "voice activity detection" (VAD), segmentation of separated words into phonemic segments (phonemes) and sub phonemic segments (frames) as well as extraction of relevant discriminatory features at both levels. Each separation of speech segments implies their differentiation according to the defined similarity criterion, so it is necessary from the start to introduce appropriate parameterization.

The VAD algorithm of high reliability is still unavailable, which poses a major unsolved problem and affects many applications such as: reliable speech translation (Ramirez et al. 2003; Karray et al. 2003), real-time Internet voice transmission (Sangvan et al., 2002).

Theoretically speaking, well-chosen features should prevent samples from overlapping between speech and silence classes or between typical and atypical phonemes. A training pattern of auditory stimuli and relevant vectors of marks are formed to represent a training pattern for the MLP classifier to automate the segmentation procedure (Furundzic et al. 2009, 2012b, 2013, 2017).

Extraction of characteristic features of phonemes

In accordance with the above facts about the extraction of different speech signal characteristics, following relevant acoustic features have been proposed. The extraction and segmentation process, as well as the articulation quality assessment applied in this research, is based on the Pattern Recognition approach.

Set of Selected Relevant Features

nw - the number of samples of a wave signal that refers to an entire word that contains actual phonemes in the initial position,

nph - number of signal values related to current phonemes,

$nq = nph / nw$ - the ratio of previous lengths.

E_f - *Phoneme Mean Energy*,

E_r - *Mean energy of the frame of the corresponding word*,

E_{fu} - *Total Phoneme Energy*

E_{ru} - *The total energy of the current word*,

MFCC coefficients - *The values of a series of 12 coefficients*.

The length of this input feature vector is 19. The length of the output feature vector is 1 (binary values 1 and 0). All the listed features were used to solve problems of Articulation Quality Assessment. The results obtained by applying the features are presented in Chapter four.

4 RESULTS OF ARTICULATION QUALITY ASSESSMENT

Reliable classification is conditioned by the representativeness of the training samples. The representativeness of the samples is directly correlated with the balance of the opposing classes, that is, with the degree of uniformity of the distribution of the instances of the classes over the space of their characteristics. For this reason, various pattern balancing techniques have been developed and the problem has been defined as imbalanced learning. This is one of the biggest challenges in the field of learning inductive predictors. The research presented here uses a new algorithm called Distance Based Balancing (DBB) (Furundzic et al. 2017). In this chapter we present the results by comparing several classifiers for evaluating the quality of voice articulation, and also, evaluating the impact of the applied DBB algorithm on increasing the efficiency of the classifiers.

Results of Articulation Quality Assessment Using Five Models

The previous chapters show the preparation for the most important part of the research that is, determining the computer model for assessing the quality of the articulation of Serbian language voices. Of the four different methods which have been subjected to comparative analysis in this section, the optimal model will be selected. A general overview of the block diagram of for determining the optimal model for evaluating articulation quality is given in Figure 4.1. Using two training sets of different representativeness (50% of the original sample and its balanced counterpart), we took the opportunity to take advantage of the DBB algorithm to increase the prediction reliability of the classifiers used.

The decision module generates a series of binary values, where 0 is reserved for typical and value 1 represents an atypical articulation. The end result of the research is the determination of the computer model of the process of speech therapists evaluation of the phoneme articulation quality. The optimal model will be declared to be the model that demonstrates the highest reliability of voice quality prediction according to the mean score given by the speech therapist (Table 4.1). As we said, our objective GAT-based quality score represents the average score of a group of five (5) experienced speech therapists.

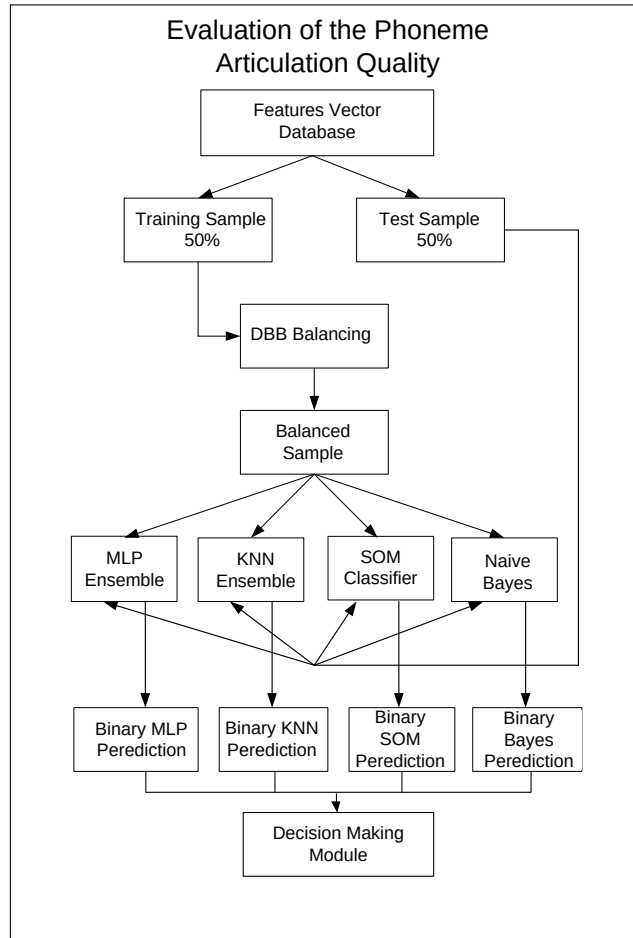


Figure 4.1 Determination algorithm of optimal model for articulation quality assessment.

In this way, a starting ideal standard of accurate articulation quality ratings was assumed, which presumably has a maximum AUC value (1) for each phoneme, a maximum mean AUC value (Mean AUC = 1), and a minimum standard deviation value (Std AUC = 0). The results on the accuracy of the different predictors are shown in Table 4.1, in the form of AUC values. Information on the total number of positive (1) and negative (0) examples is also given in Table 4.1. The ratio of training and test set was (50%: 50%) and the results presented refer to the test set. Table 4.1 provides a comparative overview of the results of the predictors trained on the two training samples: 50% of the unbalanced original and the sample obtained by balancing the same training sample using the DBB algorithm (Furundzic et al. 2017). It should be noted that the Optimal MLP ensemble is determined based on the algorithm (Furundzic et al. 2012a).

Table 4.1 Prediction accuracy (AUC) on the test sample of the predictor group trained on unbalanced (originals) and balanced (DBB) training samples.

	T R A I N I N G											
Speech Therapists and Learning Predictors	ORIGINAL TRAINING SET (50%)						BALANCED TRAINING SET (DBB OF ORIGINAL)					
	T E S T											
	ORIGINAL TEST SET (50%)						ORIGINAL TEST SET (50%)					
	S	Š	Z	Ž	Mean (AUC)	Std (AUC)	S	Š	Z	Ž	Mean (AUC)	Std (AUC)
Majority Decision of Speech Therap.	1	1	1	1	1	0	1	1	1	1	1	0
KNN Ensemble	0.8904	0.9483	0.9901	0.7929	0.9054	0.0854	0.8916	0.9677	0.9796	0.7964	0.9071	0.0787
Naive Bayes	0.7983	0.8291	0.8453	0.7550	0.8069	0.0397	0.8831	0.9405	0.9391	0.9670	0.8697	0.0756
SOM	0.6939	0.5988	0.6524	0.6124	0.6394	0.0429	0.7275	0.7510	0.7704	0.7650	0.6964	0.0683
Optimaly Selected MLP Ensemble	0.8660	0.9030	0.9607	0.9818	0.9279	0.0530	0.8992	0.9068	0.9628	0.9939	0.9343	0.0462
Simple Averaged MLP Ensemble	0.8560	0.9134	0.9507	0.8114	0.8829	0.0615	0.8739	0.8851	0.9481	0.9632	0.9176	0.0446

Each test example has an a priori associated score generated by the speech therapist group. On the other hand, each predictor generates a corresponding vector of binary values for the same test sample. Using the confusion matrix and the accompanying metric equations to evaluate the performance of the classifiers, we obtained the AUC values, shown in Table 4.1, for each phoneme and each predictor as a measure of agreement with the standard values. Thus, a higher AUC value corresponds to a higher degree of prediction accuracy. In Table 4.1 bolded values are related to the best prediction values. Mean AUC values are particularly important as a general measure of predictor performance (rank), and to this extent MLP Ensemble has maximum values both in the domain of models trained on an unbalanced training sample and in the domain of models trained on a balanced sample. According to Table 4.1 MLP structures with balanced data have the lowest deviation values. By analysis of the values, we calculate the total rank for all predictors and conclude that the MLP ensemble achieves the highest mean AUC values for both training sample cases. Also, the MLP ensemble in the Ranking takes first place in the case of a balanced training sample, while the KNN predictor has primacy in the case of an unbalanced training sample. These results demonstrate both the benefits of the MLP ensemble and the high comparability of KNN predictors with respect to proven flexible classifiers such as neural networks.

With these results, we confirmed the assumption of the best performance of an MLP ensemble.

5 CONCLUSION

This study presents the design of computer model of the speech-quality evaluation process of Serbian phonemes, using different models for pattern recognition. Normal speech development is a necessary condition for healthy development of all aspects of a person's life, so the standard speech assessment methods already exist in speech therapy, based on a trained listening. A shortcoming of the existing solutions implies the need for creation of better, reliable, objective and efficient computer model with a high degree of autonomy.

The general assumption of the feasibility and purposefulness of such a model had to satisfy main prerequisites that imply determination of a set of relevant attributes of phonemes and classifiers that will evaluate the quality of articulation with accuracy at the speech therapist level.

The final research step concerned the choice of the type and structure of the proposed predictor that should establish an acceptable model of correspondence between the feature vector and the quality of phoneme articulation. Through comparative performance analysis of several proposed model types and structures, we selected the optimal model - the MLP ensemble. Achieving this goal required the several specific research steps:

- Preparation of the Continuous Speech Stimulus database of the subjects in accordance with the GAT test;
- Determination of a set of acoustic indicators for distinguishing between active speech (words) and silence signals for training VAD detectors;
- Extraction of phoneme speech stimuli by segmentation of word signals from the word stimulus database;
- Determining a set of acoustic features for assessing the quality of the articulation of Serbian phonemes;
- Analysis and increase of the representativeness level of the selected training sample using the new DBB method;
- Choosing the optimal model (MLP ensemble) through comparative performance analysis of several proposed model types and structures.

The validity of the basic assumptions was confirmed through adequate tests carried out and through analysis of the results.

REFERENCES

- Bilibajkić, R., Šarić, Z., Jovičić, S., Punišić, S., Subotić, M., (2016). Automatic detection of stridence in speech using the auditory model. *Computer Speech and Language*, Volume 36, pp.122–135.
- Furundžić, D., Stanković, S., Jovičić, S., Punišić, S., Subotić, M., (2017). Distance based resampling of imbalanced classes: With an application example of speech quality assessment, *Engineering Applications of Artificial Intelligence*, vol. 64 (2017), pp 440–461.
- Furundžić, D., Subotić, M., Punišić, S., (2009). Determination of relevant parameters influence in articulation regularity rating for Serbian phoneme “š” using neural networks, *Speech and Language* (2009), Proceedings 3rd International Conference on Fundamental and Applied Aspects of Speech and Language, pp. 158-167, Belgrade, Serbia, November (2009).
- Furundžić, D., Djurović, Z., Celebic, V., and Salom, I., (2012a). Neural Network Ensemble for Power Transformers Fault Detection, *Proceedings of Eleventh Symposium on Neural network Applications in Electrical Engineering, Neurel* (2012), Beograd, September (2012), ISBN: 978-1-4673-1571-5, IEEE Catalogue Number: CFP12481-PRT, pp. 247-251
- Furundžić, D., Jovičić, S., Subotić, M., Punišić, S., (2012b). Acoustic Features Determination for Regularity Articulation Quantification of Serbian Fricatives, *Proceedings of Eleventh Symposium on Neural network Applications in Electrical Engineering, Neurel* (2012), Beograd, September (2012), ISBN: 978-1-4673-1571-5, IEEE Catalog Number: CFP12481-PRT, pp. 197-201.
- Godino-Llorente, J. I., Gómez-Vilda, P., (2004). Automatic Detection of Voice Impairments by Means of Short-Term Cepstral Parameters and Neural Network Based Detectors, *IEEE Transactions on Biomedical Engineering*, vol. 51, pp. 380-384.
- Hadjitodorov, S., Boyanov, B., Teston, B., (2000). Laryngeal pathology detection by means of class-specific neural maps, *IEEE Transactions on Information Technologies and Biomedicine*. vol. 4, pp. 68–79.
- Hadjitodorov, S., P. Mitev, P., (2002). A computer system for acoustic analysis of pathological voices and laryngeal diseases screening. *Journal ELSEVIER, Medical Engineering & Physics*, 24(6), pp. 419-29.
- Hansen, L.K., Salamon, P., (1990). Neural network ensembles, *IEEE Trans Pattern Anal* vol. 12, pp. 993-1001.
- Hossein, K., Babak, S. A., Mansour, N. B., (2009). Optimal feature selection for the assessment of vocal fold disorders, *Computers in Biology and Medicine*, vol. 39, pp. 853-946.
- Jovičić S., Kašić Z., Punišić S., (2010). Production and perception of distortion in word-initial friction duration. *Journal of Communication Disorders* 43/5., DOI:10.1016/j.jcomdis.2010.04.007.
- Kašić, Z., (2003). *Fonetika*. Autorizovani rukopis, udžbenik za studente defektološkog fakulteta, Beograd, v(In Serbian).

- Karray, L.; Martin. A., (2003). Toward improving speech detection robustness for speech recognition in adverse environments, *Speech Communication*, no. 3, pp. 261–276.
- Kostić, Đ., Vladislavljević, S., Popović, M. (1983): Testovi za ispitivanje govora i jezika. Zavod za udžbenike i nastavna sredstva, Beograd, (in Serbian).
- Maier, A., Hönig, F., Bocklet, T., Nöth, E., Stelzle, F., Nkenke, E., Schuster M., (2009). Automatic detection of articulation disorders in children with cleft lip and palate, *Journal of the Acoustical Society of America*, Vol. 126, No. 5, pp. 2589–2602.
- Manfredi, C., (2001). Adaptive noise energy in pathological signals, *IEEE Transactions on Biomedical Engineering*, vol. 47, pp. 1538–1543.
- Markaki, M., Stylianou, Y., (2011). Voice Pathology Detection and Discrimination Based on Modulation Spectral Features, *Audio, Speech, and Language Processing*, *IEEE Transactions on* , vol.19, no.7, pp.1938,1948.
- Ramirez, J., Segura, J.C., Benítez, C., de la Torre, A., Rubio, A., (2003). A new adaptive long term spectral estimation voice activity detector, *Proc. EUROSPEECH (2003)*, Geneva, Switzerland, pp. 3041–3044.
- Sangwan, A.; Chiranth, M.C.; Jamadagni, H.S.; Sah, R.; Prasad, R.V.; Gaurav, V., (2002). VAD Techniques for Real-Time Speech Transmission on the Internet, *IEEE International Conference on High-Speed Networks and Multimedia Communications*, pp. 46-50.
- Vasilakis, M., Stylianou, Y., (2009). Voice pathology detection based on short-term jitter estimations in running speech, *Folia Phoniatrica ET Logopaedica*, 61 (3), pp.153-170.
- Vladislavljević, S., (1981). Poremećaj artikulacije. Privredni pregled. Beograd, (1981), (in Serbian).
- Wallen, E. J, Hansen, H.L., (1996). A Screening Test for Speech Pathology Assessment Using Objective Quality Measures, *ICSLP, Proceedings of Fourth International Conference*, PA, USA, vol.2, pp.776-779.

Accented Vowels in Serbian Language

Milan Vojnović, Ružica Bilibajkić

Life Activities Advancement Institute

Gospodar Jovanova 35, Belgrade, Serbia

vojnovicmilan@yahoo.com, ruzica.bilibajkic@hotmail.com

ABSTRACT

Vowels have an important role in speech analysis because they frequently appear in speech, they are not problematic for pronunciation, and they well reflect the oscillations of vocal cords and the position of articulatory organs. The classic definition of the vowel pronunciation, according to the International Phonetic Alphabet (IPA) standard, uses the F_1 - F_2 diagram. According to this classification, in Serbian language, we distinguish open and closed vowels (with two gradations: medium-open and medium-closed) as well as front and back vowels (with one gradation: central). In order to define the vowels according to the IPA standard, the values of the first two formant frequencies are considered important. The formant frequencies of the vowels depend on the position of the articulatory organs, i.e. the shape of the vocal tract. Speech as a non-deterministic process implies that there are different shapes of vocal tract for the realization of the same vowel. In order to determine the position of the vowels in the F_1 - F_2 diagram (IPA standard), the mean values for the first two formant frequencies are used. To get a valid statistical estimation for the first two formants, they are calculated on a sufficiently large speech database.

There are five vowels in Serbian language and sometimes their definition according to the IPA standard is problematic. In addition to co-articulation, the most important factor in vowel pronunciation is their accentuation. Some previous studies showed that formant frequencies of the same vowel can be significantly different depending on the accent.

This paper analyzes the formant frequencies for all five Serbian vowels and four accents: short-falling, long-falling, short-rising and long-rising. The results of the analysis show that accents have a significant effect on formant frequencies and should certainly be taken into account when analyzing vowel pronunciations.

Keywords : accent, formant frequency, IPA, vowel.

1 INTRODUCTION

Speech is a basic form of communication among human beings. According to (Denes & Pinson, 1963) there are three levels of speech communication: linguistic, physiological and acoustical. Due to this complex speech synthesis procedure, information carried using speech communication is multidimensional. In a certain sense, speech depicts the entire mental-physical dimension of the speaker. Transfer of information is of primary importance, but psycho-physical speaker characteristics are embedded as well. This is the main reason for declaring speech as a biometric parameter and its utilization in the forensic speaker identification.

During the forensic speaker identification it is of utmost importance to define which phonemes and parameters should be analyzed. This selection depends on the length and quality of questionable and unquestionable recordings. The primary criteria for phoneme selection are:

- high rate of appearance during speech,
- not being problematic to pronounce and
- having a clearly defined spectral structure.

When speaker identification is considered, in the case of forensics, mostly short phone calls are implied - lasting a couple of dozens of seconds. In order to obtain statistically valid parameters of a certain

phoneme, it is necessary for that particular phoneme to appear often during speech. For example (Tomić, 1978) for Serbian language, vowels represent almost every other pronounced phoneme, to be precise 44% out of all pronounced phonemes. If single vowels are observed, then the distribution is as follows: 12% vowel /a/, 10% vowel /i/, 9,6% vowel /o/, 8,3% vowel /e/ and 4,4% vowel /u/. This fact alone shows great significance of vowels in speech communication.

The condition stating that analyzed phonemes should not be problematic for pronunciation comes from the need for great likelihood during the repetition of that particular phoneme. On the other hand, this leads to a higher statistical fidelity of the analyzed data. Vowels are certainly not problematic for pronunciation, since those are the phonemes first adopted by children. Vowel pronunciation is not accompanied by constrictions, or complete shutting of the vocal tract as in fricative, plosive and affricative pronunciation. Septum forming inside of the vocal tract and its controlling is a complex process and hence difficulties arise during pronunciation of fricatives, plosives, affricatives, etc. There are, of course, cases when phonemes with problematic pronunciation are separately analyzed (/š/, /č/, /ć/, /ž/, /r/, /l/ ...). This falls in the domain of idiosyncratic pronunciation, where speakers are identified based on the atypicalities when pronouncing certain phonemes.

Due to a higher reliability of certain phoneme parameter estimation, a high repeatability of its spectrum is needed, along with clear formant frequencies and oscillation frequency of the vocal cords (fundamental frequency). Considering that vowels are considered as voiced phonemes, their spectrum clearly shows the oscillation of the vocal cords. Out of all phonemes, the formant structure of vowels is the clearest most clear since there are no great constrictions in the vocal tract. Therefore, the acoustical model of the vocal tract (during vowel pronunciation) is well-known and often considered in the literature (Fant, 1970) (Flanagan, 1972) (Badin & Fant, 1984). Vowel formant frequencies are directly linked with the shape of the vocal tract. When other phonemes are considered, the spectral structure is also influenced by, aside from the vocal tract shape, turbulent and frictional air fluctuation in regions where constrictions are positioned in the vocal tract. The shape of the vocal tract, during vowel pronunciation, can be seen as an irregularly-shaped tube with no significant constrictions which could lead to turbulent and frictional air flow during the phonation process. During vowel pronunciation there are no transient areas: occlusion, restriction forming, septum release, explosion, friction, etc. on the contrary, there is one quasi-stationary area of pronunciation which is mostly used for estimation of the formant frequencies. Facts stated above are main reasons for choosing vowels during forensic speaker identification.

As far as analyzed parameters are considered, the most often chosen ones are:

- vowel formant frequencies,
- fundamental frequency,
- intonation contour,
- energy contour, etc.

Of course, formant frequencies are very significant in the process of forensic speaker identification, since they are directly correlated with the vocal tract shape. This correlation is the base for declaring speech as a biometric parameter. By analyzing vowel formant frequencies, vocal tract shape is indirectly analyzed along with the movement of the articulatory organs. Speech can be somewhat seen as a coding process of the vocal tract shape variation, into appropriate sound waves.

Formant frequencies are considered as basic parameters and based on them many other parameters can be derived. For example, often instead of formant frequencies cepstral coefficients and their derivatives are used. Introducing new parameters in speech analysis tends toward creating a robust method for forensic speaker identification, which would be resistant to different kinds of interferences and distortions. However, these new parameters are still strongly correlated with formant frequencies.

On the other hand, the basic principle when choosing the parameters for the forensic speaker identification process is minimizing intra-speaker and maximizing inter-speaker differences. The parameter to be analyzed should be selected in such a way so it doesn't differ significantly during the pronunciation from a single person, and at the same time to present significant differences when different speakers are considered. The analyzed parameter discriminatory field should be minimal for one speaker, and as large as possible when different speakers are analyzed.

When we analyze formant frequencies of a single vowel during a continuous pronunciation, differences in each pronunciation can be observed. These differences reside in the fact that speech is not a deterministic process, and also in the fact that co-articulation exists during continuous pronunciation. Co-articulation implies that pronunciation of a certain phoneme (for example, a vowel) depends on its surroundings; it depends on which phonemes are pronounced before, and which after the considered vowel. As far as non-deterministic nature of the speech process is considered, there is not much one can do: simply put, speech falls into the group of stochastic processes. The co-articulation effect could be diminished if vowels were to be spoken as individually and continuously. However, this is quite far from a real-life situation in forensic practice, and can't be counted on. The situation is somewhat made easier due to the fact that, during vowel pronunciation, quasi-stationary period always occurs. In addition, the co-articulation effect could be also diminished if accented vowels were to be analyzed. The term accented vowel implies a familiar phenomenon: those vowels are pronounced using higher voice intensity and are hence clearer, easier to understand and somewhat separated from the pronunciation of other phonemes. This fact intuitively brings us to the conclusion that these vowels are easier to recognize, meaning that their discriminatory field is wider.

As formant frequencies, the base voice frequency is also an important parameter in forensic speaker identification. This is a very robust parameter which can be successfully estimated in the presence of great noise and distortions. Upon speaking, the pitch is altered (the base voice frequency is altered) which depends on many different parameters: vocal cords mass and tightness, speaker health condition, style of pronunciation, etc. Hence, when analyzing the fundamental frequency, a statistical analysis is performed through estimating its histogram distribution. The most popular parameters obtained from this distribution are the mean value and the standard deviation. However, for a detailed presentation of the histogram distribution, an entire plethora of additional parameters is utilized, used to describe the shape of the histogram distribution.

2 THE PROBLEM SETTING

The main motivation for this research was to analyze the differences in formant frequencies of Serbian vowels when they are pronounced accented and unaccented. In Serbian language there are four accents: short-falling, long-falling, short-rising and long-rising. It is common to accentuate the first syllable. This last fact contributes to the selection of accented vowels for the forensic speaker identification, since the energy contour of the word pronunciation decreases toward the end of each word. In other words, each word is pronounced in such a way that the pronunciation energy (maximal volume) is greatest at the beginning of the word, and decreases toward its end. Hence the accented vowels are pronounced with a higher intensity, which also favors the signal-to-noise ratio. Accented vowels have a higher signal-to-noise ratio rendering the formant frequencies estimation more valid. This in turn means a lower standard deviation value and less dispersion of analyzed parameter values.

For one, pre-defined, speech database we perform the estimation of vowel formant frequencies. The process consisted of estimating the formant frequencies of all vowels (regardless whether the pronunciation was accented or unaccented), and afterwards only the accented vowel formant frequencies were estimated. Based on the observed differences, we define the influence of vowel accentuation. This procedure was repeated for each of the five vowels in Serbian language.

For the experimental measurements, the GEES Serbian language database recordings were used (Jovičić, et al., 2003) (Govorne Ekspresije, Emocije i Stavovi). For the sake of GEES database, the following was recorded: short and long sentences, single words, orders (commands), threats and a short discourse. All (except for orders and threats) was recorded for five emotional states: anger, fear, joy, sorrow and neutral. Neutral pronunciation implies no emotions whatsoever. The results presented in this paper include neutral pronunciation of the following three categories: discourse, short and long sentences. The analysis included only two speakers: one male and one female.

Table 1: List of analyzed vowels. Abbreviations: LF-long-falling, LR-long-rising, SF-short-falling and SR-short-rising.

Vowels	/a/	/e/	/i/	/o/	/u/	Σ
All vowels	263	202	161	198	97	921
LF	19	8	6	17	4	54
LR	26	2	14	6	12	60
SF	22	35	13	36	15	121
SR	15	21	12	22	8	78

We analyzed 921 vowels, 313 of which were accented. Table 1 lists the analyzed vowels. It is interesting to note the order in which the accents appear: short-falling (121 appearance), short-rising (78 appearances), long-rising (60 appearances) and long-falling (54 appearances). In Serbian language, short accents are much more common, which could be a consequence of "economics" in speech communication - short accents are more "economic".

For estimating the formant frequencies, we used PRAAT software package (Boersma & Weenink, 2005). We analyzed the distributions of the estimated formant frequencies, i.e. their mean values and standard deviations. The analysis parameters were:

- upper boundary frequency : 5500 Hz
- number of estimated formants : 5
- width of the analysis window : 25 ms
- dynamical range of the analysis : 30 dB
- signal pre-amplification (6 dB/octave) : above 50 Hz
- formant estimation method : Burg (Anderson, 1978)

Upper boundary frequency equal to 5500 Hz was used in the estimation of the formant frequencies in the case of the female speaker, while the same parameter in the case of the male speaker was equal to 5000 Hz.

3. MEASUREMENT RESULTS

The estimation results of Serbian vowel formant frequencies are given in Figs. 1 and 2. Fig. 1 depicts formant frequencies for vowels pronounced by the female speaker, and Fig. 2 depicts formant frequencies for vowels pronounced by the male speaker. The results are presented using a classical F_1 - F_2 diagram. On both diagrams, formant frequencies denoted with empty circles (connected with a dashed line) relate to all the vowels regardless whether they were pronounced accented or not. Formant frequencies denoted with full squares (connected with a solid line) relate to only accented vowels. Formant frequencies of the accented vowels in Figs. 1 and 2 are averaged regarding the type of the accent, i.e. are related to all four types of accents.

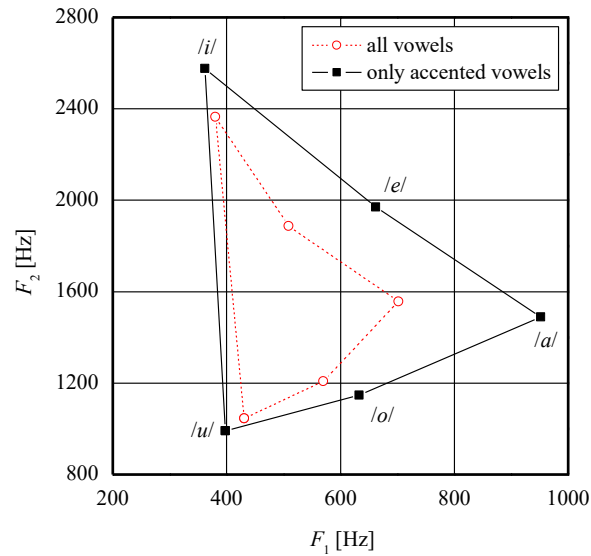


Figure 1: Formant frequencies of Serbian vowels, regardless of the accent, (empty circles) and formant frequencies of accented vowels (full squares) pronounced by the female speaker.

As can be seen from Figs. 1 and 2, the area of accentuated formant frequencies is larger compared to all vowels. This effect is particularly pronounced in the case of the female speaker (Fig. 1). On the other hand, standard deviations are smaller in the case of accentuated vowels. From the viewpoint of forensic speaker identification, this is a more favorable situation since the discriminatory field of accented vowels is wider compared to the case of unaccented vowels. This implies a more reliable and valid formant frequency estimation. On the other hand, a wider formant frequency discriminatory field, when different speakers are considered, means larger inter-speaker differences. A larger inter-speaker difference in turn provides valid and more statistically stable speaker identification.

It can be concluded that vowel accentuation affects mostly the frequency of the first formant. Variations of the second formant frequency are around $\pm 5\%$ for both speakers, except in the case accented vowel /i/ when pronounced by the female speaker (Fig. 1), and also in the case accented vowel /u/ when pronounced by the male speaker (Fig. 2). For both speakers, largest variations were observed for the vowel /a/: 36% (female speaker) and 17% (male speaker). Similar effect can be observed for the vowel /e/: increase of the first formant frequency of 30% (female speaker) and 13% (male speaker). Milder variations of the first formant frequencies were measured for the vowel /o/: increase of 11% (female speaker) and 6% (male speaker). Upon analyzing the vowel /u/, an 8% decrease in the first formant frequency was observed in the case of the female speaker and a 10% decrease in the second formant frequency in the case of the male speaker. On the other hand, when accented vowel /i/ was pronounced by the female speaker, second formant frequency increased by 9%. The results obtained with the male speaker present no significant differences when accented vowel /i/ was pronounced (these variations are around $\pm 5\%$).

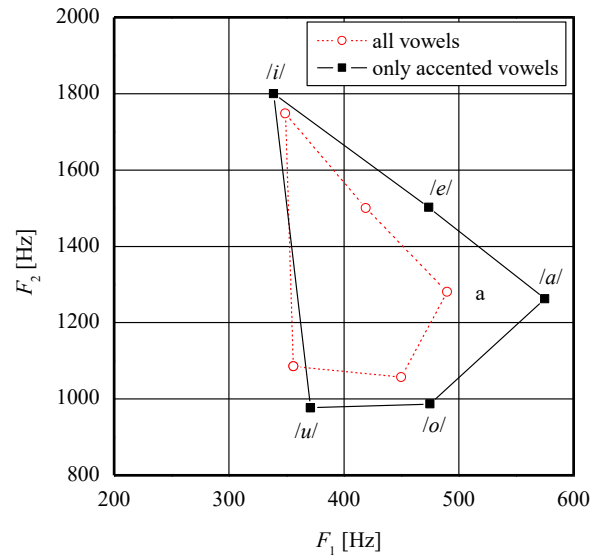


Figure 2: Formant frequencies of Serbian vowels, regardless of the accent, (empty circles) and formant frequencies of accented vowels (full squares) pronounced by the male speaker.

Former analysis regarded mean values of formant frequencies for accented vowels. Fig. 3 (female speaker) and Fig. 4 (male speaker) depict F_1 - F_2 diagrams with separated values for all four types of accent. Mean values of formant frequencies of accented vowels are denoted using full squares, and formant frequencies for four types of accents are denoted using empty squares.

In the case of the female speaker (Fig. 3), formant frequencies of vowels /a/ and /i/ are least dependant on the type of accent; variations are on the order of 5%. Largest variations were observed for the vowel /e/ and are around 25% for the first formant frequency and around 20% for the second formant frequency. Measured in an absolute manner, these differences are 400 Hz and 160 Hz, respectively. Fig. 3 clearly shows clustering in the case of long and short accents. This kind of arrangement of estimated formant frequencies implies that there is in fact two different vowels /e/: one corresponding to long accents and the other corresponding to short accents. Variations of formant frequencies of the vowels /o/ and /u/ are quite similar. Namely, the first formant frequency variation is slightly above 10%, and the second formant frequency variation is slightly less than 20%.

In the case of the male speaker (Fig. 4), the dependence of the accented vowel formant frequencies varies as a function of the accent type, compared to the female speaker (Fig. 3). It is interesting that also in the case of the male speaker accentuation has the least influence on the vowel /a/ (around 5%). Largest variations were measured for the second formant frequency of the vowel /u/ (around 20%). Relatively high variation (15%) was obtained for the second formant frequency of the vowel /o/. 10% variations were measured for the first formant frequencies of vowels /e/ and /i/. All other formant frequency variations of accentuated vowels were less than 5%.

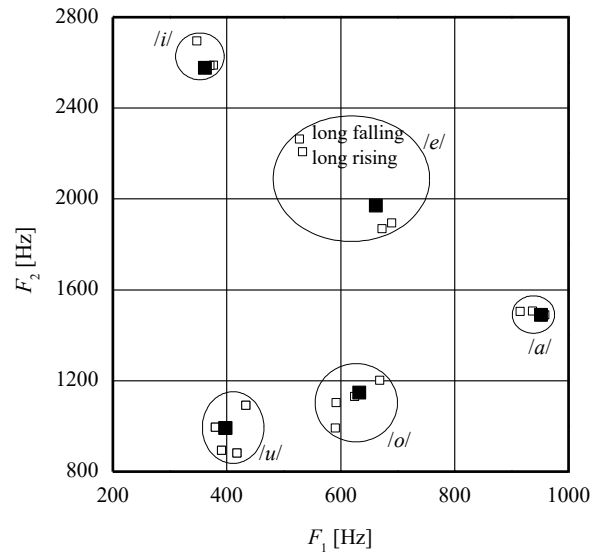


Figure 3: Formant frequencies of accented Serbian vowels when pronounced by the female speaker. Mean values are denoted using full squares.

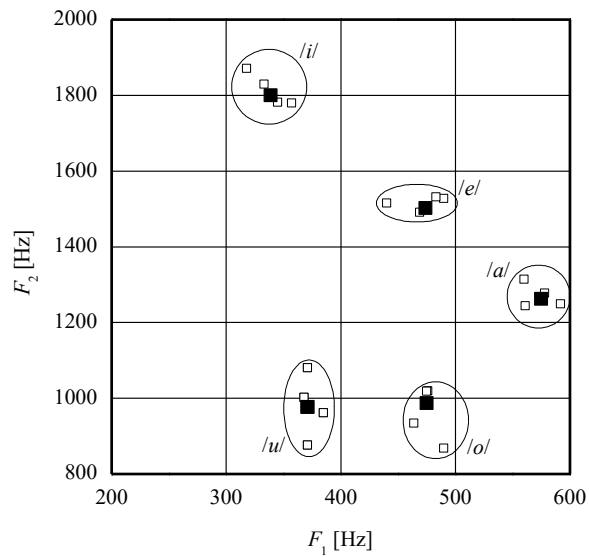


Figure 4: Formant frequencies of accented Serbian vowels when pronounced by the male speaker. Mean values are denoted using full squares.

It should be noted that standard deviations of estimated formant frequencies are smaller in the case of accented vowels. This implies less scattering of the formant frequencies, i.e. a better statistical estimation of formant frequencies.

4 DISSCUSION

Based on the presented results, it can be noted that there are significant differences between formant frequencies of accented and unaccented Serbian vowels. These differences range beyond 30%, i.e. over 250 Hz. Accentuation has a larger influence on the first formant frequency compared to the second formant frequency. Variation of the second formant frequency is more or less equal for all vowels and in the range from 5% to 6%. If single vowels are analyzed, it can be observed that largest variations were measured for the vowel /a/, then /e/ and /o/. Vowels /i/ and /u/ have modest variations of the formant frequencies when accented. According to Figs. 1 and 2, it can be concluded that a much larger widening of the first and second formant area was observed in the case of the female speaker.

Formant frequencies variation of vowel /a/ is quite small depending on the accent type. A similar case can be observed with the vowel /i/. In the case of vowels /u/ and /o/ a moderate scattering of formant frequencies was measured depending on the type of accent. Largest variations were noted in the case of vowel /e/ when pronounced by the female speaker (Fig. 1). Variations are over 20%, or 160 Hz for the first formant frequency and 400 Hz for the second formant frequency. Fig. 1 depicts an unusual clustering of formant frequencies in the case of long accents on the one side, and short accents on the other. As if we could observe two vowels /e/ when pronounced accented.

Fig. 5 shows the IPA (International Phonetic Alphabet) diagram and the position of Serbian vowels. Arrows point out the vowel position variations in the case of an accented pronunciation.

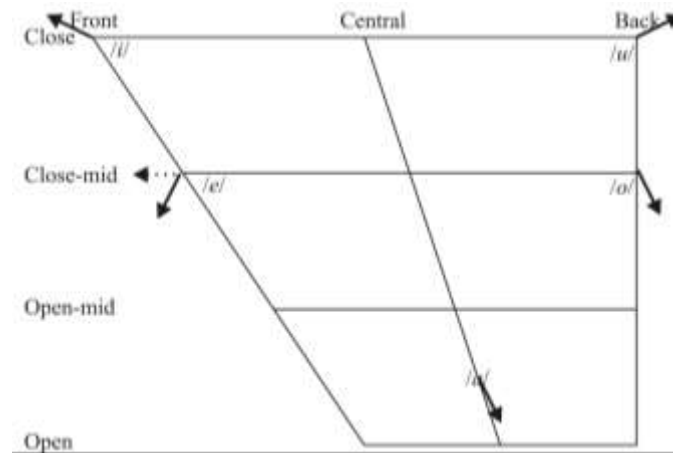


Figure 5: Position of Serbian vowels in the IPA diagram; arrows denote position variations when pronounced accented.

When vowels /a/, /o/ and /e/ are pronounced accented they are more "open" compared with unaccented pronunciation. An exception from this rule is the pronunciation of long-falling and long-rising vowel /e/ in the case of the female speaker. Vowel /e/ pronounced with long accents doesn't become more "open" but instead more "frontal".

When accented vowels /u/ and /i/ are pronounced, they sound more "closed".

5 CONCLUSION

Formant frequency analysis shows that the F_1 - F_2 field is wider if vowels are pronounced accented. This means that vowels in the F_1 - F_2 field are more separated and that their recognition is more reliable. Standard deviations of estimated formant frequencies are smaller in the case of accented vowels. Less

scattering of the formant frequencies means more clustering around certain mean value. From the standpoint of forensic speaker identification this produces smaller intra-speaker differences. Minimizing these differences is one of the vital prerequisites for reliable forensic speaker identification.

In the field of forensic speaker identification these preliminary research results are sufficient in order to safely expect a higher reliability of speaker identification if accented vowels are used. Surely, a basic condition is that analyzed recording is long enough and that there are a sufficient number of accented vowels. A statistically valid formant frequency estimation of a vowel implies 20-30 appearances during the speech recording. If unaccented vowels are used as well, then a larger number of appearances (40-50) are needed in order to obtain valid statistical results.

Vowel /a/ showed the largest first format frequency variation (Figs. 1 and 2), and on the other side the influence of the accent type was negligible (Figs 3 and 4). Large variation of formant frequencies mean value of vowel /a/ and a small standard deviation goes to show that its analysis is vital for the process of forensic speaker identification.

It should be noted once again, that the presented research results are related to two different speakers: one male and one female. In our future investigations more speakers need to be included in the analysis. This fact, at the same time, starts the problem regarding a relevant speech signal database to be used in these investigations.

Acknowledgments - This paper was supported in part by the Ministry of Education and Science of the Republic of Serbia under Grant number TR-32032.

REFERENCES

- Anderson N. (1978). On the calculation of filter coefficients for maximum entropy spectral analysis. In Childers: *Modern Spectrum Analysis*, IEEE press, 252-255.
- Badin, P., & Fant, G. (1984). Notes on vocal tract computation. *STL-QPSR* 2-3, 53-108.
- Boersma P., Weenink D. (1992-2005). "PRAAT: A system for doing phonetics by computer", <http://www.praat.org/>.
- Denes P., & Pinson E. (1963). *The speech chain*, Bell Telephone Laboratories.
- Fant, G. (1970). *Acoustic theory of speech production*, Mouton, The Hague.
- Flanagan, J. (1972). *Speech analysis, synthesis and perception*. Springer-Verlag, New York, 1972.
- Jovićić S., Kašić Z., Đorđević M., Vojnović M., Rajković M. (2003). Formiranje korpusa govorne ekspresije emocija i stavova u srpskom jeziku - GEES, XI Telekomunikacioni forum TELFOR, Sekcija 7.10, Beograd.
- Tomić T. (1978). *Statistička analiza srpsko-hrvatskog teksta pomoću računata*, Institut za jezik i književnost, Sarajevo.

Duration of Utterance in Developmental Verbal Apraxia

Vivien Đorđević, Marijana Panić, Vladica Žikić

Institute for Research and Development- Life Activity Advancement Centre
Gospodar Jovanova 35, 11000 Belgrade, Serbia
viviendj@yahoo.com

ABSTRACT

The aim of this study was to determine the duration of speech utterance in developmental verbal apraxia, developmental dysphasia and developmental phonological disorders. The research was carried out at the Institute for Experimental Phonetics and Speech Pathology and at the Institution for Psychophysiological and Speech Disorders in Belgrade. An adequate diagnosis conducted by the professional team: speech therapist, clinical psychologist, neurologist, we select children whose speech and language disorders were diagnosed as developmental verbal apraxia, developmental dysphasia and developmental phonological disorders.

The sample consisted 45 children aged 4-5 years. The first group (N = 15) were children with diagnosed developmental verbal apraxia, the second group (N = 15) children with diagnosed developmental dysphasia, and the third group of subjects (N = 15) included children with diagnosed developmental phonological disorders. The groups were uniform compared to age. The results show that children with developmental verbal apraxia need much more time and attempts to properly pronounce the word, and therefore the speech production is longer than usual.

Keywords: developmental verbal apraxia, developmental dysphasia, developmental phonological disorders, speech and language development

1 INTRODUCTION

Developmental verbal apraxia is a neurological disorder characterized by an inability execution of coordinated movements of articulation with the absence of muscle weakness. Programming is a disorder of speech movements.

There is multiple etiology, such as a genetic predisposition to a disorder of motor coordination, prenatal and natal causes, differences in the speed of development and the quality of myelination, neurological disorders, and developmental delay (Golubović, 2003.).

The cause of developmental verbal apraxia is still unknown. Some believe that the developmental verbal apraxia is disorder associated with the development of speech. Others believe that it is a neurological disorder that affects the brain's ability to send proper signals to the muscles involved in speech. (Djordjević, Golubović, 2007.) Much of the literature has attributed the deficit of verbal apraxia to a lesion of Broca's area and its environment. Some studies have observed verbal apraxia from isolated damage to the anterior portion of the insula (Dronkers, 1996.). Dronkers adhere a strong hypothesis, which states that the insula must be damaged in order for verbal apraxia to occur.

Neuroimaging and other studies have provided data on brain lesions or differences in brain structure in children with developmental verbal apraxia. Children with developmental verbal apraxia often have family members who have communication disorders or learning difficulties. Earlier studies have shown that genetic factors may have an impact on this type of disorder (Boutsen, Christman, 2002)

Experts from ASHA's 2007., described the developmental verbal apraxia as a children's neurological speech disorder in which the precision and consistency of the corrupted speech movements without neuromuscular defects that cause abnormal reflexes or tone. Developmental verbal apraxia may occur as a result of apparent neurological damage as a result of neurofunctional disorder known or unknown cause, or

may be idiopathic neurogenic speech disorder. The main problem is in the planning and / or programming of the space-time parameters of motion that result in errors in pronunciation and prosody.

Children with developmental verbal apraxia have called "neurological soft signs". This includes the following: a benign congenital hypotonia, impaired gross and fine motor skills, difficulty in motor planning, sensory integration, delayed or undecided hand dominance (Morgan et al., 2018, Murray et al., 2015).

The complex of symptoms indicated for developmental verbal apraxia includes both non-verbal and speech characteristics. There is no agreement on the behaviors and symptoms necessary and insufficient to diagnose developmental verbal apraxia (Grigos et al., 2015). There is little empirical evidence and no precise description of how this evidence can be used as diagnostic indicators. Children with developmental verbal apraxia are most often silent babies with poor sucking coordination, reduced babbling with limited use of consonants and vocals and limited syllabic imitation (Frota, D'Imperio, 2012).

The use of spontaneous gestures at an early age due to the limited ability of verbal apraxia does not exist. Developmental verbal apraxia is present from birth on a continuum from mild to severe and basically has: 1) a neurologically based communication disorder that impairs the child's ability to correctly pronounce voices, syllables and words; 2) interruption in the fine execution of voluntary movements in speech production; 3) disorder in a series of complex oral movements involved in speech; 4) interruption in establishing a "motor plan" for the word to be spoken automatically; 5) potential interruption of typical expressive language development; 6) an obstacle to the development of intelligible speech.

There is an opinion that two phonological organization domains, segmental representation / categorization and articulatory motor output, do not function in mutually exclusive development, nor can phonological development be separated from morphological and syntactic (Cole et al., 2010).

The same authors assume that the child does not have the basic processing and internal representation mechanism that needs to develop along with speech abilities. Support for this view is in the study of rhyming and syllables. Children with developmental verbal apraxia were found to exhibit an inability to recognize and produce rhymes and an underdeveloped vocal representation system. Deficit lies within the widespread phonemic, phonetic, prosodic and linguistic characteristics of the disorder.

Children with developmental verbal apraxia need much more time and effort to speak the word correctly. It has been found that with increasing the length of the utterance there is a more pronounced prosodic disorder (Davis et al., 1998).

The same authors found that prosody was longer than the normal duration of the segment, that the pitch was unstable and that there was a reduced voice substitution. It is still not possible to determine whether prosody disorder is a central symptom of the disorder or whether a compensatory mechanism arose in response to a motor programming disorder. Verbal apraxia can be so severe that a person cannot begin speaking or is so mild that the person has only occasional difficulty in speaking multiple words.

The pattern of speech behavior contains a reduced rate of speech that encompasses articulatory prolongations and syllable segregations (separation). Articulatory prolongations refer to the extension of portable components in continuous speech. Syllabic segregation is defined as temporal isolation or separation of syllables in a syllable series. A rough measure of the degree of segregation can be formulated as the sum of the lengths of syllable intervals divided by the total duration of the utterance (Mass et al., 2014).

Comparison of normal aprosodic (right hemisphere lesions) and dysprosodic (verbal apraxia) speech models shows a difference in the rate that is reduced in aprosodic and dysprosodic ones due to nasalization and articulatory influence. The interval between syllables is longer in subjects with apraxia. Vocals have a longer duration of 200 ms versus a duration of 50 ms which is normal (Golubović, 2007).

2 THE AIM

The aim of this study was to determine the duration of utterance in developmental verbal apraxia, developmental dysphasia, and developmental phonological disorders.

3 RESEARCH METHODOLOGY

The research was conducted at the Institute for Experimental Phonetics and Speech Pathology and at the Institution for Psychophysiological and Speech Disorders in Belgrade.

The sample

With an adequate diagnosis conducted by the expert team: speech therapist, clinical psychologist, neurologist, made the selection of children whose speech and language disorders were diagnosed as developmental verbal apraxia, developmental dysphasia and developmental phonological disorders. The sample consisted of 45 children aged 4-5 years. The first group of subjects ($N = 15$) were children diagnosed with developmental verbal apraxia, the second group ($N = 15$) were children diagnosed with developmental dysphasia and the third group ($N = 15$) included children with diagnosed developmental phonological disorders. The groups were uniform in age. The research was done individually. Each child received the same instructions before testing. The Test Strip Story was used as a measuring instrument (Vladislavljevic, 1983). The Test Strip Story consists of four pictures which are interconnected in the order of events. The examination is individual. The following pictures are placed in front of the child and asked to tell the story. Responses are recorded and measured with a stopwatch to evaluate the length of the statement.

4 RESULTS OF THE RESEARCH WITH DISCUSSION

Table 1 presents the results of a study based on the examination of the duration of utterance in children with developmental verbal apraxia, developmental dysphasia and developmental phonological disorders.

The duration of utterance in children with developmental phonological disorders is a minimum of 6 seconds and a maximum of 18 seconds. Children with developmental dysphasia (minimum 7 and maximum 17 seconds) have approximately the same duration of utterance, while children with developmental verbal apraxia have a significantly longer duration of utterance (minimum 11 seconds and maximum 27 seconds). Children with developmental verbal apraxia have a significantly longer duration of utterance than children with developmental phonological disorders and developmental dysphasia ($p < 0.01$). There are no differences in the utterance duration ($p > 0.05$) between children with developmental phonological disorders and developmental dysphasia. Children with developmental verbal apraxia need much more time and effort to pronounce the word correctly, and thus, spoken production is longer than usual.

Table 1: Test results of statement duration in children with developmental verbal apraxia, developmental dysphasia and developmental phonological disorders (time expressed in seconds)

Developmental dysphasia and developmental phonological disorders (time expressed in seconds)							
Group	N	%	Mean.	SD	Med	Min	Max
Phon.dis. (1)	15	33.3	10.53	3.00	10.00	6.00	18.00
Dysphasia (2)	15	33.3	11.73	3.17	12.00	7.00	17.00
Verbal. apraxia (3)	15	33.3	18.20	4.75	18.00	11.00	27.00
Total	45	100					
ANOVA							
Time in sec		Sum	df	Mean Square	F	Sig	
Between groups		510.178	2	255.089	18.375	.000	
Within groups		583.067	42	13.883			
Total		1093.244	44				
Group		Average difference		Sig.			
				.383			
				.000			
(1)	(2)	-1.2000		.383			
	(3)	-7.6667*		.000			
				.000			
				.000			
(2)	(1)	1.20000					
	(3)	6.4667*					
(3)	(1)	7.6667*					
	(2)	6.4467*					

*Significance of differences at 0.05

5 CONCLUSION

Children with developmental verbal apraxia have slow, monotonous speech with longer speech production, as confirmed by this research. Children with developmental verbal apraxia need much more time and effort to pronounce the word correctly, and thus, spoken production is longer than usual. Longer duration of utterance was found in children with developmental verbal apraxia (min.11 sec, max 27 sec) unlike children with developmental phonological disorders (min 6 sec, max 18 sec) and developmental dysphasia (min 7 sec, max 17 sec) which had a shorter duration of utterance. There are variations in speech production as well as dysfunction of phonetic context or length of expression. The longer duration of the utterance is accompanied by an increase in errors and a decrease in speech intelligibility. Error inconsistency can be used as an important diagnostic indicator in differential diagnosis.

REFERENCES

- American Speech-Language-Hearing Association (2007). Childhood Apraxia of Speech (Technical Report). Retrieved from <http://www.asha.org/policy>
- Boutsen, F., Christman, S. S. (2002). Prosody in apraxia of speech. *Seminars in Speech and Language*, 23, 245-255.
- Cole, J., Mo, Y. Baek, S. (2010). The role of syntactic structure in guiding prosody perception with ordinary listeners and everyday speech. *Language and Cognitive Processes*; 25:1141-1177.

- Davis, B., Jakielski, K., Marquardt, T. (1998). Developmental apraxia of speech: Determiners of differential diagnosis. *Clinical Linguistics and Phonetics*, 12, 1, 25-45.
- Dronkers, N. (1996.): A new region for coordinating speech articulation, *Nature*, 384, 159-161
- Đorđević, V., Golubović, S. (2007). Accentuation of Sound and Word in Children with Developmental Apraxia of Speech. *27th World Congress of the International Association of Logopedics and Phoniatrics*, Copenhagen, Denmark, Abstracts.
- Frota, S. A. A., D'Imperio, M. (2012). Prosodic representations: Prosodic structure, constituents, and their implementation. Segment-to-tone association. Tonal alignment. In *Handbook in Laboratory Phonology*, Abigail Cohn, Cécil Fougeron, Marie K., Huffman (eds), 254–287. Oxford: OUP.
- Golubović S. (2003). Diferencijalno-dijagnostičke specifičnosti razvojne govorne apraksije, dizatrije i fonoloških deficita, *Beogradska defektološka škola* 1-2/2003., 111-121.
- Grigos, M., Moss, A., Lu, Y. (2015). Oral Articulatory Control in Childhood Apraxia of Speech. *Journal of Speech, Language, and Hearing Research*, Vol. 58, 1103-1118.
- Maas, E., Gildersleeve-Neumann, Jakielski, K., J., Stoeckel, R. (2014). Motor- Based Intervention Protocols in Treatment of Childhood Apraxia of Speech (CAS). *Current Developmental Reports*, 1, pp.197.
- Morgan, A. T., Murray, E., Liégeois, F. J. (2018). Interventions for childhood apraxia of speech. *Cochrane Database of Systematic Reviews*, 2018 (5).
- Murray, E., McCabe, P. Heard, R., Ballard, K.J. (2015). Differential Diagnosis of children with suspected Childhood Apraxia of Speech. *Journal of Speech, Language and Hearing Research*, 58, (1), 43-60.

Characteristics of Auditory Information Processing in Children with Specific Language Impairment

Ljiljana Jeličić^{1,2} Ivana Bogavac^{1,2} Ivana Veselinović³

¹ Institute for research and development „Life Activities Advancement Centre“,
Belgrade, Serbia

² Institute for Experimental Phonetics and Speech Pathology, Belgrade, Serbia

³ Faculty for special education and rehabilitation, Belgrade, Serbia
lilijen@ymail.com

ABSTRACT

The application of quantitative EEG in the examination of speech-language processing in children with typical and atypical speech-language development enables a better understanding of relations between brain regions in mechanisms of speech-language comprehension and production. Research in the field of speech language processing in children with specific language impairment (SLI) has shown that children with SLI have disturbed and insufficient auditory and speech-language information processing. In this paper, a few very important findings of the auditory information processing in children with specific language impairment will be presented. The main emphasis is placed on a significant reduction of general interpretative area space, its dissociation and/or predominantly right-hemispheric presentation when examining the processing of auditory stimulation in children with SLI. Conclusions drawn from these findings may be widely used not only in the treatment of speech and language disorders but also for prognostic purposes.

Key words: QEEG, auditory information processing, specific language impairment

1 INTRODUCTION

Auditory information processing as well as speech-language information processing are widely distributed in different cortical regions. Research in the field of speech language processing in children with specific language impairment (SLI) has shown that children with SLI have disturbed and insufficient auditory and speech-language information processing (Radičević et al. 2009a; Radičević et al. 2009b).

Paper presents comparison of research results regarding the estimation of auditory information processing in children with specific language impairment (SLI) (Radičević et al., 2015; Jeličić et al. 2017). The main emphasis is placed on the analysis of:

- a) participation of low and high alpha activity during defined auditory stimulation in children with SLI aged 3-4 years;
- b) number of activated regions in general interpretative area in high alpha activity versus the low alpha activity during defined auditory stimulation in children with SLI aged 4-5 years.

2 METHODOLOGY

Sample

a) The participation of low and high alpha activity during defined auditory stimulation was analysed in research sample consisted of 16 children with SLI, aged 3-4 years, and it was divided into two groups: Experimental 1 group (E1=8) consisted of children who have expressive and receptive language disorder (F80.2), while Experimental 2 group (E2=8) consisted of children who have only expressive language disorder (F80.1).

b) The number of activated regions in general interpretative area in high alpha activity versus the low alpha activity during defined auditory stimulation was analysed in 12 children (E3=12) with SLI aged 4-5 years.

Children from all examined groups were on continuous speech-language treatment in the Institute for experimental phonetics and speech pathology (IEPSP) in Belgrade. The children were gender balanced and did not have localized or non-localized lesions of the central nervous system listed in either a medical history or in a neurological and magnetic resonance imaging findings. They also did not have any congenital malformations, syndromes and their EEG findings did not register any epileptic or subepileptic activity.

Method

The method included the use of cartographic EEG. Cartographic EEG patterns was performed on Nihon Kohden Corporation, EEG – 1200K Neurofax apparatus in longitudinal bipolar electrode assembly schedule by utilizing 10/20 International electrode positioning. Impedance was maintained below 5 k Ω , with not more than 1 k Ω differences between the electrodes. Lower filter was set at 0.53 Hz and higher filter at 35 Hz. Recording was performed in resting state and during stimulation procedure that include speech and language basis (listening the story "Three pigs" in period of three minutes).

For the analysis of low and high alpha activity participation during defined auditory stimulation in E1 and E2 groups we chose the samples which lasted 4 seconds from both situations (resting state and auditory stimulation (listening the story) from the trace without artefacts.

For the analysis of number of activated regions in general interpretative area in high alpha activity versus the low alpha activity during defined auditory stimulation in E3 group we chose EEG trace parts lasting from 10 seconds and without artefacts which were taken immediately before or behind the middle of resting state or the auditory stimulation period (listening to story).

The obtained material was analyzed in terms of activating processing in higher spectral powers (higher than 50% on the scale) by electrode points. That means that electrode point which had spectral power higher than 50% on the scale in alpha 1 and alpha 2 rhythms was determined as point that is involved in information processing and is marked as positive processing value, while those electrode points which spectral powers were below the average value on the scale were not considered as belonging to information processing and were marked as negative processing values.

In both groups spectral powers of alpha 1 and alpha 2 rhythms were analyzed.

3 RESULTS

Table 1 shows the average participation of regions (all 19 points) regarding the activation of the higher powers (expressed in μ V) in low and high alpha during resting state and during auditory stimulation (listening the story) in the E1 and E2 group.

There is a significant difference in the average number of activated regions in terms of higher powers activation for a period of listening the auditory information (the story) in children who have speech-language disorder at the level of speech production and comprehension (E1 group) in relation to children

who have the disorder only at the level of speech production (E2 group). Children from E2 group had more activated regions in high alpha activity during auditory stimulation compared to children from E2 group.

Table 1. The average number of engaged regions in terms of higher powers of low and high alpha activity in resting state and in the period of listening to story E1 and E2 group

Rhythms	E2 group (F80.1)		E1 group (F80.2)	
	Resting state	Auditory stimulation	Resting state	Auditory stimulation
	Average number of engaged regions	Average number of engaged regions	Average number of engaged regions	Average number of engaged regions
Alpha 1	5	4.1	4.1	1.7
Alpha 2	1.25	4.7	0.8	1.6

Analysis of resting state has shown that there is no significant difference in terms of overall regions engagement in alpha 1 and alpha 2 rhythms in both groups of children.

Table 2 shows data regarding the engagement of activated regions (regions with positive processing values) during resting state in alpha 1 and alpha 2 in children from E3 group.

Table 2. Resting state in children with SLI aged 4-5 years: activated regions with positive processing values

E3	RESTING STATE in children with SLI and regular EEG patterns														
	Alpha 1 – low alpha										Alpha 2- high alpha				
	Fp1	F7	T5	O1	Fz	Pz	P4	T4	T6	O2	T5	O1	P4	T6	O2
PD	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+
VS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
KP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
JL	-	-	+	+	-	-	-	-	-	-	+	+	-	-	-
SL	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+
KF	-	-	-	-	-	+	+	-	+	-	-	-	-	-	-
Σ	1	1	2	2	1	2	2	1	2	1	1	2	1	1	2

There is a noticeable advantage regarding the number of activated regions in low alpha versus high alpha rhythm, especially in auditory, visual and parietal regions.

Table 3. Auditory stimulation (listening to story) in children with SLI aged 4-5 years: activated regions with positive processing values

E3	Auditory stimulation in children with SLI and regular EEG patterns																			
	Alpha 1- low alpha										Alpha 2- high alpha									
	Fp1	F3	F7	P3	T5	O1	Pz	Fo2	F4	F8	P4	T4	T6	O2	P3	T3	T5	O1	Pz	Fo2
PD	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+	+	-	-
VS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
KP	+	+	+	-	-	-	-	-	+	+	-	+	+	-	-	-	-	+	+	+
JL	-	-	-	+	+	+	+	-	-	-	+	-	-	+	-	-	-	+	+	-
SL	-	-	-	-	-	+	-	+	+	-	-	-	-	+	-	-	-	+	+	-
KF	-	-	-	-	-	+	-	-	-	-	+	+	+	-	+	+	+	-	-	+
Σ	1	1	1	1	1	3	1	1	2	1	2	2	2	3	2	1	2	4	4	1

Table 3 shows results of auditory stimulation processing (listening to story) in children with SLI aged 4-5 years in terms of activated regions with positive processing values. It is shown that the total number of activated regions with positive processing values is increased in both low and high alpha but this increase is higher in alpha 2 than in alpha 1 rhythm. It is also remarkable that the advantage of alpha 2 activity in relation to alpha 1 activity is particularly expressed in auditory, visual and parietal (Pz) regions. Right-hemispheric engagement of auditory and visual regions is more frequent in both alpha than left-hemispheric engagement.

4 DISCUSSION

In this study, we decided to examine the processing of auditory information through the analysis of spectral powers in EEG signal (μV). This decision we made on the basis of long-standing routine confirmation about matching the EEG findings with the clinical findings. The regions get into network according to similarity of spectral powers which are higher than 50% in relation to the average, and this analysis suggests the relevance of our assumptions. The primary importance is reflected in the comparison of individual rhythms which imply certain degree of awareness in the search and elaboration of information.

Analysis of resting state (if such indeed exists) is showed that E1 and E2 group of children aged 3-4 years do not significantly differ. It is also noticed that children in E2 group who have only expressive language disorder activated significantly higher average number of engaged regions in high alpha during auditory information processing compared resting state while children in E1 group – with both expressive and receptive language disorder activated reduced number of engaged regions in high alpha during auditory information processing compared resting state. If we observe activation of high alpha as opened consciousness and attention organization (Thompson & Thompson, 2003) in opposite to low alpha activation which represents unconscious state, it is obviously that children who have only expressive speech disorder during listening to story have better auditory information processing compared to children who have both expressive and perceptive speech disorder.

As it is mentioned, the participation of high alpha activity during defined auditory stimulation was significantly higher in group of children who have only expressive language disorder. These findings also lead us to the assumption about suspected superiority (probably in a cognitive status) in children who have the expressive speech disorder in relation to children who have expressive and receptive speech disorder.

General Interpretative Area is located in the forefront parts of the occipital lobe, posterior parts of the upper temporal lobe as well as in posterior and central parts of the parietal lobe. This area is by long neural pathways projected into specific associative regions among which are those responsible for complete speech-language processing located in the central and medial structures of the prefrontal and motor areas (Guyton & Hall, 2008). Generally speaking, general interpretative area receives info from all sensory areas and integrates sensory info and coordinates access to visual and auditory memories.

When analysing the number of activated regions in general interpretative area in low and high alpha activity during resting state in children with SLI aged 4-5 years, it is noticed that low alpha rhythm had advantage in number of activated regions compared to high alpha rhythm which can be explained by fact that domination of low alpha activation represents state of relaxation and unconscious state. On the other side, when analysing the number of activated regions in general interpretative area during auditory stimulation, it is noticed that the total number of activated regions with positive processing values is increased in both low and high alpha but this increase is higher in alpha 2. These findings could have been expected as high alpha activation (alpha 2) represents state of opened consciousness and attention organization.

It is also observed as important findings regarding activated regions that right-hemispheric engagement of auditory and visual regions is more frequent in both alpha rhythms (alpha 1 and alpha 2) during auditory information processing than left-hemispheric engagement in children with SLI.

5 CONCLUSION

On the basis of obtained results it may be concluded that children with SLI aged 3-4 years who have both expressive and receptive language disorder, have processed complex auditory information by low alpha activity, while children with SLI who have only expressive language disorder activated high alpha activity during auditory information processing.

Children with SLI aged 4-5 years have activated regions in general interpretative area when processed complex auditory information. Although increased number of activated regions was observed in high alpha activity during auditory stimulation, it is noticeable that engagement of auditory and visual regions is more frequent in right hemisphere compared to left hemisphere.

ACKNOWLEDGMENT

This study was supported by Ministry of Education, Science and Technological Development of the Republic of Serbia (Lj. Jeličić Grant No. OI178027 and I. Veselinović Grant No. 179055).

REFERENCES

- Guyton AC, Hall JE. (2013). *Medical physiology*, ISBN-978-86387-0772-2, Savremena administracija, Belgrade. (In Serbian).
- Jeličić, Lj., Radičević, Z., Stanojević, N. (2017). Irregular patterns in EEG activity as a potential predictor of speech – language deficits, In: Jovičić S., Sovilj M, Subotic M., Maksimović S (Eds.) *Proceedings of 4th International Conference on Fundamental and Applied Aspects of Speech and Language*, Belgrade, ISBN 978-86-89431-24-7, pp. 253-259.
- Radičević, Z., Dobrijević, Lj., Sovilj, M., & Vujovic, M. (2009a). Processing speech and language information in children with different speech language disorders in theta, alpha and beta1 rhythm of quantitative encephalogram (EEG). In: M. Sovilj & S. Jovicic (Eds.) *Proceedings on 3rd International Conference on Fundamental and applied Aspects of Speech and Language*, (pp. 67–72), Belgrade.
- Radicevic Z., Jelcic, Lj., Sovilj M., Barlov, I. (2009b). Comparison of mapping quantitative theta encephalograms during directed and required visual–verbal activity and passive period in children with different disorders of speech–language functioning. *Experimental Brain Research*, Vol. 195(4), 569-574.
- Radicevic Z., Jelcic Lj., Stokic M., Nenadovic V., Sovilj M., Subotic M. (2015). Auditory information processing in children with specific language impairment examined by EEG cartography. *Proceedings of 5th International Conference on Fundamental and Applied Aspects of Speech and Language*, Belgrade, ISBN 978-86-89431-07-0, pp.354-358.
- Thompson, M., Thompson, L. (2003). *The Neurofeedback Book - The association for Applied Psychophysiology and Biofeedback*, Wheat Ridge, Colorado, USA

Risk Factors at Birth and their Impact on Prelingual and Early Lingual Development in Prematurus

Vivien Đorđević, Marijana Panić, Nina Stanojević

Institute for Research and Development- Life Activity Advancement Centre

Gospodar Jovanova 35, 11000 Belgrade, Serbia

viviendj@yahoo.com

ABSTRACT

This paper presents the results obtained for risk factors at birth in preterm infants that influence the development of speech and language, which was the goal of this research. From the resulting research objectives are the following research tasks: determine the number and type of risk factors at birth in preterm infants and to determine the state of development of speech and language in premature infants at the age of three to four years. The sample consisted of 60 children aged between three and four years of age. The experimental group consisted of 30 children with premature infants under 32 weeks of gestation with a birth weight below 1500gr. The control group consisted of 30 children born at term, over 38 weeks of gestational age and birth weights above 3000 g. Research variables were: the beginning of sitting, walking age, the chatter and beginning to speak (medical history list). It was found that between premature and term newborn infants there is no statistically significant difference in early motor development: an independent sitting and to beginning to walk. Statistically significant differences were found in the beginning of chatter, and to speak. The qualitative analysis of the results was found to be in preterm infants and infants born at term ability too seating occurs between 6th and 7th months, and beginning to walk between 13th and 14th months of age. Phase chatter is in premature slightly delayed and occurs between 7th and 8th months of age, whereas in children born at term occurs in the 6th months of age. Phase of speaking characterized by the emergence of the first word is also delayed in preterm infants and occurs about 15th months of age, whereas in children born at term first word occurs between 12th and 13th months of age. With the qualitative analysis of the results we have found the presence of articulation disorders through omissions, substitutions and distortions of voices in both groups of children. It was also found that when the articulation voices no statistically significant differences between premature infants and infants born at term, or that in both groups occurring disorders of articulation.

Key words: articulation disorders, early motor development, speech-language development

INTRODUCTION

The risk factors that can lead to speech and language disorders are divided into prenatal, perinatal and postnatal. Prenatal (pre-natal) include: genetic predisposition, pregnancy rubella, viral infections, fetal hypoxia, maternal vaginal infections, use of ototoxic drugs in pregnancy, chronic and infectious maternal diseases, Rh incompatibilities, toxoplasmosis, maternal toxicity, stress, cardiopathy, hypertension, diabetes, addiction diseases. Perinatal (at birth) include: neonatal asphyxia, hyperbilirubinemia, hypoglycaemia, birthmark below 9 (APGAR), respiratory distress syndrome, prolonged physiological jaundice, low birth weight, preterm birth, cerebral hemorrhage. Postnatal (after birth) consists of: middle ear inflammation, enlarged third tonsil, high fever, frequent respiratory infections, encephalitis, meningitis, febrile convulsions, ototoxic drugs, bacterial and mycotic infections (*Candida*, *Escherichia coli*, *Clostridia*) head injury, intolerance to foods, different intoxication, different sensorimotor disorders (Rennie, 2013).

In this paper, we will describe in more detail the perinatal risk factors of prematurity, or those most common: respiratory distress syndrome, asphyxia, hyperbilirubinemia, and intracranial hemorrhage. Respiratory distress syndrome (RSD) is an acute primary disease of the newborn lung. It occurs more frequently in male children. It occurs as a consequence of the lack of surfactant leading to a decrease

in respiratory volume, a decrease in pulmonary complication, disturbance of the ventilation-perfusion ratio, an increase in pulmonary vascular resistance, an increase in respiratory function. The consequences of these disorders are hypoxemia, hypercapnia, respiratory, then mixed acidosis. The incidence of occurrence is 2% in all infants and 20% in preterm infants, depending on gestational age and body weight (Grenough, 2013, Levene et al., 2000, Ramadani, 2017, Rennie, Robertson, 2002).

Asphyxia (the true meaning of "no pulse") is a condition of impaired gas exchange before, during, or immediately after birth, which, if sustained, causes a progressive decrease in oxygen partial pressure (pO₂) and an increase in partial pressure of carbon dioxide (pCO₂), followed by acidosis. (American Society for Gynecology and Obstetrics, 1992).

It is a progressive and potentially reversible process, the extent and duration of which determines the outcome. The incidence is six children per thousand live births. Asphyxia can occur: perinatal (51%) due to maternal hypertension, maternal diabetes, maternal anemia, respiratory and heart failure; peripartum (40%) due to the use of forceps and vacuum extractors, umbilical cord prolapse, umbilical cord tightening, aspiration of the birth canal contents, hypotension, use of sedatives and analgesics in childbirth; and postnatal (9%) due to apnea, respiratory distress syndrome, hypoglycemia, hypocalcemia, convulsions, etc. (Avery, 2010).

According to the Apgar score, asphyxia can be: light (Apgar 7-5) characterized by cyanosis, dyspnea, tachypnea, bradypnea, impaired reactivity and impaired tone; moderate (Apgar 4-3) and characterized by: cyanosis, bradypnea or apnea, bradycardia, barely noticeable reactivity and low tone; and severe (Apgar to 2) and is characterized by: pallor, lack of breathing function, heart tones weak or inaudible, lack of reactivity and muted tone. Further, CNS, myocardial, lung, kidney, gastrointestinal, metabolic disorders are manifested and cyanosis occurs (Fanaroff, Martin, 2000). Hyperbilirubinemia is an increased serum bilirubin concentration. Limit values of normal depend on the age and health of the infant. The diagnosis is confirmed by measuring bilirubin. Treatment depends on the cause and the extent of the increase in bilirubin concentration and includes phototherapy and exanguinotransfusion. It can be physiological and pathological most commonly due to hemolytic anemia, polycythemia, and hematoma (Paneth, 2015).

Intracranial hemorrhages include various types of hemorrhage, some of which are the most common cause of morbidity and mortality, primarily preterm infants, and some are rare in the newborn period. It can be caused by trauma, asphyxia, rarely by coagulation disorders or vascular anomalies. In infants with a birth weight of less than 1500 grams, its incidence is high, 20-40%, whereas it is much less common in term babies. The most common form of intracranial hemorrhage is intraparenchymal hemorrhage, which occurs spontaneously in the preterm without clear trauma, and ranges from mild to severe. Subdural hemorrhage is more common in children born at term and is clearly associated with trauma. Subarachnoid hemorrhage is common in newborn children and often goes unnoticed (Volpe, 2015).

Neonatal prematurity mortality tends to decrease, but this is why the number of children with disabilities is increasing. Prematurely born infants are at high risk for multiple lesions including bronchopulmonary dysplasia, ductus arteriosus persistence, sepsis, necrotic enterocolitis, intraventricular hemorrhage, and retinopathy (Ramadani, 2017).

Hospitalizations for respiratory diseases and surgical interventions are also common. Prematurely born children with underdeveloped lungs and with respiratory distress syndrome requiring oxygen use and artificial ventilation have slow speech development from prelingual speech phases (vocalization and babbling) to reading and writing disorders at school age. We have the same regularity with preterm children who had intracranial hemorrhage (Savic, 2010, 2011).

So, one of the most comprehensive and lasting consequences of premature birth is the slow development of speech and language.

AIM OF THE RESEARCH

The aim of the study is to determine the risk factors at birth in prematures that influence the development of speech-language disorder. The following research objectives were derived from the research objective: to determine the number and type of risk factors at birth in prematures and to determine the status of speech and language development in prematures at the age of three to four years of age.

METHODOLOGY

The research was conducted at the Institute for Experimental Phonetics and Speech Pathology in Belgrade, and is part of the project: "Interdisciplinary Research on the Quality of Verbal Communication", No.178027, funded by the Ministry of Science of the Republic of Serbia. The sample consisted of 60 children aged between three and four years. The experimental group consisted of 30 prematures children, below the 32nd week of gestational age, with a birth weight below 1500gr. The control group consisted of 30 children born at term, above the 38th week of gestational age and body weight at birth over 3000 gr. The study variables were: the beginning of sitting, walking, bubbling and talking (Anamnestic sheet), statistical analysis of the results was done in SPSS. Non-parametric tests were used: rank sum test (Wilcoxon test and Mann-Whitney U test for the following reasons: a small sample of subjects and no normal distribution of data), and a multifactorial MANOVA to assess statistical significance between the two groups.

RESULTS

The table 1 shows the gestational age of premature and term babies.

Table 1: Gestational age of prematures and term babies

	Mean value	SD	Min	Max	Hmg%
K group (n=30)	39.61	1.08	38	41	83.7
E group (n=30)	29.76	1.52	27	32	93.3

The gestational age of children born at term is 40 weeks, while the gestational age of prematures is 30 weeks. Homogeneity for children born within 83.7% and for prematurity 3.3%.

The table 2 presents anthropometric regiments and risk factors for prematurity and term births.

Table 2: Anthropometric regiments and risk factors of premature babies and term babies
circumference of the head body weight

	circumference of the head						body weight									
	Mv	Sd	Se	Min	max	p	mv	Sd	Se	Min	Max	P				
K gr	34.5	1.6	0.3	31	38	0.690	3408	346	62	2520	4260	0.875				
E gr	29.2	2.9	0.5	26	38	0.004	1388	226	41	1000	20140	0.027				
	body length						risk factors									
	Mv	Sd	Se	Min	max	p	asf		Hbil		rean.		Ikh		Rds	
							N	%	N	%	N	%	N	%	n	%
K gr	50.4	2.4	0.4	43	55	0.220	3	9	8	26	2	6	2	6	0	0
E gr	38.7	2.3	0.4	34	45	0.267	19	63	9	30	8	27	15	50	19	64

Children born at term have an average head circumference of 34.5 cm, body weight 3408 gr, body length 50.4 cm. The distribution of values ranges within the normal distribution (p) of head circumference (0.69), body weight (0.88), and body length (0.22). The most common risk factor at birth is hyperbilirubinemia (26%), followed by asphyxia (9%), intracranial hemorrhage and resuscitation (6%), whereas respiratory distress syndrome was not present in the group of children born at term.

Infant prematures have an average head circumference of 29.2 cm, a body weight of 1388 gr and a body length of 38.7 cm. The distribution of values ranges within the normal distribution (p) at body length (0.22) and deviates at head circumference (0.004) and body weight (0.027). The most common risk factor at birth is respiratory distress syndrome (64%), followed by asphyxia (63%), intracranial hemorrhage (50%), hyperbilirubinemia (30%), and resuscitation (27%).

In table 3 shows statistically significant differences between prematurity and term babies in the number of risk factors.

Table 3: Statistically significant differences between prematures and term babies in the number of risk factors

risk factors	MANOVA				
	X	R	F	P	Dpr%
asphyxia	0.552	0.662	46.022	<0.001	44.93
hyperbilirubinemia	0.418	0.459	15.791	<0.001	1.82
Reanimation	0.499	0.576	29.289	<0.001	5.14
intercranial hemoralgia	0.523	0.614	35.768	<0.001	0.30
respiratory distress syndrome	0.589	0.730	67.135	<0.001	47.81
Total of Risk factors			19.941	<0.001	
discriminant analysis			19.402	<0.001	

Statistical analysis of the results revealed a highly statistically significant difference ($p < 0.001$) between prematures and infants born at term in the presence of risk factors at birth. Respiratory distress syndrome gives the characteristic of a group because it is present with a value of 47.81.

The table 4 presents a statistical analysis of the results obtained by examining the early motor, prelingual and lingual development of prematures and children born at term. Early motor development was observed through two variables: the onset of self-sitting and walking. Prelingual development was observed through the variable of onset of chatter, and early lingual development was observed through the variable of pronunciation or occurrence of the first word with meaning.

Table 4: Statistical analysis of the results obtained by examining early motor and lingual development of prematures and children born at term

Group	Early motor, prelingual and early lingual development							
	sit		walk		bubble		talk	
	Mean rank	Sum of Rank	Mean rank	Sum of Rank	Mean rank	Sum of Rank	mean rank	Sum of Rank
E group (n=30)	31.60	948.00	33.75	1012.5	35.30	1059.00	34.52	1035.50
K group (n=30)	29.40	882.0	27.25	817.5	25.70	771.00	26.48	794.50
Mann-Whitney U	417.000		352.500		306.000		329.500	
Wilcoxon W	882.000		817.500		771.000		794.500	
Z	-.538		-1.472		-2.211		-1.936	
Stat. significance	.590 $p > 0.05$		.141 $p > 0.05$		0.27 $p < 0.05$		0.49 $p < 0.05$	

Statistical analysis of the results revealed that there were no statistically significant differences in prematurity and term births in early motor development: sitting alone (.590; $p > 0.05$) and walking (.141; $p > 0.05$). Statistically significant differences were found at the beginning of the chatter (0.27; $p > 0.05$), and pronunciation (0.49; $p > 0.05$).

Table 5 shows the qualitative research results obtained by examining the early motor, prelingual and lingual development of prematures and children born at term.

Table No.5 Qualitative research results obtained by examining early motor, prelingual and lingual development of premature and term-born children.

variables	prematuruses (n=30)		in the term (n=30)	
	Number of months	average	Number of months	average
Sit	202	6.7	198	6.6
walk	410	13.6	391	13.3
bubble	229	7.6	180	6
talk	454	15.13	381	12.7

Qualitative analysis of the results revealed that in prematurity and children born in term, the ability to sit occurs between the 6th and 7th months, and the walk between the 13th and 14th months of life. The babbling phase is slightly delayed in the prematurus and occurs between the 7th and 8th months of life, whereas in babies born in term it occurs in the 6th month of life. The pronunciation phase, characterized by the appearance of the first word, is also delayed in the prematurus and occurs around the 15th month of life, whereas in children born in term the first word occurs between the 12th and 13th months of life.

DISCUSSION OF RESULTS

The analysis of the results identified the following risk factors at birth that were present in both groups of subjects: hyperbilirubinemia, asphyxia and intracranial hemorrhage, while in addition to these risk factors, respiratory distress syndrome was also present in prematurity. Hyperbilirubinemia was found in approximately the same number in term babies (26%) and prematures (30%). Other risk factors were more prevalent in prematurity (asphyxia - 63%; intracranial hemorrhage - 50%; resuscitation - 27%) than in children born at term (asphyxia - 9%; intracranial hemorrhage - 6%; resuscitation - 6%), while respiratory distress syndrome was present in 64% of prematures. A highly statistically significant difference ($p < 0.001$) was found between prematures and infants born at term with the presence of risk factors at birth. Respiratory distress syndrome gives the characteristic of a group because it is present with a value of 47.81.

Research (Miljkovic, 2008) points out that premature birth occurs in less than 10% of pregnancies and is the cause of more than 60% of all neonatal deaths. This indirectly indicates that the remaining live infants often have consequences of preterm birth that are reflected in the child's psychophysical development. Of the risk factors, perinatal asphyxia, RDS, hyperbilirubinemia, infections, HIC, congenital anomalies and others are the most common. (Miljkovic, Jonovic, Jovanovic, Stojanovic, 2008).

Children with a history of neonatal hyperbilirubinemia often have neurological impairments. The incidence of bilirubin encephalopathy is higher in premature infants with less birth weight. Increased blood brain barrier permeability is important in the pathogenesis of bilirubin encephalopathy. In preterm infants it is significantly higher than in term babies (Subanda, Komang, & Abdul, 2013).

The results of our study indicate that babies born in term and prematures have identical development of early motor skills (sitting and walking), while the prelingual phase (babbling) and early lingual phase (occurrence of the first word with meaning) are delayed in prematures. The ability to sit occurs between 6 and 7 months, and the walk between 13 and 14 months of age. The babbling phase occurs between 7 and 8 months of age in prematures, while it occurs in children born at term of 6 months of age. The pronunciation phase,

characterized by the appearance of the first word, is also delayed in the prematurus and occurs around the 15th month of life, whereas in children born in term the first word occurs between 12 and 13 months of age. Statistical analysis of the results showed that there were no statistically significant differences in prematurity and term births in early motor development: sitting alone (.590; $p > 0.05$) and walking (.141; $p > 0.05$).

Statistically significant differences were found at the beginning of the chatter (0.27; $p > 0.05$), and pronunciation (0.49; $p > 0.05$). These results can also be interpreted by the fact that prematurus children very often go for motor development stimulation and equate to the control group, while speech-language stimulation begins much later only when the parent or pediatrician, at the age of two, does not say that he or she is not coming do not refer the child to speech therapy until speech development. There is very little research into the examination of prelingual and early lingual development in prematurus. We hypothesize that a small developmental delay in prelingual and early lingual development in children born before term, if not remedied on time, results in greater speech and language disorders at a later age.

To put it simply, children who are two to three months late in prelingual and lingual development are even more late at a later age and will have serious diagnoses of speech and language disorders at school age. These findings are confirmed by a study of prematurus children at the age of 10 years when the presence of speech-language disorders (dysphasia, dyslalia, specific disorder in mastering school skills, etc.) was detected in 84% of cases (Miljković et al., 2008).

CONCLUSION

Prematurus are children of low gestational age and low birth weight. The incidence of preterm birth varies from 5 to 10%. Prematuruses, especially those with a birth weight of less than 1500 grams and a gestational age of less than 35 weeks, are at high risk for neonatal mortality and morbidity. The most common risk factors are: hyperbilirubinemia, asphyxia and intracranial hemorrhage, while in addition to these risk factors, respiratory distress syndrome was present in prematurus. Hyperbilirubinemia is present in approximately the same number in term babies (26%) and prematurus (30%). Other risk factors are present in a much higher number in prematurus (asphyxia - 63%; intracranial hemorrhage - 50%; resuscitation - 27%) than in children born at term (asphyxia - 9%; intracranial hemorrhage - 6%, resuscitation - 6 %), while respiratory distress syndrome is present in 64% of prematurus. A highly statistically significant difference ($p < 0.001$) was found between prematurus and term babies in the presence of risk factors at birth. Respiratory distress syndrome gives the characteristic of a group because it is present with a value of 47.81.

Infants born in term and prematurus have identical development of early motor skills (sitting and walking), while the prelingual phase (babbling) and early lingual phase (occurrence of the first word with meaning) are delayed in prematurus. The ability to sit occurs between 6 and 7 months, and the walk between 13 and 14 months of age. The babbling phase occurs between 7 and 8 months of age in prematurus, while it occurs in children born at term of 6 months of age. The pronunciation phase, characterized by the appearance of the first word, is also delayed in the prematurus and occurs around the 15th month of life, whereas in children born in term the first word occurs between 12 and 13 months of age. There were no statistically significant differences between prematurus and infants born at term in early motor development: sitting alone (.590; $p > 0.05$) and walking (.141; $p > 0.05$). Statistically significant differences were found at the beginning of the chatter (0.27; $p > 0.05$), and pronunciation (0.49; $p > 0.05$).

REFERENCES

- Avery B. (2010). Neonatology. Philadelphia: JB Lippincot Company.
- Fanaroff A. A, Martin R. J. (2000). Neonatal-perinatal medicine. St. Louis, Baltimore, Boston, Chicago, Sidney, Toronto: Mosby Year Book.
- Greenough A. (2013). Respiratory Distress Syndrome. In: Rennie JM, Robertson NRC, editors. Neonatal Respiratory Disorders. 1st ed. London: Arnold, pp.238-280.
- Levene M.I., Tudehope D.I., Thearle M. J. (2000). Essential of neonatal medicine. London: Blackwell Science.
- Miljković B., Jonović M., Jovanović G., Stojanović N. (2008). Neonatalni morbiditeti mortalitet pretermiske novorođenčadi, 41 Pedijatrijski dani Srbije sa međunarodnim učešćem, Zbornik radova, Niš, 25-27.; p 168.
- Paneth N. (2015): Incidence and timing of germinal matrix/ intraventricular hemorrhage in low-birty-weight infants. Am J. epidemiol.
- Ramadani R. (2017). Respiratorni Distress in drom novorođenčeta. Acta Medica Pediatrica Pedijatrijska pulmologija; 2:23-63. 4.
- Rennie J. M, Robertson N.R.C. (2002). A manuel of neonatal intesive care. London: Arnold.
- Rennie J. M (2013). Neonatal cerebral ultrasound. Cambridge university press.
- Savić G. (2011): Kategorizacija, porođajne karakteristike i govorno jezički poremećaji djece sa kombinovanim smetnjama u razvoju. Timočki medicinski glasnik, ISSN 0350-2899, br.4 p.201-207.
- Savić G. (2010): Uticaj riziko faktora na pojavu govorno jezičkih poremećaja, magistarska teza, Fakultet za specijanu edukaciju i rehabilitaciju, Beograd.
- Subanada B.,I., Komang K, Abdul H. (2013): Neuro-logical impairment of children with history of prematurity and neonatal hyperbilirubinemia. Paediatrica Indonesiana; 43:59-65.
- Volpe J. J. (2015). Neurology of the newborn. Philadelphia: WB Saunders Company.

Physiology of Speech and Sleep-Converging Evidences about the Core Pathophysiological Mechanism of Chronic Tinnitus

Zoran Matić¹, Stefan Mandić Rajčević², Ivan Soldatović³, Ljiljana Čvorović⁴, Zorica Rašić Milutinović⁵, Aleksandar Kalauzi⁶, Tijana Bojić⁷

¹Biomedical engineering and technologies, University of Belgrade, Studentski trg 1, 11000 Belgrade, Serbia

²Innovation Centre of the Faculty for Technology and Metallurgy University of Belgrade, Karnegijeva 4, 11000 Belgrade, Serbia

³Institute for Medical Statistics and Informatics, School of Medicine University of Belgrade, Doktora Subotića 1, 11000 Belgrade, Serbia

⁴Clinical Center of Serbia, School of Medicine, University of Belgrade, Dr Subotica 9, 11000 Belgrade, Serbia

⁵Clinic of Internal Medicine, University Hospital Zemun, University of Belgrade, Vukova str. 9, 11080 Zemun, Belgrade, Serbia

⁶Department for Life Sciences, Institute for Multidisciplinary Research, University of Belgrade, Kneza Višeslava 1, 1030 Belgrade, Serbia

⁷Laboratory for molecular genetics and radiobiology, Institute of Nuclear Sciences Vinča University of Belgrade, P.O. Box 522, Mike Petrovića Alasa 11-14, 11000 Belgrade, Serbia

ABSTRACT

Tinnitus is a specific *phantom* sound perception whereby the brain compensates for missing sensory input from the ear (De Ridder et al, 2014a, Bojić et al, 2017, Cederroth et al, 2019). Precise mechanisms of tinnitus are unknown, though still valid deafferentational model of Jastreboff based on central neuroplasticity changes (Jastreboff, 2011) provides useful basis for upgrading. Recent investigations reported significant coexisting of tinnitus and decrease of speech perception (Omidvar et al, 2018; Liu et al, 2018) especially in noise (Liu, 2018) where auditory brainstem responses on speech stimuli are distorted in time (latencies) and frequency domains (F1 and HF spectral magnitudes) (Omidvar et al, 2018). Furthermore, REM sleep (REMS) is reciprocally incompatible with chronic tinnitus: during REMS, tinnitus is not perceived (De Ridder et al, 2014a) and vice versa - in chronic tinnitus patients the amount of REMS is notably diminished (Attanasio et al, 2013). This reciprocity indicates an alternative usage of common neural networks, as in the case of REMS and thermoregulatory system (Parmeggiani and Rabini, 1967).

Based on foregoing, we bring special attention to the cerebral core structures: i) *Brainstem structures* (nc. accumbens, lateral lemnisc and inferior collicle) possess fundamental importance for speech auditory processing and with ii) *thalamic nuclei* form gain-control mechanism for the unwanted auditory stimulus from the environment. Once lesioned, the phantom sound is generated. Moreover, *brainstem regions* are highly active during REMS while forming a functionally operative centrencephalic unit (Maquet et al, 1996, Pigneux et al, 2001, Zoccoli et al, 2005); *thalamic neurons* exhibit desynchronization in this state, participate in the generation of ponto-geniculo-occipital waves and are, hypothetically, irresponsive to pathological auditory information coming from caudal regions. Vice versa, thalamocortical dysrhythmia, proposed as tinnitus pathophysiological model (Llinás et al, 1999) would prevent normal REMS pattern of thalamocortical fibers.

Therefore, on the basis of speech and sleep physiology insights, deafferentational model of Jastreboff (2011) should be focused on brainstem-thalamic circuits, looking there for the potential tinnitus functional core.

Key words: tinnitus, speech, sleep

1 INTRODUCTION

For hearing, humans use auditory system specialized in registering air mechanical oscillations in frequency range between 20 and 20 000 Hz. It is perceived and experienced as *sound*. Usually, sound originates from external environment and human subjects are capable of locating the source of the sound (direction and distance, Smith, 1997) and categorizing types of sound (most probably according to acoustic cues, Kroos et al, 2019). The phenomenon of sound perception without external source is defined as tinnitus. It is a raising pathology of the industrialized world that strikes 6-26% of adult population (Elgoyhen and Langguth, 2014, Geven et al, 2014). Being a therapeutically unsolved problem, tinnitus can significantly diminish the patents' quality of life (Tyler et al, 2019). According to recent findings it seems that the key of the tinnitus problem is in the pathologically changed connectivity between brain networks involved in sound perception.

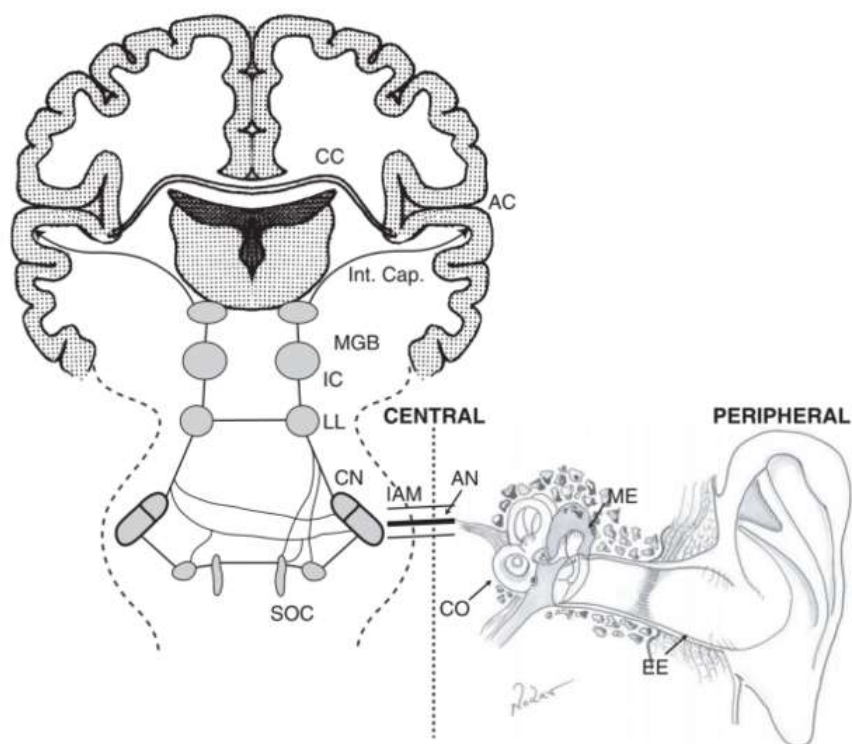


Figure 1: Schematic representation of auditory system (EE – external ear and canal, ME – middle ear, CO – cochlea, AN – auditory nerve, IAM – internal auditory meatus, CN – cochlear nucleus, SOC – superior olivary complex, LL – lateral lemniscus, IC – inferior colliculus, MGB – medial geniculate body, int.cap. – internal capsule, AC – auditory cortex, CC – corpus callosum (Musiek & Baran, 2018).

The perception of phantom sound (i.e. tinnitus) has no real external stimuli on cochlea neither meaningful sense. Still, the perception of tinnitus is not imaginary, but a real sensation - pathologic neural activity of the brain circuits that generates “hearing” of tinnitus sound as a real one (Jastreboff, 2011). Hearing both the real sound and phantom sound of tinnitus is occurring in a conscious awake state (Cederroth et al, 2019). Although some types of chronic tinnitus could be constantly present in many patients, there is growing evidence that some types of chronic subjective tinnitus are not experienced during REM sleep (REMS, de Ridder, 2014a). Additionally, tinnitus and speech perception problems also overlap, pointing on the role of common neural networks of “tinnitus generator”/“REMS generator” and “tinnitus generator”/“speech perception network”, respectfully. The insights from physiology of sleep and speech could be used to explain the tinnitus pathogenesis and for future designing of new therapeutic approach for tinnitus.

2 PHYSIOLOGY OF SPEECH AND SLEEP

Modern research has confirmed that proper explanation of tinnitus should incorporate not only hearing mechanisms in cochlea and not only auditory system as assumed earlier, but more complex neurophysiologic functionality such as dynamic interconnections between several brain networks (Jastreboff, 2011). So far, the most credible neurophysiologic model of tinnitus is the one proposed by Pawel Jastreboff. He postulated that tinnitus signal appearing from maladaptive neural plasticity could originate from the periphery of the auditory system, i.e. as the lack of auditory input (in hearing loss). According to Jastreboff, in the initial stage, this signal passes through conscious, cognitive processing in the brain ("high loop", LeDeux, 1992). During the time of chronicisation, it reaches deeper learning network as it is registered and processed on subconscious level ("low loop", LeDeux 1992). The main problem is that this is not the end of the tinnitus evolution. The tinnitus signal (sound perception) activates limbic and autonomic nervous system (ANS, increasing sympathetic activity) that in turn induces consequent involuntary reactions. Those are negative reactions/responses that can be divided in two groups: psychological reactions like anxiety, depression, sleep disorders (Jastreboff, 2011, Tyler et al, 2019) and cognitive and behavioral reactions such as disturbed attention (Krick et al, 2017), mental stress and bad subjective feelings (annoyance, antipathy, emotive unacceptance, panic, aggression up to suicidal thoughts) (Low, 2007, Jastreboff, 2011). Negative reactions induce overloading of neural pathways and amplification of tinnitus signal, ending as serious health and life quality limitations.

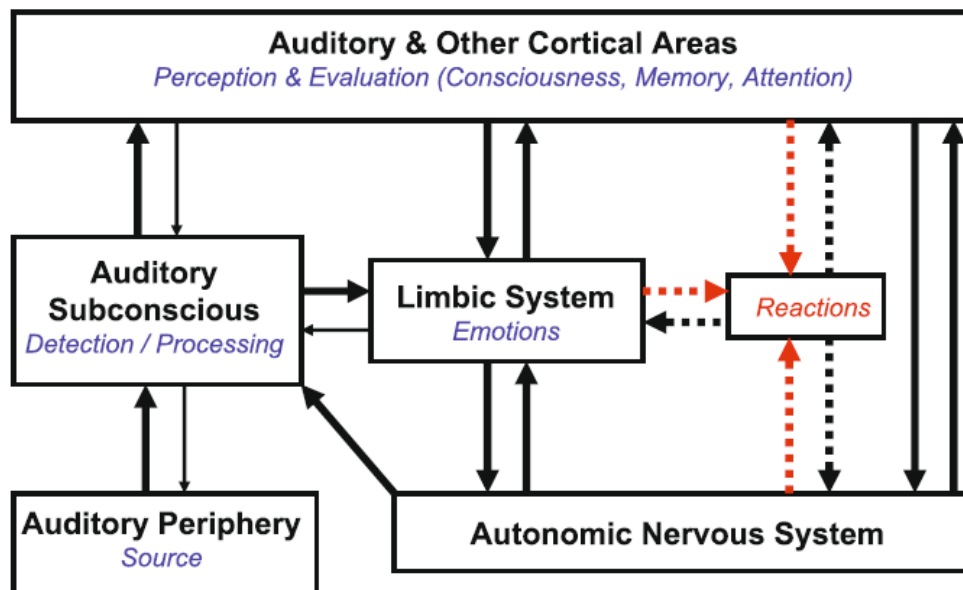


Figure 2: The neurophysiological model of tinnitus by Pawel Jastreboff (2011).

Notrarely tinnitus can be accompanied with other disorders such as deafness and decreased sound tolerance (hyperacusis and misophonia, Jastreboff, 2011). Recently, it was reported that tinnitus patients have weakened timing processing of speech stimuli at the sub-cortical level (Figure 3, adopted from Omidvar et al, 2018). This might be significant for explanation why tinnitus contributes to the problems of sound localization and speech recognition (Omidvar, 2018, Liu et al, 2018, Jagoda et al, 2018), especially in a noisy environment (Liu et al, 2018, Jagoda et al, 2018). It is probably related to defected differential sensitivity for frequency, intensity and duration of acoustic patterns in tinnitus patients (Ravirose et al, 2019). However, heterogeneity in results related to influence of tinnitus on speech recognition indicate on a multifactorial problem: auditory (presence, level or absence of deafness) and non-auditory circumstances (age, psychological aspects like level of subjective acceptance of tinnitus and disturbance of mental attention, Low et al, 2007, Bureš et al, 2019).

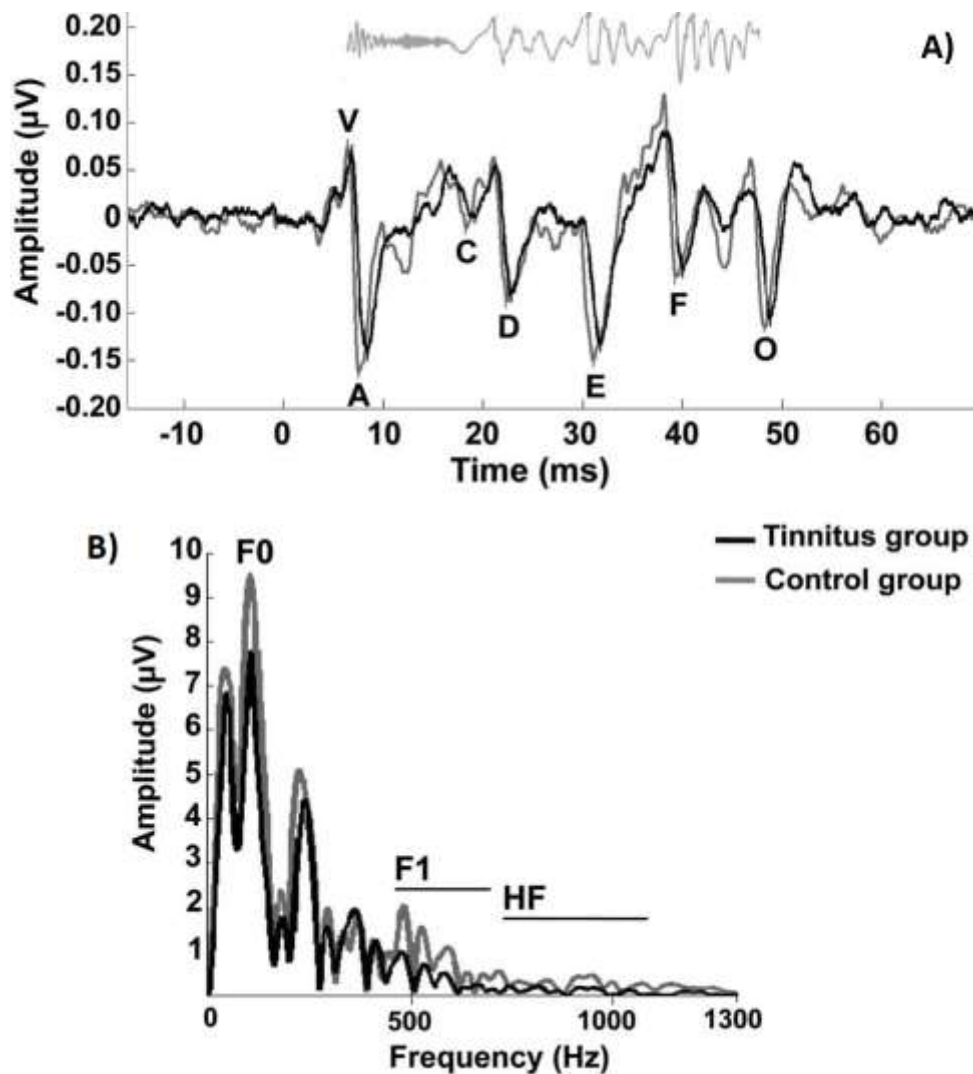


Figure 3: Speech auditory brainstem response a) time domain; b) frequency domain (adopted from Omidvar et al, 2018).

Therefore, certain relation between tinnitus and speech does exist. In order to specify this as significant we need to overview the most relevant insights about physiology of speech ability that has a profound and complex evolution story. It comprises: evolution adjustment of lungs and larynx anatomy for producing rhythmic frequency patterns of speech and neural circuits, connecting cortex, basal ganglia and subcortical structures that enable voluntary control of speech rhythm. The key factor for development of speech ability in Neanderthals and humans was gene FOXP2 that triggers formation of neural circuits involved in motor control of speech related organic structures, inducing increased synaptic connectivity and plasticity in basal ganglia circuits (Lieberman, 2019).

Further confirmation of significance of neural circuit connectivity and plasticity for tinnitus understanding and solving could be gained from sleep physiology.

Sleep is specific psycho-physiological state in which complex processes of recovery and consolidation take place. Normally, these processes are followed by dreaming which appears prevalently in the state of REMS. It can be recognized by low voltage EEG activity, fast eye movements and muscle atonia (Rechtschaffen and Kales, 1968). There is also evidence that phantom sound of tinnitus is not

perceived in REMS (de Rider et al, 2014a). On the other hand, chronic tinnitus patients often suffer from reduced REMS (Atanasio et al, 2013). This reciprocal incompatibility of REMS and tinnitus suggest their alternative partaking of common neural networks, which has analogy with REMS and thermoregulatory system (Parmeggiani and Rabin, 1967). We propose that indication on these common neural hubs of REMS and tinnitus could provide new insights on auditory perception and potential new approach for tinnitus treatment by means of combination of sound therapy, drugs and noninvasive neuromodulation (Peter and Kleinjung, 2015). Thus, we can point on the common structures involved both in REMS and tinnitus as presented on Figure 4.

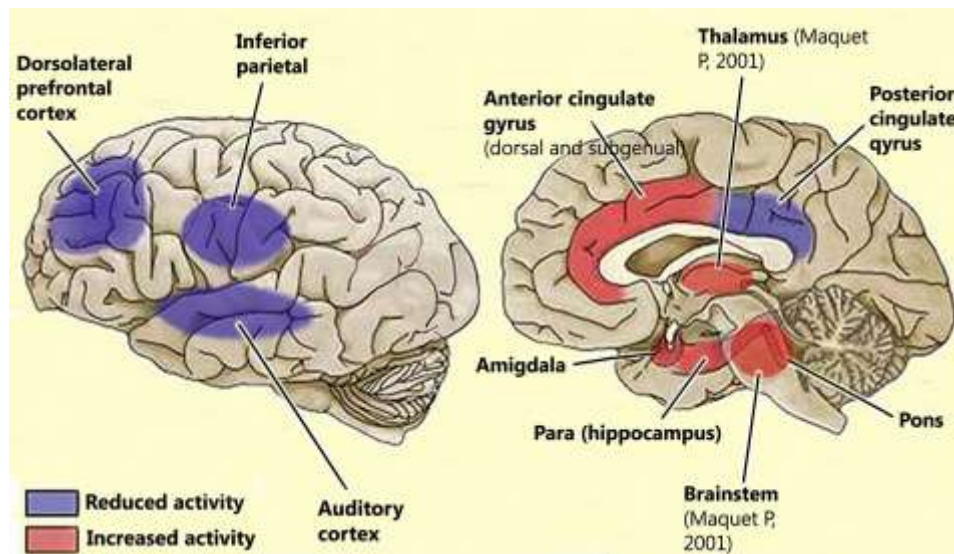


Figure 4: Neuroanatomical structures common for REMS and tinnitus (Bojić et al, 2017).

Based on above-mentioned, we bring special attention to the cerebral core structures: i) *brainstem structures* (nc. accumbens, lateral lemnisc and inferior collicle), with fundamental importance for speech auditory processing and ii) *thalamic nuclei*, that form gain-control mechanism for the unwanted auditory stimulus from the environment. These structures, once dysfunctional, could be a part or the tinnitus core network. Brainstem regions are highly active during REMS, forming a functionally operative centrencephalic unit (Maquet et al, 1996, Pigneux et al, 2001, Zoccoli et al, 2005). Thalamic neurons exhibit desynchronization in REMS, participate in the generation of ponto-geniculo-occipital waves and are, plausibly and in analogy with REMS abolition of thermoregulation, irresponsive to pathological auditory input coming from caudal regions. Vice versa, once established pathological thalamocortical dysrhythmia, proposed as tinnitus pathophysiological model by Llinás et al (1999) would prevent normal REMS pattern of thalamocortical fibers.

Boxes represent building blocks of tinnitus network brain structures. Underlined structures make part of the REM sleep neural networks. * excitation, □ inhibition. ACC: Anterior Cingulate Cortex, PCC: Posterior Cingulate Cortex, DLPFC: Dorsolateral Prefrontal Cortex, VLPFC: Ventrolateral Prefrontal Cortex, Amyg: amygdala, PreACC: pregenual Anterior Cingulate Cortex, vmPFC: ventromedial Prefrontal Cortex, OFC: Orbitofrontal Cortex, sg ACC: subgenual anterior cingulate cortex, dACC: dorsal anterior cingulate cortex, LC: Locus Coeruleus, NTS: Nucleus Tractus Solitarius (Bojić et al, 2017).

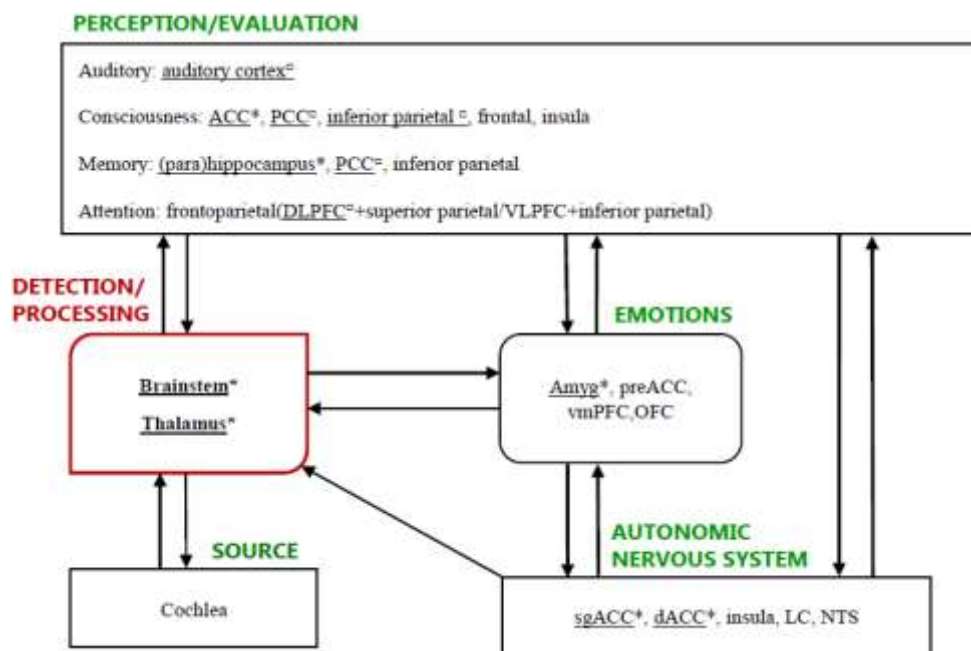


Figure 5. Neurophysiological model of tinnitus (Adopted and modified from Jastreboff (2011)).

3 THERAPEUTIC APPROACHES

In recent years many attempts have been made towards clinical solving of the tinnitus problem by use of diverse techniques such as sound therapies: artificial beep tones (Tas et al, 2019, Tyler et al, 2019); music (Tian et al, 2017, Krick et al, 2015), natural and ocean sounds (Lim et al, 2019, Munro & Searchfield, 2019, Sheppard et al, 2019); invasive (Deklerck et al, 2019) and noninvasive neuromodulation (Peter & Kleinjung, 2015, Ylikosky et al, 2017); drugs (Cederroth et al, 2018); psychotherapy (cognitive-behavioral approach, (Hesser et al, 2011, Li et al, 2019) and empathetic counseling (Aazh et al, 2016, Sheppard et al, 2019)); acupuncture (Pang et al, 2019) etc. None of them has been demonstrated as complete and definite solution for all tinnitus patients. Main reasons might be the inability of individual techniques to cover the heterogeneity of tinnitus manifestations and pathophysiological substrates in patients, or, more probably, the lack of fundamental understanding of common tinnitus pathophysiological mechanisms. Assessment of adequate therapy for tinnitus patients depends very much on medical anamnesis that might be improved with knowledge of recent insights about tinnitus physiological mechanisms. For sound therapy, it is important to highlight neurological basis of phantom sound generation. Since there exists no real sound background in tinnitus, it should be clear that “auditory masking” of tinnitus *phantom* sound by some external sound is not possible (Jastreboff, 2011). Instead, focus should be on interaction of neural activity evoked by sound therapy with “tinnitus-related neuronal activity” (Jastreboff, 2011). Also, it is assumed that therapy with sound stimulations could induce plastic changes in the central auditory networks in order to repair maladaptive neural plasticity related with tinnitus perception (Theodoroff et al, 2017). Nevertheless, it is of particular importance the diagnosis of the patient’s subjective “auditory” properties of tinnitus (for setting frequencies of sound stimulation) and sound tolerance (threshold) by patient’s audiogram (for setting intensity of sound stimulation) (De Ridder et al, 2014b, Ravitose et al, 2019). Then, sound tones with frequencies near the pitch of a patient’s tinnitus should be delivered to his/her ears. Therapeutic effect by this approach is achieved through the mechanism of inhibition of neurons that are involved in tinnitus sound production due to activation of other neurons by non-tinnitus frequency sound tones from therapeutic device (Jastreboff, 2011). This sound adjusting therapy achieved noticeable results

in suppression of tinnitus perception. Yet, there are still speculations on general effectiveness of sound therapy in curing tinnitus (Sheppard et al, 2019) based on diverse results in studies. They might be due to different study setting related to environmental and auditory circumstances and current psycho-physical state of subjects (including paying attention or not to tinnitus, Neff et al, 2019). Besides, it should be suggested that sound therapy alone demands systematic strategy of personalized diagnosis of tinnitus characteristics and accordingly targeted therapeutic approach as demonstrated in study of Zhao Y et al (2019).

Several years ago a new therapeutic method of pairing sound tones with noninvasive vagus nerve stimulation (VNS) was successfully applied on rats (Engineer et al, 2011), and then on humans (De Ridder et al, 2014b). It implies electromagnetic stimulation of the vagus nerve of the neck or earlobe synchronous with emitting series of sound tones that are tuned against tinnitus frequency and timed to follow VNS (De Ridder et al, 2014b). Its notable therapeutical potential, as reported, is due to its possibility of improving the auditory cortex plasticity (Bojić T, 2017). Further research should estimate the degree in which this method could extenuate ANS disbalance (shift from sympathetic to parasympathetic predominance as demonstrated in Ylikoski et al, 2017) and negative reactions of tinnitus. As a matter of fact, as advised by Jastreboff, instead of suppression of tinnitus perception, therapy should rather be directed at blocking the tinnitus signal propagation from the auditory system to the limbic system and ANS. Through the unloading of limbic system and ANS from tinnitus signal, habituating of negative reaction of tinnitus follows. When negative reactions become suppressed/disabled enough, tinnitus itself stops to psychologically burden the patient. Then, auditory conscious attention on tinnitus perception spontaneously decreases with time because of tendency of the brain to habituate unimportant sound sensations (Jastreboff, 2011).

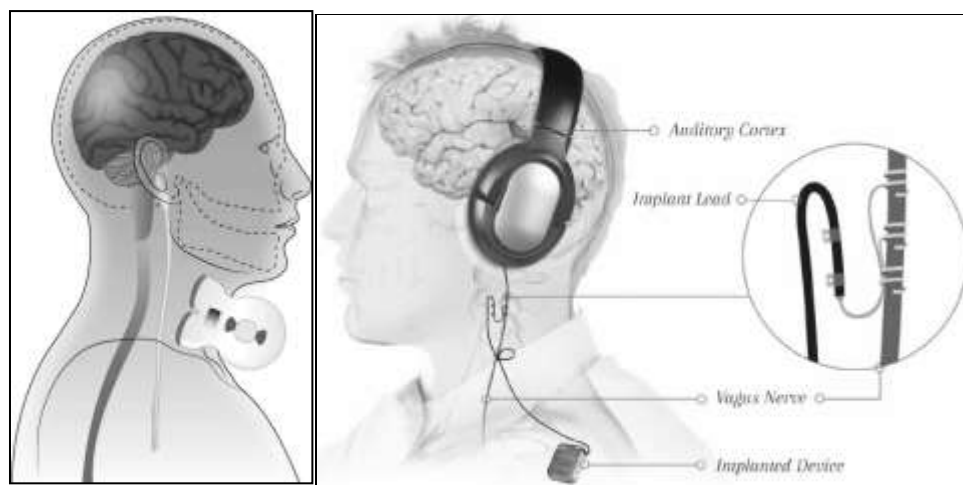


Figure 6: left) Non-invasive vagus nerve stimulation (Mertens et al, 2018); right) invasive vagus nerve stimulation paired with sound tones (Tyler et al, 2017)

A very promising method for curing tinnitus could be recognized in sound therapy during sleep. Motivated by the hypothesis that neural network learning could be in the basis of therapeutic effect of sound, Pedemonte et al (2014) designed a study to explore influence of tinnitus mimicking sound stimulations on different stages of sleep. They gave instructions to patients to match their tinnitus with the most similar acoustic stimulus. Then, these tinnitus-matched acoustic stimulations were delivered to them during different stages of sleep. They found that the largest changes in EEG power spectrum and coherence of EEG waves occurred during N2 (sleep spindles) and N3 (slow wave sleep) stages, in delta and theta spectral bands (which are known to reflect sound processing during sleep), in temporal region (region of auditory cortex (Pedemonte et al, 2014)). Study of Pedemonte et al was used for development of device Levo[®] system designed for sound therapy during sleep. In a study of Theorodoff et al (2017) Levo[®] system showed the best performance in reducing tinnitus perception in comparison to noise stimulations and bedside

generator (Theorodoff et al, 2017). According to our intention to correlate REMS and tinnitus generation, instead of tinnitus-like sound stimulus, we could suggest monitoring REMS of tinnitus subjects when exposed to sound stimulations composed of tones with frequencies near the pitch of a patient's tinnitus (but excluding tinnitus-matching tones).

4 CONCLUSION

Data from speech and sleep physiology critically evaluate deafferentational model of tinnitus of Jastreboff (2011) focusing the attention on brainstem-thalamic circuits, and suggesting them as the potential tinnitus functional core. New insights open promising lines for the development of tinnitus therapeutic modalities.

REFERENCES

- Aazh, H., Moore, B.C., Lammaing, K., and Cropley, M. (2016). Tinnitus and Hyperacusis Therapy in a UK National Health Service Audiology Department: Patients' Evaluations of the Effectiveness of Treatments. *International Journal of Audiology* 55 (9): 514–522. doi:10.1080/14992027.2016.1178400.
- Attanasio, G., Russo, F.Y., Roukos, R., Covelli, E., Cartocci, G., Saponara, M. (2013). Sleep architecture variation in chronic tinnitus patients. *Ear Hear.* 34(4):503-7. doi: 10.1097/AUD.0b013e31827bc436.
- Bojić, T., Perović, V.R., Senčanski, M., Glišić, S. Identification of Candidate Allosteric Modulators of the M1 Muscarinic Acetylcholine Receptor Which May Improve Vagus Nerve Stimulation in Chronic Tinnitus. (2017). *Front Neurosci.* 11:636. doi: 10.3389/fnins.2017.00636.
- Bojić, T., Matić, Z., Mandić-Rajčević, S., Platiša, M., Kalauzi, A. Tinnitus and REM sleep incompatibility – a pathophysiological milestone for unraveling functional neural networks overlaps”, Proceedings of the conference 11th Tinnitus Research Initiative (TRI) Meeting and TINNET Conference 2018, Regensburg, Germany, March 14-16, 2018, ID 152.
- Bureš, Z., Profant, O., Svobodová, V., Tóthová, D., Vencovský, V., Syka, J. (2019). Speech Comprehension and Its Relation to Other Auditory Parameters in Elderly Patients With Tinnitus. *Front Aging Neurosci.* 11:219. doi: 10.3389/fnagi.2019.00219.
- Cederroth, C.R., Dyhrfeld-Johnsen, J., Langguth, B. (2018) An update: emerging drugs for tinnitus. *Expert Opin Emerg Drugs.* 23(4):251-260. doi: 10.1080/14728214.2018.1555240.
- Cederroth, C.R., Gallus, S., Hall, D.A., Kleinjung, T., Langguth, B., Maruotti, A., et al. (2019) Editorial: Towards an Understanding of Tinnitus Heterogeneity. *Front Aging Neurosci.* 19:11:53. doi: 10.3389/fnagi.2019.00053.
- Deklerck AN, Marechal C, Pérez Fernández AM, Keppler H, Van Roost D, Dhooge IJM. Invasive Neuromodulation as a Treatment for Tinnitus: A Systematic Review. *Neuromodulation.* 2019 Sep 16. doi: 10.1111/ner.13042.
- De Ridder, D., Vanneste, S., Weisz, N., Londero, A., Schlee, W., Elgoyhen, A.B., and Langguth, B. (2014a). An integrative model of auditory phantom perception: tinnitus as a unified percept of interacting separable subnetworks. *Neurosci Biobehav Rev* 44, 16-32. doi: S0149-7634(13)00081-X [pii]10.1016/j.neubiorev.2013.03.021.
- De Ridder D, Vanneste S, Engineer ND, Kilgard MP. (2014b). Safety and efficacy of vagus nerve stimulation paired with tones for the treatment of tinnitus: a case series. *Neuromodulation.* 17(2):170-9. doi: 10.1111/ner.12127.
- Elgoyhen, A.B., Langguth, B., De Ridder, D., Vanneste, S. (2015) Tinnitus: perspectives from human neuroimaging. *Nat Rev Neurosci.* 16(10):632-42. doi: 10.1038/nrn4003.
- Engineer, N.D., Riley, J.R., Seale, J.D., Vrana, W.A., Shetake, J.A. Sudanagunta, S.P., Borland, M.S., Kilgard, M.P. (2011). Reversing pathological neural activity using targeted plasticity. *Nature.* 470(7332):101-4. doi: 10.1038/nature09656
- Geven, L.I., De Kleine, E., Willemsen, A.T., and Van Dijk, P. (2014). Asymmetry in primary auditory cortex activity in tinnitus patients and controls. *Neuroscience* 256, 117-125. doi: S0306-4522(13)00859-2 [pii]10.1016/j.neuroscience.2013.10.015.
- Gordon, M. S., Hall, M. D., Gaston, J., Foots, A., & Suwangbutra, J. (2019). Individual differences in the acoustic properties of human skulls. *The Journal of the Acoustical Society of America*, 146(3), EL191–EL197. doi:10.1121/1.5124321

- Heald, S., Van Hedger, C., Nusbaum, H. (2017). Chapter Three – Understanding Sound: Auditory Skill Acquisition. *Psychology of Learning and Motivation*, 67, 53-93.
- Hesser, H., Weise, C., Westin, V.Z. and Andersson, G. (2011). A Systematic Review and Meta-Analysis of Randomized Controlled Trials of Cognitive–Behavioral Therapy for Tinnitus Distress. *Clinical Psychology Review* 31 (4): 545–553. doi:10.1016/j.cpr.2010.12.006.
- Jagoda, L., Giroud, N., Neff, P., Kegel, A., Kleinjung, T., Meyer, M. (2018). Speech perception in tinnitus is related to individual distress level - A neurophysiological study. *Hear Res.* 367:48-58. doi: 10.1016/j.heares.2018.07.001.
- Jastreboff, P.J. (2011). Tinnitus retraining therapy, in Textbook of Tinnitus, eds Møller A. R., Langguth B., DeRidder D., Kleinjung T., editors. (New York, NY: Springer-Verlag;), 575–596.
- Juan, Y.H, Hsu, C.T. and Hwang, J.H. (2019). Outcomes of Triple-Combination Therapy for Chronic Tinnitus. *In Vivo*, 33(5), 1707–1712. doi:10.21873/invivo.11660.
- Krick, C.M, Argstatter, H., Grapp, M., Plinkert, P.K., Reith, W. (2017) Heidelberg Neuro-Music Therapy Restores Attention-Related Activity in the Angular Gyrus in Chronic Tinnitus Patients. *Front Neurosci.* 11:418. doi: 10.3389/fnins.2017.00418.
- Kroos, C., Bones, O., Cao, Y., Harris, L., Jackson, P.J.B., Davies, W.J. et al. Generalisation in environmental sound classification: the ‘making sense of sounds’ data set and challenge. (2019). ICASSP 2019 – 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Brighton, UK, 12-17 May 2019, doi: 10.1109/icassp.2019.8683292.
- LeDoux JE (1992) Brain mechanisms of emotion and emotional learning. *Curr Opin Neurobiol* 2(2):191–197.
- Li, J., Jin, J., Xi, S., Zhu, Q., Chen, Y., Huang, M., He, C. (2019). Clinical efficacy of cognitive behavioral therapy for chronic subjective tinnitus. *Am J Otolaryngol.* 40(2):253-256. doi: 10.1016/j.amjoto.2018.10.017.
- Lieberman, P. (2019). The antiquity and evolution of the neural bases of rhythmic activity. *Ann N Y Acad Sci.* 1453(1):114-124. doi: 10.1111/nyas.14199.
- Lim, K.H, Nam, K.J, Rah, Y.C, Cha, J., Lee, S.J., Lee, M.G., Choi, J. (2019). The Effect of Natural Ocean Sound Exposure and Ocean-Side Relaxation on Chronic Tinnitus Patients: A Pilot Study in Korea. *Ear Nose Throat J.* 29:145561319873907. doi: 10.1177/0145561319873907.
- Liu, YW., Cheng, X., Chen, B., Peng, K., Ishiyama, A., Fu, Q.J. (2018). Effect of Tinnitus and Duration of Deafness on Sound Localization and Speech Recognition in Noise in Patients With Single-Sided Deafness. *Trends Hear.* 22:2331216518813802. doi: 10.1177/2331216518813802.
- Llinás, R.R., Ribary, U., Jeanmonod, D., Kronberg, E., Mitra, P.P. (1999) Thalamocortical dysrhythmia: A neurological and neuropsychiatric syndrome characterized by magnetoencephalography. *Proc Natl Acad Sci U S A.* 21;96(26):15222-15227.
- Low, Y.F, Trenado, C., Delb, W., Corona-Strauss, F.I., Strauss, D.J. (2007). The role of attention in the tinnitus decompensation: reinforcement of a large-scale neural decompensation measure. *Conf Proc IEEE Eng Med Biol Soc.* 2007. 2007:2485-8.
- Maquet, P., Péters, J., Aerts, J., Delfiore, G., Degueldre, C., Luxen, A., Franck, G. (1996) Functional neuroanatomy of human rapid-eye-movement sleep and dreaming. *Nature.* 383(6596):163-166.
- Mertens A, Raedt R, Gadeyne S, Carrette E, Boon P, Vonck K. Recent advances in devices for vagus nerve stimulation. *Expert Rev Med Devices.* 2018 Aug;15(8):527-539. doi: 10.1080/17434440.2018.1507732.
- Munro, B.A, Searchfield, G.D. (2019). The short-term effects of recorded ocean sound with and without alpha frequency binaural beats on tinnitus perception. *Complement Ther Med.* 44:291-295. doi: 10.1016/j.ctim.2019.05.005.
- Musiek, F.E and Baran, J.A. (2018). The Auditory System: Anatomy, Physiology and Clinical Correlates. Second edition. (San Diego: Plural Publishing Inc).
- Neff, P., Hemsley, C., Kraxner, F., Weidt, S., Kleinjung, T., Meyer, M. (2019). Active listening to tinnitus and its relation to resting state EEG activity. *Neurosci Lett.* 16;694:176-183. doi: 10.1016/j.neulet.2018.11.008.
- Omidvar, S., Mahmoudian, S., Khabazkhoob, M., Ahadi, M., Jafari, Z. (2018). Tinnitus Impacts on Speech and Non-speech Stimuli. *Otol Neurotol.* 39(10). doi: 10.1097/MAO.0000000000002002.
- Pang, P., Shi, Y., Xu, H., Deng, L., Wu, S., Chen, X. (2019). Acupuncture methods put to the test for a tinnitus study: A Bayesian analysis. *Complement Ther Med.* 42:205-213. doi: 10.1016/j.ctim.2018.11.017.
- Parmeggiani, P.L. and Rabini, C. (1967) Phases of sleep and environmental temperature. *Helv Physiol Pharmacol Acta.* 25(2): CR214-CR216.
- Pedemonte, M., Testa, M., Díaz, M., Suárez-Bagnasco, D. (2014). The Impact of Sound on Electroencephalographic Waves during Sleep in Patients Suffering from Tinnitus. *Sleep Sci.* 7(3):143-51. doi: 10.1016/j.slsci.2014.09.011.

- Peigneux, P., Laureys, S., Fuchs, S., Delbeuck, X., Degueldre, C., Aerts, J., Delfiore, G., Luxen, A., Maquet, P. (2001). Generation of rapid eye movements during paradoxical sleep in humans. *Neuroimage*. 14(3):701-8.
- Peter, N. and Kleinjung, T. (2019). Neuromodulation for tinnitus treatment: an overview of invasive and non-invasive techniques. *J Zhejiang Univ Sci B*. 20(2):116-130. doi: 10.1631/jzus.B1700117.
- Ravivose, U., Thanikaarasu, P., Prabhu, P. (2019). Evaluation of Differential Sensitivity for Frequency, Intensity, and Duration around the Tinnitus Frequency in Adults with Tonal Tinnitus. *J Int Adv Otol*. 15(2):253-256. doi: 10.5152/iao.2019.6698.
- Rechtschaffen, A. and Kales, A. (1968) A manual of standardized terminology, techniques and scoring system for sleep stages of human subjects. Brain Information Service, Brain Research Institute, UCLA, LA, CA, 1968.
- Sheppard, A., Stocking, C., Ralli, M., Salvi, R. (2019). A review of auditory gain, low-level noise and sound therapy for tinnitus and hyperacusis. *Int J Audiol*. 9, 1-11. doi: 10.1080/14992027.2019.1660812.
- Smith, S.W. (1997). The scientist and engineer's guide to digital signal processing. (San Diego: California Technical Publishing), 351-372.
- Tass, P.A., Silchenko, A.N., Popelka, G.R. (2019). Acoustic coordinated reset therapy for tinnitus with perceptually relevant frequency spacing and levels. *Sci Rep*. 9(1):13607. doi: 10.1038/s41598-019-49945-w.
- Theodoroff, S.M., McMillan, G.M., Zaugg, T.L., Cheslock, M., Roberts, C., and Henry, J.A. (2017). Randomized Controlled Trial of a Novel Device for Tinnitus Sound Therapy during Sleep. *American Journal of Audiology* 26 (4), 543–554. doi:10.1044/2017_AJA-17-0022.
- Tian, R.R., Diao, M.F., Tian, F.J., Sun, J.J., Lin, X. (2017). Preliminary analysis of the effects of tailor-made notched music therapy on chronic idiopathic tinnitus. *Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi*. 52(5):343-348. doi: 10.3760/cma.j.issn.1673-0860.2017.05.005.
- Tyler R, Cacace A, Stocking C, Tarver B, Engineer N, Martin J (2017). Vagus Nerve Stimulation Paired with Tones for the Treatment of Tinnitus: A Prospective Randomized Double-blind Controlled Pilot Study in Humans. *Sci Rep*. Sep 20;7(1):11960. doi: 10.1038/s41598-017-12178-w.
- Tyler, R., Perreau, A., Mohr, A.M., Ji, H., Mancini, P.C. (2019). An Exploratory Step Toward Measuring the 'Meaning of Life' in Patients with Tinnitus and in Cochlear Implant Users. *J Am Acad Audiol*. doi: 10.3766/jaaa.19022.
- Tyler, R.S., Perreau, A., Powers, T., Watts, A., Owen, R., Ji, H., Mancini, P.C. (2019). Tinnitus Sound Therapy Trial Shows Effectiveness for Those with Tinnitus. *J Am Acad Audiol*. doi: 10.3766/jaaa.18027.
- Ylikoski, J., Lehtimäki, J., Pirvola, U., Mäkitie, A., Aarnisalo, A., Hyvärinen, P., Ylikoski, M. (2017). Non-invasive vagus nerve stimulation reduces sympathetic preponderance in patients with tinnitus. *Acta Otolaryngol*. 137(4):426-431. doi: 10.1080/00016489.2016.1269197.
- Zhao, Y., Zhao, F., El Refaie, A., Wang, B., Chen, D., Chen, K., Lan, T. (2019). The Long-term Effectiveness of Tinnitus Multivariate Integrated Sound Therapy (T-MIST) in 148 Tinnitus Patients with Normal Hearing Thresholds: Our Initial Experience. *Clin Otolaryngol*. doi: 10.1111/coa.13426.
- Zoccoli, G., Bojić, T. and Franzini, C. (2005). Regulation of cerebral circulation during sleep. In P.L. Parmeggiani and R. Velluti (Eds.). *The Physiological Nature of Sleep*. Imperial College Press, 351-369.

Development of Linguistic and Cognitive Skills in Children with Scholastic Skills Disorders

Vladica Žikić^{1,2}, Marijana Panić^{1,2}, Slavica Golubović³

¹Institute for research and development „Life Activities Advancement Centre“,
Belgrade, Serbia

²Institute for Experimental Phonetics and Speech Pathology, Belgrade, Serbia

³University of Belgrade, Faculty of special education and rehabilitation
vladica@gmail.com

ABSTRACT

Scholastic skills disorders are disorders in which a child cannot reach level of writing, reading and numeracy predicted for their age. This discrepancy is not associated with brain injury, intellectual deficits, visual or hearing impairment. The aim of this research was evaluation and descriptive analysis of language skills and cognitive abilities of children with scholastic skills disorders, as well as to establish correlations between speech and language abilities with other developmental abilities (graphomotor, auditory and visual abilities). The sample included 30 children with scholastic skills disorders, ages 7 years and 4 months to 11 years and 10 months, 19 boys and 11 girls. The Acadia test was used for research purposes. Tests of visual memory, auditory memory, sequence and encryption, ability in forming concepts, acquired language treasure, automatic language treasure, drawing were used to test linguistic and cognitive abilities. The results of the study show that children with scholastic skills disorders perform poorly on subtests that directly show the level of development of these children's language and cognitive abilities. The importance of this research is reflected in the acquisition of new knowledge that would allow early detection, diagnosis and treatment of children with scholastic skills disorders (reading, writing, calculating).

Keywords: scholastic skills disorders, language skills, cognitive abilities, reading

1 INTRODUCTION

Classification DSM-IV classifies scholastic skills disorders as disorders diagnosed at a young age, during childhood or adolescence, that are divided into reading disorders, math disorders, writing disorders, and unspecified learning disorders. These disorders are not a direct consequence of other disorders such as intellectual disability, major neurological deficits, uncorrected visual and hearing impairment, or emotional disorders, although they may exist at the same time as scholastic skills disorders (ICD 10)

Scholastic skills disorders are disorders of one or more basic psychological processes involved in understanding or using spoken or written language. Scholastic skills disorders is a common term referring to a diverse group of neurobehavioral disorders that manifests in unexpected, specific, and persistent reading disabilities (dyslexia), writing disabilities (dysgraphia) or difficulties of mathematical operations (dyscalculia), even if a child had good school teaching, had no problem with sense of sight and hearing, doesn't have cognitive difficulties, and have proper motivation and adequate sociocultural opportunities (Karande, Mehta, Kulkarni, 2007)

Children with specific reading disorder have significant impairment in the development of reading skills. The reading performance will be significantly below the level expected on the basis of age, general intelligence and school placement. They experience significant impairment in the acquisition of reading accuracy, reading fluency and reading comprehension which cannot be accounted for by low IQ, visual acuity problems, neurological damage or poor educational opportunities (Johnson, 2015)

There is specific and significant impairment in the development of spelling skills. The spelling skills of the child will be significantly below the expected level related to age, general intelligence and school placement. Ability to spell orally and to write the words correctly, will be impaired. This will also be associated with grammatical errors, punctuation errors, poor paragraph organization and poor handwriting (Johnson, 2015).

Scholastic skills disorders are generally noticed in the first grade of primary school when the child is unable to master the school material. However, despite this, children are usually diagnosed after they turn eight years.

According to the ICD-10 classification, as many as 40% of these children do not continue their education. The etiology of scholastic skills disorders has not yet been sufficiently examined. Possible etiological factors include: maturation problems, abnormalities of cerebral lateralization, genetic factors, minimal cerebral dysfunction, neurological issues (Golubović, 2011). Also, these symptoms can also represent a child's inability to master school material and are related to some other primary disorder. It is also important to take into account the individuality of each child when making the final diagnosis. The disorders can vary by type of symptoms, their frequency, intensity and severity. Also, each of these variables will affect each child differently depending on his or her individual personality characteristics (Golubović, 2006).

More recently, a number of authors have suggested that the fundamental deficit in scholastic skills disorders is a limitation in the brain's capacity to rapidly process information of verbal working memory. Contemporary neuropsychological thinking defines working memory as the capacity to keep information on line, as necessary, for an ongoing task. According to this view, working memory is not for 'memorizing' in itself, but is used for complex cognitive activities such as language, reasoning, problem solving and decision-making (Papageorgiou, C., et al., 2005).

Relationship between early language disorder at the pre-school level and later problems in reading and writing in elementary school is often discussed. Early language impairment is related to learning difficulties especially in reading and writing. In the study of Weindrich et al. (2000) from 21 children with early language delay seven, i.e. one third, had reading/writing problems at the age of 8 years. In contrast, such problems were found in only 8% of the 299 children without an early language delay. This difference is statistically highly significant. Research showed that children whose non-verbal intelligence score did not deviate enough from their scholastic performance have problems with reading and spelling (Weindrich, D. et al, 2000).

Cognitive development is a necessary but not sufficient condition for language development (Golubović, 1998, 2006). Cognitive and linguistic processes differ, and meeting cognitive prerequisites is not the most important factor for linguistic development. There is a reciprocal interaction between them, so language can affect cognition just as cognition affects language, but the development of one does not directly affect the development of the other (Golubović, 1998, 2006).

2 METHODOLOGY

The aim of the research was to determine the level of speech and language development in children with scholastic skills disorders, as well as the correlation of this ability with other developmental abilities (graphomotor, auditory and visual).

The sample consisted of 30 children scholastic skills disorders aged 7 years and 4 months to 11 years and 10 months (19 boys and 11 girls). The diagnosis of this disorder was made using adequate tests from the Test Battery of the Institute for Experimental Phonetics and Speech Pathology "Djordje Kostić" (IEFPG), which assessed reading, writing and computing skills. The research was conducted at IEFPG "Djordje Kostić" in Belgrade. The Acadia Development Test was used as a relevant measuring instrument. The language skills tests: ability in forming concepts, automated language treasure and acquired language treasure (Atkinson, Johnston, & Lindsay, 1972), translated and adapted in 1985 (Novosel, Cavor, 1985), were used to assess language skills. The test was further adapted to the specificities of the Serbian language,

and the results were normalized based on the achievement of young children of our population (Gligorović et al., 2005). It can be applied individually or in groups. It is not of the speed type, so it gives the opportunity to adjust the rhythm of each child. Acquired language treasure and ability in forming concepts tests were used to assess semantic and lexical ability.

Subtest X of ACADIA test – Acquired Language Treasure. It consists of 20 tasks divided into three sets. In the first set of tasks a child is expected to recognize a picture or a written word orally presented by the examiner. In the second set of tasks a child is required to make a choice from a number of written words as instructed by the examiner. In the third set of tasks the participants confirms or denies the veracity of certain statements. One point is awarded for each correct answer.

Subtest IX of ACADIA test – Concept Formation. It consists of four sets of tasks the completion of which requires identifying, comparing, and naming characteristics, knowing concept relations, classifying and organizing lexemes into subordinate and superior classes. Drawings and verbal instructions are combined in the Subtest. It consists of 20 tasks. One point is awarded for each correct answer.

Morphology and syntax were assessed by Subtest XI of ACADIA test – Automatic Language Treasure. It consists of 20 tasks in which the participants has to choose a word or a set of words to complete the sentence uttered by the examiner. One point is awarded for each correct answer.

Visual discrimination was assessed by Subtest III of ACADIA test – Visual Discrimination. It consists of 20 tasks in which a child is expected to choose one out of four options based on a given model. First part consists of drawings, while the second and the third part consist of words arranged from simple to more complex ones. One point is awarded for each correct answer.

Strategy formation was assessed by Subtest VII of ACADIA test – Sequence and Coding. It consists of 20 tasks. In the first part a child is expected to choose a geometric shape, a number or a word that continues the given sequence, and in the second part to discover and apply the principle of forming words by decoding numbers into letters. One point is awarded for each correct answer.

Most of these subtests can be considered as requiring either problem solving or knowledge or cognitive ability.

Statistical data processing was done in the SAS statistical package. The following parameters were used: range, measures of central tendency, measures of variability, parametric and non-parametric analysis of variance, F-test and Pearson's correlation coefficient.

3 RESULTS AND DISCUSSION

The results of the research were qualitatively and quantitatively processed, presented in tables. Table no. 1 shows the speech and language development of young children with scholastic skills disorders.

Table 1. Ranks of achievement on the subtests ability in forming concepts, Acquired language Treasure, and Automatic language Treasure in Children with scholastic skills disorders

No.	Concept creation skills		Acquired language Treasure		Automatic language Treasure	
	No.	%	No.	%	No.	%
1	8	26.6	5	16.7	6	45.5
2	6	20.1	3	10.0	9	4.5
3	16	53.3	22	73.3	15	50.0

Qualitative analysis of the results revealed that in children with scholastic skills disorders, 53.3% of the results were age-appropriate. On the Concept creation skill subtest, 73.3% on the acquired language

treasure subtest and 50.0% on the automatic languages treasure subtest. In the subtest ability in formatting concepts, 26.6% of scores had one SD below age, and 20.1% of scores had two or more SDs below age. In the acquired language treasure subtest, 16.7% of scores had one SD below the norms, while 10.0% had two or more SDs of the defined standards. In the automatic language treasure subtest, 45.5% of scores had one SD below the norms, while 4.5% had two or more SDs of the defined standards.

In order to accurately solve the tasks at subtest ability in forming concepts, it is necessary to identify, compare and name the characteristic, to know the relations between the concepts, to be able to classify and place specific lexeme in the subordinate class and superior class, ie the ability of inclusion (Gligorović, 2005).

Children with scholastic skills disorders show difficulties at subtest acquired language treasure and ability in forming concepts subtest, which indicates the underdeveloped lexical and semantic abilities of these children, which was also found in the research of Purvis et. Al (1997). It was shown that children with scholastic skills disorders demonstrate deficits in receptive and expressive semantic language abilities on the language processing tests (Purvis and Tannock, 1997).

Table 2 Results of language development assessment in children with scholastic skills disorders

Variables	N	Mean	Std Dev	Sum	Min	Max	F-test according to gender
Ability in forming concepts	30	46.93	10.86	1408	25.0	64	0.43; $p > 0.05$
Acquired language treasure	30	52.06	10.84	1562	20.0	64	0.02; $p < 0.05$
Automatic language treasure	30	45.33	9.84	1360	20.0	60	0.74; $p > 0.05$

Based on the F test, it was found that there were statistically significant differences between the boys and girls with scholastic skills disorders at subtests acquired language treasure ($p < 0.05$) in girls favour. No statistically significant differences ($p > 0.05$) were found at subtests ability in forming concepts and automatic language treasure between boys and girls.

In the research of Čolić (2013) i.e. a statistically significant correlation was found between achievement category and children gender category at semantic test. The relationship between gender and scores on the semantic test (in favor of girls) is at a significance level of $p = 0.000$. Study didn't show significant gender correlations at subtests ability in forming concepts and acquired language treasure (Čolić, 2013).

Tab 3. shows the correlations between subtests Ability in forming concepts (T9), acquired language treasure (T10) and automatic language treasure (T11) subtests with other ACADIA developmental subtests: auditory discrimination (T1), visual motor coordination and traceability (T2), visual discrimination (T3), shapes drawing (T4), visual memory (T5), audio-visual discrimination (T6), sequence and encryption (T7), auditory memory (T8), visual association (T12) drawing (T13). The values from 0.00 to 0.20 show a slight correlation, that is, there is no correlation at all. Values from 0.20 to 0.40 indicate low correlation or low correlation; from 0.40 to 0.70 is a moderate correlation, that is, a significant correlation; from 0.70 to 0.90 is a high correlation, that is, a strong correlation; and from 0.90 to 1.00 is a very high connectivity.

Table 3 Correlation between ability in forming concepts, acquired language treasure and automatic language treasure with other Acadia subtests

Pearson's correlation coefficient							
	T1	T2		T3	T4	T5	T6
9	0.52	0.11		0.80	0.50	0.49	0.63
10	0.60	0.02		0.80	0.50	0.61	0.67
11	0.25	0.13		0.73	0.52	0.31	0.48
Pearson's correlation coefficient							
	T7	T8	T9	T10	T11	T12	T13
T9	0.84	0.56	1.0	0.77	0.85	0.45	0.07
T10	0.80	0.54	0.77	1.0	0.60	0.61	0.11
T11	0.78	0.58	0.85	0.60	1.0	0.41	1.0

The research results showed that the subtest ability of forming concepts did not correlate with the subtest: Visual motor coordination and traceability (T2) and drawing (T13). There were no low correlations. A moderate correlation exists with the subtests: auditory discrimination (T1), shapes drawing (T4), visual memory (T5), auditory visual association (T6), auditory memory (T8), and visual association (T12). A high correlation exists with the subtests: visual discrimination (T3), sequence and encryption (T7), and automatic language treasure (T11). There were no very high correlations.

The results of the study showed that the subtest acquired language treasure was not correlated with the subtest visual-motor coordination and traceability (T2). There were no low correlations. A moderate correlation exists with the subtests: auditory discrimination (T1), shapes drawing (T4), visual memory (T5), auditory visual association (T6), auditory memory (T8), automatic language treasure (T11), and visual association (T12)). A high correlation exists with the subtests: visual discrimination (T3), sequence and encryption (T7), ability in forming concepts (T9). There were no very high correlations.

The results of the study showed that the subtest automatic language treasure was not correlated with the subtest visual motor coordination and traceability (T2). A low correlation exists with the subtests: auditory discrimination (T1), visual memory (T5). A moderate correlation exists with the subtests: shapes drawing (T4), auditory-visual association (T6), auditory memory (T8), acquired language treasure (T10), and visual association (T12). High correlation exists with the subtests: visual discrimination (T3), sequence and encryption (T7), ability in forming concepts (T9). There were no very high correlations.

Research conducted by Gligorović et.al. (2011) found that results at visual association subtest significantly correlate with subtests that evaluate lexical abilities and nonverbal reasoning. Difficulties in visual discrimination hinder mental representation of objects, which can influence a child's ability to consistently recognize objects, letters, numbers, symbols, words, or pictures. These difficulties are manifested in positioning elements in space, and determining that position with regard to other elements, which influences reading, writing, and mathematical skills. They also found that Homogenous mean of the results on subtests Sequence and Coding, Acquired Language Treasure and Automatic Language Treasure occurs in groups of participants with different achievements in visual discrimination. Thus, this area may be considered a clear discrimination parameter in strategy formation, lexis, and syntax (Gligorović et al. 2011). In the work of Buha, N. and Gligorović, N. (2015) it was shown that poor achievement on the Acadia test as a whole may be a valid indicator of a lower level of intellectual functioning. Subtests sequence and encryption, drawing shapes, ability in forming concepts and automatic language treasure have shown the highest correlations with achievement on cognitive tests, and can serve as screening for general cognitive potential in this regard (Buha and Gligorović, 2015).

4 CONCLUSTION

Obradović (2011) showed that educators are familiar with the conceptual definitions of scholastic skills disorders. When it comes to early detection and identification of developmental problems, as well as prevention and early intervention, educators are not sufficiently educated for adequate work (33% of educators think they are). Educators' observation of clinical indicators of scholastic skills disorders indicates that the nature of this developmental difficulties is not familiar to them. Mostly, these developmental difficulties are recognized solely as a language problem, although their nature is much broader as it implies altered cognitive functioning. Only small number of the educators was able to recognize and relate other indicators to scholastic skills disorders (such as insufficient motor behavior and poor working memory) although these indicators are very readily visible at these ages (Obradović, 2011).

In recent years, an increase in speech and language disorders and therefore the number of "risk children" for the development of scholastic skills disorders is increasing. Early symptoms of dyslexia and dysgraphia and dyscalculia are identified by the child start of speak, so that there remains sufficient time to implement the next rehabilitation and stimulating treatment. If the symptoms of dyslexia, dysgraphia and dyscalculia are detected at an early stage, treatment will be successfully completed by the start of school. Speech therapy work with children who have disorders in reading, writing and arithmetic is carried out according to individual plans and work programs for each child. The cooperation of teachers, psychologists and speech therapists, and other associates is necessary in order to reach the best possible work program.

REFERENCES

- Atkinson, J.S., Johnston, E.E., Lindsay, A. (1972). Acadia test of developmental abilities.
- Buha, N., Gligorović, N.(2015). Odnos postignuća na akadija testu razvojnih sposobnosti i inteligencije kod dece mlađeg školskog uzrasta. Specijalna edukacija i rehabilitacija (Beograd), Vol. 14, br. 3. 265-284
- Čolić, G. (2013). Dinamika razvoja leksikona kod dece mlađeg školskog uzrasta. Specijalna edukacija i rehabilitacija, 12(4), 441-453
- Dickinson, D. K., & Porche, M. V. (2011). Relation Between Language Experiences in Preschool Classrooms and Children's Kindergarten and Fourth-Grade Language and Reading Abilities. *Child Development*, 82(3), 870–886. doi: 10.1111/j.1467-8624.2011.01576.x
- Gligorović, M., Glumbić, N., Maćešić-Petrović, D. i dr. (2005). Specifične smetnje u učenju kod dece mlađeg školskog uzrasta. U S. Golubović i grupa autora (Ur.), *Smetnje u razvoju kod dece mlađeg školskog uzrasta* (str. 415-523). Beograd: Univerzitet u Beogradu – Defektološki fakultet.
- Gligorović, M., Radić Šestić, M., Nikolić, S. & Ilić Stošević, D. (2011), Perceptual–motor abilities and prerequisites of academic skills, *Specijalna edukacija i rehabilitacija*, 10 (3), 405–434.
- Golubović S. (2011). Disleksija disgrafija dispraksija. Fakultet za specijalnu edukaciju i rehabilitaciju, Univerzitet u Beogradu, Merkur, Beograd.
- Golubović, S. (1998). *Clinical logopedy II*. University of Belgrade, Belgrade (In Serbian)
- Golubović, S. (2006). Diferencijalno- dijagnostičke karakteristike dece sa verbalnim i neverbalnim smetnjama u učenju. Međunarodni znanstveni i stručni skup, *Rehabilitacija stanje i perspektive dece sa teškoćama u racvoju i osoba sa invaliditetom*. Rijeka, 12-13. Listopad,Knjiga sažetaka, str33. Zbornik radova, str. 134-160
- Johnson, B. (2015). Specific Developmental Disorders of Scholastic Skills. *BMH Medical Journal* - ISSN 2348–392X, 2(3), 74-78.
- Karande, S., Mehta, V., & Kulkarni, M. (2007). Impact of an education program on parental knowledge of specific learning disability. *Indian Journal of Medical Sciences*, 61(7), 398. doi: 10.4103/0019-5359.33189
- Novosel, M. I., Marvin Cavor, Lj. (1985). Acadia test razvoja sposobnosti. *Primijenjena psihologija*, 1-2, 103-108.
- Obradović, S., Zlatić, L., & Vučetić, M. [2011]. Specifične smetnje u učenju (disleksija, disgrafija i diskalkulija) na predškolskom uzrastu. *Zbornik radova Učiteljskog fakulteta, Užice*, (13), 299-312.
- Papageorgiou, C., Anagnostopoulos, D., Giannakakis, G. A., Sakelariou, K., Tsiaparas, N., Paraskevopoulou, P., ... Soldatos, C. (2005). Preattentive deficits in developmental disorders of scholastic skills. *NeuroReport*, 16(16), 1829–1832. doi: 10.1097/01.wnr.0000185963.96217.7f

- Purvis, K. L., & Tannock, R. (1997). *Journal of Abnormal Child Psychology*, 25(2), 133–144. doi:10.1023/a:1025731529006
- Weindrich, D., Jennen-Steinmetz, C., Laucht, M., Esser, G., & Schmidt, M. H. (2000). Epidemiology and prognosis of specific disorders of language and scholastic skills. *European Child & Adolescent Psychiatry*, 9(3), 186–194. doi: 10.1007/s007870070042
- World Health Organization. (2004). ICD-10 : international statistical classification of diseases and related health problems : tenth revision, 2nd ed. World Health Organization. <https://apps.who.int/iris/handle/10665/42980>

Speech and Language Development in Children with Developmental Dysphasia

Jelena Nikolić¹, Marija Đorđević^{1, 2}, Aleksandra Veselinović^{1, 2}

¹Institute for Experimental phonetics and Speech pathology

²Life Activities Advancement Centre

lejla92jn@yahoo.com

ABSTRACT

Speech and language development is a complex process that begins right after the birth of a child. Language development depends on the different systems in the brain, causing problems in any of these systems can lead to atypical speech and language development.

The aim of this research was to examine the development of speech and language in children with developmental dysphasia and children of typical development. The sample consisted of 15 children with a developmental dysphasia diagnosed at the Institute for Experimental Phonetics and Speech Pathology and 10 children of typical development. All examined children were aged 4 to 6 years. For this research were used Language Development Examining Test and part of the Semantic Test (Antonyms).

The results of the Semantic test show that there is a statistically significant difference between children with developmental dysphasia and children of typical development in the use of antonyms. Comparing all the results obtained with the Language Development Examining Test, we notice a statistically significant difference between children with developmental dysphasia and children of typical development due to the definition of known concepts (man, mother, life, house and sun). Generally speaking, children with developmental dysphasia were the most commonly used functional definitions, an echolalic response or an incorrect response, while the children of typical development most often used descriptive definitions and logical definitions of the first and second levels.

Key words: speech and language development, antonyms, developmental dysphasia.

1 INTRODUCTION

Speech and language development is a complex process that begins right after the birth of a child. Language development depends on the different systems in the brain, causing problems in any of these systems can lead to atypical speech and language development (Jovanović-Simić, Slavnić, 2009).

Developmental dysphasia, as one of the common disorders in childhood in the group of Specific developmental disorders (SRP), is a slowness or deficiency in the maturation of speech and language abilities, that is, a deviation from the expected developmental flow (Krstić, 2002). Language impediments are manifested in the form of deficits in the development of expressive (language production) and receptive speech (language comprehension). Expressive speech development disorder refers to all levels of phonological, lexical, and syntactic deficits, while receptive speech disorders are typical of children with central auditory processing deficits (Golubović, 2012a; Golubović, 2012b). Developmental dysphasia occurs in children of average or even above-average intellectual capacity, and excludes hearing impairment, autism and other disorders.

The incidence of developmental language disorders is estimated at about 5-7% of which 2-3% are severe developmental dysphasia (Rapin et al., 1992; Golubović, 2012). More recent studies show that the prevalence of developmental language disorders ranges from 4% to 7% (Leonard, 2000). It is more common in boys and children who have a family history of language disorders (Golubović, 2012).

The cause of this disorder is unknown, however recent research has focused on elucidating the neuropsychological, physiological, and possible genetic dysfunction underlying this developmental language deficit. The diagnosis is made based on gross behavioral findings, and exclusion of other disorders (Tallal et al., 1991). Possible causes of developmental dysphasia may include brain development anomalies, lateralisation of the hemisphere, genetic causes, neurological deficits, cognitive deficits, auditory perception and phonological awareness deficits, motor disorders, psychogenic and emotional causes, as well as environmental influences (Golubović, 2012).

While a large body of research has been dedicated to uncovering the etiology of developmental dysphasia, much of the literature has focused on the grammatical development of impaired individuals and studies have reported persistent difficulties with morphology and syntax (Choudhury et al., 2007). Theories proposed to account for developmental dysphasia range from arguments for specific deficits in learning grammatical rules (grammarspecific model) (Gopnik & Crago, 1991) to limitations in processing capacity or working memory (Gathercole & Baddeley, 1990; Joanisse & Seidenberg, 1998; Schul et al., 2004).

The authors emphasize timeliness as the basic principle of rehabilitation of developmental dysphasia. The earlier a problem is detected and treatment initiated, the more likely it is for more favorable effects (Krstic, 2002).

2 MATERIALS AND METHODS

The aim of this study was to examine the development of speech and language in children with developmental dysphasia and children of typical development. The sample consisted of 15 children with a developmental dysphasia diagnosed at the Institute for Experimental Phonetics and Speech Pathology and 10 children of typical development. All examined children were aged 4 to 6 years.

For this research were used Language Development Examining Test and part of the Semantic Test (Antonyms).

3 RESULTS AND DISCUSSION

Results of Antonym Use Assessment

Factorial design with independent groups was used in the statistical processing of the data obtained when assessing the use of antonym. Central tendency measures and measures of variability (minimum value, maximum value, arithmetic mean - AS and standard deviation - SD) were used to present the basic statistical indicators. For the purpose of further statistical analysis, a t-test of independent samples was used.

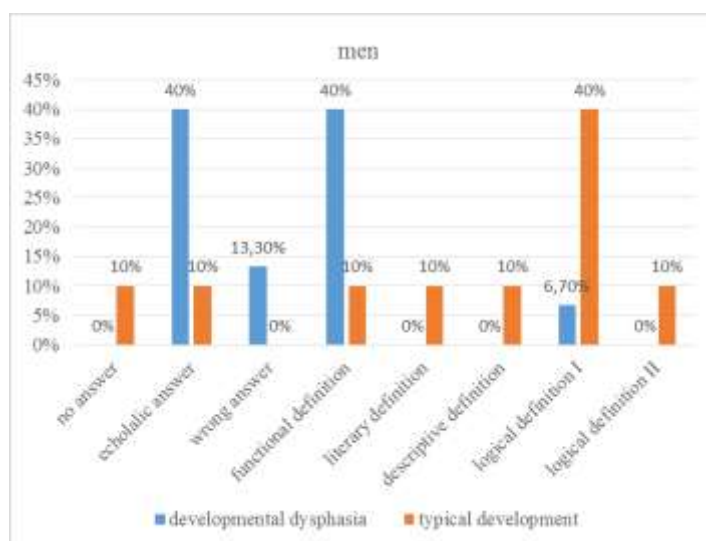
Table 1: Results of Antonym Use Assessment

Antonyms	Minimal value	Maximal value	Average value	Standard deviation
Developmental dysphasia	1	6,5	4,43	1,56
Control group	6	8,5	7,35	0,97

T-test of independent samples revealed that there was a statistically significant difference ($p < 0.05$) between children with developmental dysphasia and children of typical development in the use of antonyms (Table 1). The average score on the Antonym subtest of the Semantic Test for children with developmental dysphasia is 4.43 / 10 points, while for children in the control group the average score was 7.35 / 10, which is in favor of a better understanding of the antonyms and more extensive vocabulary of children of typical development.

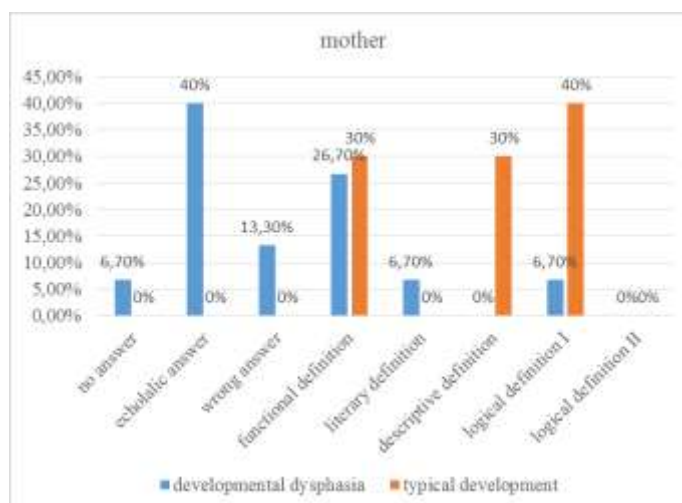
Results of assessment of speech development

A cross-sectional z-test was used to compare the type of response in the speech development test between the experimental and control groups.



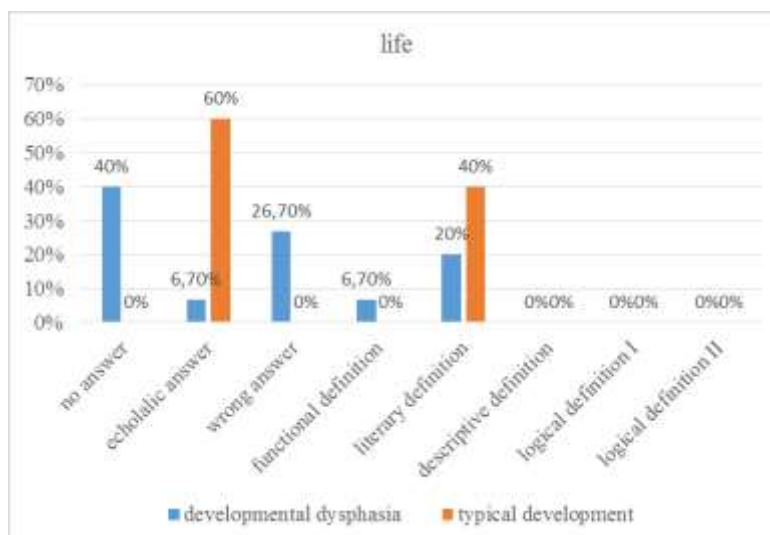
Graph 1: Results of the evaluation of the definition of the word “man”

Children with developmental dysphasia used echolalia or functional definition to define the term "human", while children of typical development most often used the logical definition I. There was a statistically significant difference ($p < 0.05$) in the use of logical definitions I between the two groups of children (Graph 1).



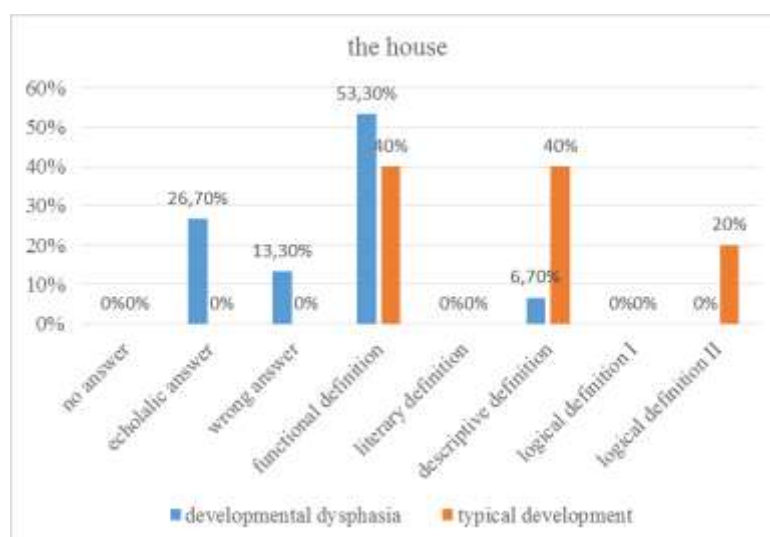
Graph 2: Results of the evaluation of the definition of the word “mother”

A statistically significant difference ($p < 0.05$) was confirmed when using the echolalic response, descriptive definitions, and logical definitions I between the two groups of children when defining the term "mother", during which children with developmental dysphasia most commonly using the echolalic response and the typical development children use descriptive definitions or logical definitions I in response (Graph 2).



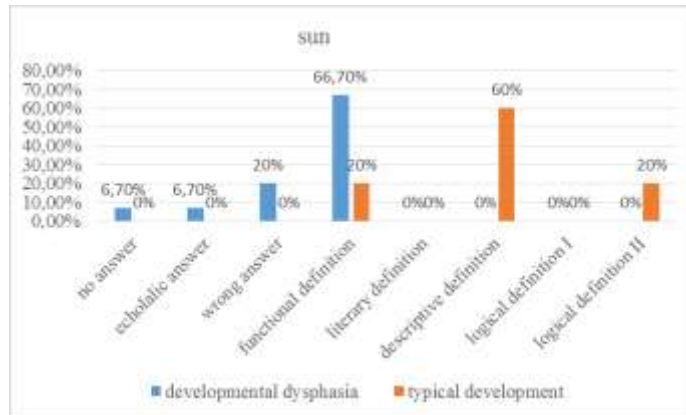
Graph 3: Results of the evaluation of the definition of the word "life"

During the definition of the term "life" is observed a statistically significant difference ($p < 0.05$) in the use of echolalic response and the lack of response (Graph 3).



Graph 4: Results of the evaluation of the definition of the word "the house"

Typical development children most commonly used descriptive definitions to define the term "the house", whereas functional definitions were most commonly used by children with developmental dysphasia. A statistically significant difference ($p < 0.05$) was observed when using descriptive definitions between the two groups of children (Graph 4).



Graph 5: Results of the evaluation of the definition of the word "sun"

Also, when defining the term "sun", a statistically significant difference ($p < 0.05$) was observed in the use of functional and descriptive definitions, where children with developmental dysphasia most frequently used functional definitions and children of typical development descriptive definitions (Graph 5).

4 CONCLUSION

Based on the results of the research, we concluded that children of typical development have a better understanding and correct use of antonyms than their peers with developmental dysphasia.

Comparing all the results obtained with speech development test, we find a statistically significant difference ($p < 0.05$) between children with developmental dysphasia and children of typical development when giving wrong answers, using functional definitions, descriptive definitions, logical definitions I and logical definitions II. Generally, children with developmental dysphasia most commonly use functional definitions, echolal response, or incorrect response when defining terms, while children of typical development most commonly use descriptive definitions and logical definitions.

REFERENCES

- Choudhury, N., Leppanen, P., Leevers, H., Benasich, A. (2007). Infant information processing and family history of specific language impairment: converging evidence for RAP deficits from two paradigms. *Dev Sci*, 10(2), 213–236.
- Gathercole, S.E., Baddeley, A.D. (1990). Phonological memory deficits in language disordered children: is there a causal connection? *Journal of Memory and Language*, 29, 336–360.
- Golubović, S. (2012a). *Razvojni jezički poremećaji*. Beograd: Društvo defektologa Srbije.
- Golubović, S. (2012b). *Poremećaji fluentnosti govora*. Beograd: Društvo defektologa Srbije.
- Gopnik, M., Crago, M. (1991). Familial aggregation of a developmental language disorder. *Cognition*, 39, 1–50.
- Joanisse, M.F., Seidenberg, M.S. (1998). Specific language impairment in children: an impairment in grammar or processing? *Trends in Cognitive Sciences*, 2 (7), 240–246.
- Jovanović-Simić, N., Slavnić, S. (2009). *Atipičan jezički razvoj*. Beograd: Društvo defektologa Srbije.
- Krštić, N. (2002). Specifični razvojni poremećaji: Otkrivanje i intervencije. *Psihijat.dan.*, 34(3–4), 215–236.
- Leonard, L.B. (2002). *Children with specific language impairment*. Bradford Book. London. England.
- Rapin, I., Allen, D., Dunn, M. (1992). Developmental language disorders. In: Segalowitz, S.J., Rapin, I. (eds.): *Handbook of Neuropsychology*, vol. 7. Amsterdam: Elsevier, p.111–137.
- Schul, R., Stiles, J., Wulfeck, B., Townsend, J. (2004). How ‘generalized’ is the ‘slowed processing’ in SLI? The case of visuospatial attentional orienting. *Neuropsychologia*, 42, 661–671.
- Tallal, P., Sainburg, P.L., Jernigan, T. (1991). The neuropathology of developmental dysphasia: Behavioral, morphological and physiological evidence for a pervasive temporal processing disorder. *Reading and Writing: An Interdisciplinary Journal*, 3, 363–377.

Examining The Effects Of Speech And Language Treatment On The Reduction Of Symptoms Which May Be Indicators Of The Presence Of Autistic Spectrum Disorder

Slavica Maksimović^{1,2}, Maša Marisavljević^{1,2}, Tatjana Adamović^{1,2}

¹Life Activities Advancement Centre
Gospodar Jovanova 35, Belgrade, Serbia

²The Institute for Experimental Phonetics and Speech Pathology "Đorđe Kostić"
Gospodar Jovanova 35, Belgrade, Serbia
masa.marisavljevic@gmail.com

ABSTRACT

Autism spectrum disorder (ASD) refers to a broad range of conditions characterized by challenges with social skills, repetitive behaviors, speech and nonverbal communication. Children with ASD require continual and comprehensive treatment. This paper's aim was to examine the effects of speech and language treatment on the reduction of symptoms that may be indicators of the presence of ASD. Sample was consisted of children who were included in the intensive speech and language therapy within the Institute for Experimental Phonetics and Speech Pathology, in Belgrade, Serbia. GARS-3 was used to determine the presence of ASD symptoms. Each child was tested twice, at several months intervals. After each test, Autism Index score was obtained, which indicated on the severity of ASD symptoms. The study results indicate on the statistically significant differences between the Autism Indices during the first and the repeated testing. Such data suggest that intense speech and language treatment can affect the reduction of ASD symptoms.

Key words: reduction of ASD symptoms, autism spectrum disorder, speech and language therapy, GARS-3

1 INTRODUCTION

Autism spectrum disorder (in further text-ASD) is the topic which has never been discussed more. The media headlines often "warn" on the "autism epidemic" (Johnson, Myers & the Council on Children with Disabilities, 2007) and point to the importance of recognizing early signs of ASD and on reaching out to experts for help. Although some scientists explain this phenomenon with increased precision and reliability of instruments for disorder's recognition and diagnosis, others argue that environmental changes, as well as today's lifestyle, have somewhat contributed to the increasing incidence of such symptomatology, but the etiology of this disorder is still not fully understood (Aleksić Hil, 2012; Johnson, Myers & the Council on Children With Disabilities, 2007).

Consideration of the developmental course during childhood is crucial for the individual's further development, but at the same time it is a great challenge for clinicians. Namely, it is important to distinguish pathological symptoms from developmental conflicts, to adequately identify disharmonies in different developmental domains, all with the aim of planning an adequate therapeutic approach. During early development, children at an early age can have various manifestations which do not have to indicate the presence of ASD at all, although they resemble it significantly. For example, it has been shown that specific language impairment (in further text SLI) has some common features with ASD, both in language and in social behavior, which has led some authors to believe that there is a continuum of pathology between SLI and ASD (Leyfer, Tager-Flusberg, Dowd, Tomblin, & Folstein, 2008). Experts in pediatric pathology agree that only maturation and further development will condition further course of overlapping symptomatology,

which may go towards normalization or pathology (Aleksić, Rudić, Popović-Deušić, Pejović-Milovančević & Karović-Banjac, 2002; Išpanovic-Radojković, Nikolić, Ćurčić, Popović-Deušić & Živkov, 1990; Popović-Deušić, 1992).

In this paper, we want to highlight the importance of early initiation to the process of treatment of children who exhibit autistic symptomatology, taking into account that it has been shown that certain symptoms disappear only after a period of treatment. In the following section, first, we will present development of ASD symptoms and the disorder's clinical picture. Next, we will describe similarities of ASD and SLI, and present the treatment process. Also, we will present a pilot study aimed at examining the effects of speech and language therapy through the use of one of the measuring instruments for detection of symptoms from the ASD. Finally, we will draw conclusions based on the literature data and our pilot study, and propose recommendations for further researchers.

2 AUTISM SPECTRUM DISORDER

Autism Spectrum Disorder (ASD) has been described as a set of neurodevelopmental disorders characterized by impairments in social interactions, communication deficits and repetitive behaviors, unusual or limited interests. In the DSM-IV classification impaired response to sensory stimuli was added as a criterion for ASD diagnosis (DSM-IV). ASD occurs in a wide variety of manifestations, lasts for a lifetime, and ASD treatment has limited reach. With growing up, the clinical picture of ASD changes-some children become more open-minded, others develop speech while in some individuals progress is minimal or they develop new problems (Aleksić Hil, 2012).

The most common diagnostic criterion for ASD is its early onset, around the 36th month, but it is often the case that these children show specific characteristics from the earliest days, even from birth (Adrien, Lenior, Martineau, & Perrot, 1993; Werner & Dawson, 2005; Wiggins, Baio, & Rice, 2006). Parents notice developmental problems with their children most often in the second year (Gray & Tonge, 2001), and usually report delayed speech development (speech and language problems) and poor social interaction (social deficits) (Milačić Vidojević, 2007). In most affected children, the symptoms of ASD develop gradually, while in some children a regression onset occurs, in terms of loss of abilities which have been acquired by then, and this regression usually occurs around the age of 18 to 24 months (De Myer, Hingtgen, & Jacson, 1981; Lord, Shulman, & DiLavore 2004; Stefanatos, 2008; Volkmar, Chawarska, & Klin, 2005; Werner & Dawson, 2005; Wiggins, Baio, & Rice, 2006).

Social symptoms

Children with ASD rarely seek connectedness, they enjoy being alone, ignore parents' bids for attention, rarely make eye contact (or not at all), and they don't engage in joint attention episodes with gestures or vocalizations. When older, they have trouble to share other people's emotional states (Johnson, Myers & the Council on Children with Disabilities, 2007).

Infants with ASD rarely follow someone's point (Zwaigenbaum, et al., 2005). Some children with ASD can make some proto-imperative pointing by opening and closing their hand which is raised and pointed to the direction of the desired object and others take their parent's hand and lead them or pull them to the object. Children with ASD do not draw parent's attention just to share the interesting experience (Lord, 1995; Mundy, Card, & Fox, 2000; Paparella & Kasari, 2004).

Also, children with ASD rarely respond or turn head when someone calls them by their name (Leekam & Ramsden, 2006; MacDonald, Anderson, & Dube, 2006). Hearing of these children is often called "selective", because they can register environmental sounds, but seem "deaf" to human voices (Leekam & Lopez, 2000).

In new situations, children in the spectrum engage in less facial expression imitation-they rarely imitate their parents' mimics (Dawson, Hill, Spencer, Galpert, & Watson, 1990). Also, they have

impairments in understanding other people's perspectives (Baron-Cohen, Leslie, & Frith, 1985; Twachtman-Cullen, 2000), so this leads to troubles in sharing, comforting and expressing empathy.

Communication deficits

Deficits in prelingual phases are often noted in children on the spectrum (Wetherby, Prizant, & Schuler, 2000; Zwaigenbaum, et al., 2005), such as lack of appropriate gaze or vocalizations in the parent-child interactions, troubles in recognizing parent's voice, or turning to name calling, delayed babbling, lack of prespeech gestures etc.

The main hallmark of ASD is the language disorder, associated with the lack of desire to communicate and lack of nonverbal compensatory efforts such as gestures. Some children with better clinical picture and children with higher cognitive status can develop speech. Their speech usually lacks communicative intent, functionality or fluency. It can be scripted, stereotypic, echolalic (Wetherby, Prizant, & Schuler, 2000), monotone or consisted of larger verbal "chunks".

On the other hand, some children on the spectrum are skilled at labeling colors, shapes, numbers, and letters of the alphabet, yet they are unable to point to them when asked to do so by another person or incorporate the labels into functional language. In other children's speech "pop-up words" can be noticed, which occur without any apparent stimulus or communicative intent. They appear in short period of time and then disappear (Aronson, Hagberg, & Gillberg, 1997; Wetherby, Prizant, & Schuler, 2000). Also, children on the spectrum can say "giant-words" which represent a whole phrase or sentence, but have trouble in understanding their meaning and combining these words into new sentences.

Restricted, repetitive and stereotyped patterns of behaviour, interests and activities

Children on the spectrum have various atypical behaviors. The most known are stereotypies which represent repetitive, nonfunctional, atypical behaviors such as hand flapping, finger movements, rocking or twirling (DSM-V, 2013), unusual eye gazing, habitual toe walking, and/or persistent sniffing and licking of nonfood items (Stone, et al., 1999).

Children with ASD usually form attachments with hard items or have specific interests to some topics and facts (for example, train schedules) (Twachtman-Cullen, 2000). They have hard times in transitioning from an activity or topic of interest or when a usual routine is changed.

Sensory issues which have been added in DSM-V classification into this diagnostic criterion are hyper- or hyporeactivity to sensory input or unusual interests in sensory aspects of the environment (e.g., apparent indifference to pain/temperature, adverse response to specific sounds or textures, excessive smelling or touching of objects, visual fascination with lights or movement).

3 SIMILARITIES BETWEEN ASD AND SLI

A child can be diagnosed with specific language impairment (SLI) when it has a language delay, but obvious reasons are unknown. SLI is a heterogeneous deficit, it can vary in disorder's severity and profile, but in most cases, problems with understanding and producing spoken language are present (phonology, morphology, syntax, semantics, word finding and pragmatics). The diagnosis of the deficit is by exclusion (Leonard, 1998). In both the clinical and research fields, a child is diagnosed with SLI if he/she presents a delay in the development of language and this delay cannot be explained by sensory-motor deficit, another diagnosed syndrome, insufficient exposure to language, a psychiatric diagnosis (Conti-Ramsden & Botting, 2006; Leonard, 1998; Tomblin, et al., 1997, according to Bishop, 2006) or impairment in cognitive development. Namely, child's language must be significantly below level expected from age and IQ. Nonverbal IQ and nonlinguistic aspects of development fall within broadly normal limits (Bishop, 2006;

Bishop, 1996, according to Conti-Ramsden, Botting & Faragher, 2001). Language delays in preschoolers may resolve with time (Bishop & Adams, 1990, according to Bishop, 2006).

Traditionally, ASD and SLI are regarded as distinct disorders, with differential diagnosis hinging on two features. First, in SLI one sees isolated language impairments in the context of otherwise normal development, whereas in ASD a triad of impairments is seen, affecting communication, social interaction and behavioral repertoire (Bishop, 2003). Despite distinct definitions, ASD and SLI have some common features, both in language and in social behavior (Leyfer, et al., 2008).

Also, research has shown that there is a high rate of language impairments in relatives of people with ASD, suggesting etiological continuities between SLI and ASD (Bishop, 2003). This has led some authors to believe that there is a continuum of pathology between SLI and ASD (Leyfer, et al., 2008), that some children have symptoms intermediate between ASD and SLI (Bishop, 2003) or that this relationship is consisted of a partial overlap between the two (Tomblin, 2011). Researchers believe that these conditions could be distinguished based on the severity of the social communication deficits and the absence of rigid and repetitive behavior in strictly defined cases of SLI (Taylor & Whitehouse, 2016), namely, it seems that the only factor differentiating the disorders is the presence of additional impairments in ASD (Bishop, 2003).

However, besides a long-standing interest in the relationship between SLI and ASD, the diagnostic boundaries between these two disorders are not clear-cut yet. Differential diagnosis difficulties lie in different causes and one of them is the insufficient sensitivity of standardized tests. Although the instruments created are aimed at preschoolers, there is a need for more precision in diagnoses in clinical setting (Stone et al., 1997). Also, the diagnosis of ASD is a months-long and sometimes years-long process. ASD diagnosis can evolve over time, so in institutions in our country, clinicians first establish the so-called “working diagnosis”, and then determine the type of treatment and apply it according to the child’s specific difficulties. Namely, research shows that a working diagnosis of ASD does not necessarily have to be a discharge diagnosis (Aleksić, et al., 2002).

Treatment

There is no targeted cure or treatment for ASD, but special education and a structured network of care reduce their behavioral problems, raise skills’ levels, and tailor made programs provide these children with a degree of education (Aleksić Hil, 2012). Early interventions can lead to significantly better prognosis in children with ASD (Filipek, et al., 1999; Harris & Handleman, 2000; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Myers & Johnson, 2007; Sallows & Graupner, 2005).

From an early age, even during the onset of the diagnostic procedure, children with ASD in our country are mostly enrolled in a therapeutic program, established for each individual child through a child assessment by a specialist team. Children with ASD have different strengths and deficits, different patterns of comorbidity, levels of severity, and different psychological/cognitive profiles. The response to therapeutic trials also showed a wide variety of outcomes, which may support the possibility that there are multiple etiologies for ASD (Beck & Horvath, 1998).

The program is mainly consisted of: exercises for psychomotor reeducation, various psychotherapy techniques aimed at the child and/or parent, group and individual work with parents or siblings. Due to the severity of the disorder and its’ chronicity, it is important to involve parents in counseling in order to provide support and help in crisis situations. The treatment is complex and the approach is multidisciplinary (Aleksić Hil, 2012; Aleksić, et al., 2002).

Current findings indicate that children with ASD are capable of learning in relation to their intellectual level and level of psychological distress. The basic principles are that learning should be tailored to each individual child, and learning ability is demonstrated by the progress made no matter how fast. The most can be achieved with a highly structured approach which implies that each task can be divided into clearly defined, easy-to-follow simple steps. The emphasis of treatment (regardless of the type of techniques used) is on improving communication, social, academic, behavioral and everyday life skills (Aleksić Hil, 2012).

Audiolingistic treatment

Early speech and language habilitation at the Institute for Experimental Phonetics and Speech Pathology (IEPSP), in Belgrade, Serbia is performed through audiolinguistic treatment (ALT) using a KSAFA and/or KSAFA-d apparatus (Sovilj, 2007, according to Maksimović & Nenadović, 2018). ALT involves the use of the KSAFA apparatus, aimed at the proper development of hearing, speech and language, behavior and successful learning, as well as their correction. Methodological approaches in ALT are tailored to the level of speech and language disorders, the individual dynamics of each child's speech and language development, and the dynamics of the natural process of speech development (Maksimović & Nenadović, 2018).

4 METHODOLOGY

Sample

Participants were 12 children (M=7; F=5), from Serbia, Bosnia and Herzegovina and Montenegro. All children were admitted into the Institute for Experimental Phonetics and Speech Pathology (IEPSP) “Đorđe Kostić” in Belgrade, Serbia. During initial assessment, multidisciplinary team of experts determined that all children had significant speech and language delays with overlapping ASD symptoms, and they all obtained ASD as a working diagnosis. These considerations were confirmed by administration of GARS-3, which indicated that all 12 children had high Autism Indices (≥ 101), which indicated severe symptoms from ASD. A trained staff member (child’s speech and language therapist) filled GARS-3. After the first assessment, the children started their intensive audiolinguistic treatment. During the continuous diagnostic period, and after months of treatment, eight children were diagnosed with SLI and four of them with ASD. After months of treatment, staff member retested all children on GARS-3. At the first measurement (Time 1), children were averagely aged 40 months (range from 21 to 60; M=39.92, SD=12.94), and averagely 52 months (range from 35 to 72; M=51.83, SD=12.68) on the last measurement (Time 2). Children were tested with GARS-3 twice, over a period of several months (Min = 2, Max = 30, M = 11.92, SD = 7.1).

Instruments

GARS-3 (Gilliam Autism Rating Scale, third edition, 2013) is one of the most widely used instruments for the assessment of ASD in the world. The GARS-3 assists teachers, parents, and clinicians in identifying ASD in individuals and estimating its severity. It is based on the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV; American Psychiatric Association, 2000) and the Autism Society of America’s (1994) definition of the disorder. The instrument is consisted of 58 statements, divided into 6 subscales: 1) Restrictive and Repetitive Behaviours; 2) Social interaction; 3) Social Communication; 4) Emotional Responses; 5) Cognitive Style; 6) Maladaptive Speech. Each of the statements is rated on a scale from 0 to 3, where 0 indicates "not applicable to the child" and 3 indicates "fully applicable to the child". Adding the raw scores and converting the total scores into scaled scores gives an Autism Index (AI score), which represents an overall estimate of ASD likelihood, where the score ≤ 54 indicates that ASD is unlikely to be present, a score of 55-70 indicates that it is likely to be present, and a score of ≥ 71 that is very likely to be present. Also, the severity of ASD is determined by these scores, where a score of 55-70 indicates Level 1, a score of 71-100 indicates Level 2, and a score of ≥ 101 Level 3, which indicates severe symptoms from the spectrum and requires the highest levels of support.

Statistical analysis

Descriptive statistical measures were used to describe the sample. A t-test for paired samples was used to examine the effect of speech and language therapy on the reduction of symptoms that may be indicative of ASD. All data were processed by the SPSS statistical package, version 22.

5 RESULTS AND DISCUSSION

The goal of this study was to examine the effects of speech and language treatment on the reduction of ASD symptoms. We wanted to explore these differences on the overall sample, and separately in two groups of children (children with ASD and children with SLI). In accordance with our aims, we will be presenting the results of our pilot study.

Test-retest measures on GARS-3: overall sample

For the current study, overall GARS-3 scores for the child participants had a range of 108 to 126 ($M = 119.58$, $SD = 5.38$), on the first measurement and a range from 52 to 112 ($M = 75.42$, $SD = 20.39$) on the second measurement.

T-test analysis indicated on the presence of significantly different ($p = .000$) Autism Indices (GARS-3 total scores) on the first ($M_1 = 119.58$; $SD_1 = 5.38$) and on the last measurement ($M_2 = 75.42$; $SD_2 = 20.39$). Also, looking at individual GARS subscales, results show statistically significant differences on Repetitive behaviours ($t = 7.17$, $p = .000$), Social interaction ($t = 6.76$, $p = .000$) and Emotional reactions ($t = 6.2$, $p = .000$), while the values for Social communication were at the level close to significant ($t = 2.2$, $SD = .05$). All data is shown in Table 1.

Table 2: Test-retest differences on the whole sample for the AI and each GARS subscale

Test-retest	M	SD	t	p
Autism Index	44,17	19,21	7,96	,000
Repetitive behaviours	6,25	3,019	7,17	,000
Social interaction	7,42	3,81	6,76	,000
Social communication	2,33	3,658	2,2	,050
Emotional reactions	44,17	19,21	7,96	,000

Test-retest measures for two groups: SLI and ASD

In the second step, we wanted to examine whether statistically significant differences occur when two groups of children are observed separately.

The results show that test-retest measures in children with SLI are statistically significant, both those related to the Autism Index ($t = 14.68$, $p = .000$) and to individual scales. Significance for Repetitive Behaviours ($t = 8.61$), Social Interaction (13.79), and Emotional Responses (8.21) ranged at a significance level of $p = 0.01$, and for Social Communication ($t = 2.43$) at a $p < 0.05$ level.

The results show that test-retest measures in children with ASD are not statistically significant in terms of the Autism Index ($t = 3.02$, $p = 0.57$), Social Interactions ($t = 1.89$, $p = .155$), and Emotional Responses ($t = 1.85$, $p = .161$), while statistically significant differences at the $p < 0.05$ level were present on the Repetitive Behaviour ($t = 3.66$) subscale. A more detailed view of the results is given in Table 2.

Table 2: Test-retest differences on the two groups of children (SLI and ASD) for the AI and each GARS subscale

Dg	GARS	M	SD	t	p
	Autism Index	54,5	10,5	14,68	,000

Specific language impairment (SLI)	Repetitive behaviours	7,63	2,5	8,61	,000
	Social interaction	9,38	1,92	13,79	,000
	Social communication	3,5	4,07	2,43	,045
	Emotional reactions	8,13	2,8	8,21	,000
Autism spectrum disorder (ASD)	Autism Index	23,5	15,54	3,02	,057
	Repetitive behavior	3,5	1,91	3,66	,035
	Social interaction	3,5	3,7	1,89	,155
	Emotional reactions	4,00	4,32	1,85	,161

Such results may indicate that in the treatment, children with ASD progress slower than children with SLI, as progress is observed in all domains in children with SLI and in children with ASD only in terms of Repetitive Behaviours. It seems that after the inclusion of a child with SLI in treatment certain ASD symptoms recede, while in children with ASD they persist. This can be explained by the fact that it has been shown that language delays in preschoolers with SLI may resolve with time (Bishop & Adams, 1990, according to Bishop, 2006), but ASD lasts for a lifetime (Aleksić Hil, 2012). On the other hand, when it comes to children with ASD, various symptoms can reduce with developmental maturation and progression, or as a consequence of an effective therapeutic approach (Milačić Vidojević, 2007), which in case of our study could be Repetitive Behaviors. Also, we have to keep in mind that children with ASD have different levels of ASD severity, and different psychological/cognitive profiles, and the response to therapeutic trials shows a wide variety of outcomes (Beck & Horvath, 1998).

However, it should be borne in mind that children with SLI were, on average, retested over a longer period ($M = 14.63$ months) than children with ASD ($M = 6.5$ months), which may suggest that children with ASD had less time to make a progress. Subsequent studies should equalize groups of children by length of treatment involvement.

Overall, some significant results have emerged, but since research presented here is only a part of a larger study which we plan to conduct, we need to interpret all results with caution. Namely, a larger sample could contribute to more accurate data. It appears that the reduction of autistic symptoms over time suggests that intensive treatment is crucial for children with overlapping symptoms. It speaks in favor of the fact that the involvement of the child in intensive treatment can turn development in one direction or another and that monitoring over time puts the disorder in the closest classification category (Aleksić Hill, 2012), as children who initially received a working diagnosis of ASD do not necessarily have a confirmed ASD diagnosis at the end of treatment period (Aleksić, et al., 2002).

6 CONCLUSION

This paper was aimed to bring closer to the reader the importance of early initiation into the speech and language treatment. Due to the increasing incidence of ASD, the increasingly complex clinical picture, and the many overlapping symptoms, we felt it necessary to further deepen this topic. To begin with, the chapter first described the ASD symptomatology then introduced the reader with the process of differentiating ASD from SLI, and the treatment process. Finally, we presented a pilot study conducted at the Institute for Experimental Phonetics and Speech Pathology (IEPSP), in Belgrade, Serbia which was aimed to examine the effects of speech and language therapy on the reduction of ASD symptoms. The results of our pilot study give the impression that GARS-3 can be an acceptable tool for monitoring the progress of treatment of both an individual child and of a group of children with a particular diagnosis, since ASD symptoms have been shown to decrease to a certain extent over a period of treatment, somewhat more in children with SLI than in children with ASD in whom they persist.

In conclusion, we can say that the process of differential diagnosis at a young age is extremely complex. Due to the overlapping of different symptoms, it is recommended to set only “working” diagnoses and to make them open for revision. Namely, initial diagnosis is not necessarily a measure of developmental

flow, but developmental outcome and prognosis can only be discussed after the child is included in treatment and after the monitoring of progress in all developmental domains.

As it has been shown that children with developmental disorders learn in relation to their intellectual level and level of psychological distress, we need to tailor treatment to each individual child, and encourage them to make progress, no matter how slow it may be. If a child engages in treatment in a timely manner, time becomes his ally in reducing symptomatology and even could lead to almost complete normalization. Only time, effort and hard work can show a definitive outcome. Many children can achieve some autonomy in self-help and personal care, which is not negligible because these skills allow them to somehow integrate into the social environment and gain a degree of independence.

For the aforementioned reasons, it seems that diagnostic criteria and measuring instruments, especially at the youngest age, should be used with caution, in combination with the clinicians' judgment, as they seem to show us certain developmental "points" or the child's progress in global or specific plan, but do not necessarily accurately indicate on the permanent presence of specific impairments. Continuous monitoring and diagnosis revisions are the only way to adequately understand the issues of the developmental period.

REFERENCES

- Adrien, J., Lenior, P., Martineau, J., & Perrot, A. (1993). Blind ratings of early symptoms of autism based upon family home movies. *Journal of the American Academy of Child and Adolescent Psychiatry*, 32(3), 617-627.
- Aleksić, O., Rudić, N., Popović-Deušić, S., Pejović-Milovančević, M., & Banjac-Karović, M. (2002). Mogućnost primene klasifikacionih sistema u oblasti pervazivnih razvojnih poremećaja. *Psihijatrija danas*, 34(3-4), 281-289.
- Aleksić Hil, O. (2012). Pervazivni razvojni poremećaji. U S. Bojanin & S. Popović Deušić (Ur.), *Psihijatrija razvojnog doba* (str. 269-286). Beograd: Dosije studio.
- American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders*, 4th Edition (DSM-IV). Washington, DC: American Psychiatric Publishing.
- American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders*, 4th Edition, Text Revision (DSM-IVTR). Washington, DC: American Psychiatric Publishing; Play Skills
- Aronson, M., Hagberg, B., & Gillberg, C. (1997). Attention deficits and autistic spectrum problems in children exposed to alcohol during gestation: a follow-up study. *Developmental Medicine & Child Neurology*, 39(9), 583-587.
- Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition*, 21(1), 37-46.
- Beck, V., & Horvath, K. (1998). Method for assisting in differential diagnosis and treatment of autistic syndromes. EP1019072
- Bishop, D.V.M. (2003). Autism and specific language impairment: categorical distinction or continuum? *Novartis Foundation Symposia*, 251, 213-226.
- Bishop, D.V.M. (2006). What Causes Specific Language Impairment in Children? *Current Directions In Psychological Science*, 15(5), 217-221.
- Conti-Ramsden, G., & Botting, N. (2006). Specific Language Impairment. *Encyclopedia of Language and Linguistics*, 629-632.
- Conti-Ramsden, G., Botting, N., & Faragher, B. (2001). Psycholinguistic Markers for Specific Language Impairment (SLI). *Journal of Child Psychology and Psychiatry*, 42(6), 741-748.
- Dawson, G., Hill, D., Spencer, A., Galpert, L., & Watson, L. (1990). Affective exchanges between young autistic children and their mothers. *Journal of Abnormal Child Psychology*, 18(3), 335-345.
- De Myer, M., Hingtgen, J., & Jacson, R. (1981). Infantile autism reviewed: a decade of research. *Schizophrenia Bulletin*, 7(3), 388-451.
- Filipek, P.A., Accardo, P.J., Baranek, G.T., Cook, E.H. Jr, Dawson, G., Gordon, B. ... Volkmar, F.R. (1999). The screening and diagnosis of autistic spectrum disorders. *Journal of Autism and Developmental Disorders*, 29(6), 439-84.
- Gray, K.M., & Tonge, B.J. (2001). Are there early features of autism in infants and preschool children. *Journal of Paediatrics and Child Health*, 37(3), 221 - 226.
- Gilliam, J.E. (2013). *Gilliam Autism Rating Scale - Third Edition (GARS-3)*. Pearson.
- Harris, S.L., & Handleman, J.S. (2000). Age and IQ at intake as predictors of placement for young children with autism: a four- to six-year follow-up. *Journal of Autism and Developmental Disorders*, 30(2), 137-142.

- Howard, J.S., Sparkman, C.R., Cohen, H.G., Green, G., & Stanislaw, H. (2005). A comparison of intensive behavior analytic and eclectic treatments for young children with autism. *Research in Developmental Disabilities*, 26(4), 359-383.
- Ispanovic-Radojkovic, V., Nikolic, S., Curcic, V., Popovic-Deusic, S., Zivkov, M. (1990). Etude de l'application de la Classification Francaise des Troubles Mentaux de l'enfant et de l'Adolescent en Yugoslavie. *Neuropsychiatrie de l'Enfance et de l'Adolescence*, 38(10-11), 582-584.
- Johnson, C.P., Myers, S.M., & American Academy of Pediatrics Council on Children with Disabilities (2007). Identification and evaluation of children with autism spectrum disorders. *Pediatrics*, 120(5), 1183-1215.
- Leekam, S., & Lopez, B. (2000). Attention and joint attention in preschool children with autism. *Developmental Psychology*, 36(2), 261-273.
- Leekam, S.R. & Ramsden, C.A. (2006). Dyadic orienting and joint attention in preschool children with autism. *Journal of Autism and Developmental Disorders*, 36(2), 185-197.
- Leonard, L. (1998). *Children with Specific Language Impairment*. MIT. Press, MA.
- Leyfer, O., Tager-Flusberg, H., Dowd, M., Tomblin, J.B., & Folstein, S.E. (2008). Overlap between autism and specific language impairment: comparison of Autism Diagnostic Interview and Autism Diagnostic Observation Schedule scores. *Autism research*, 1(5), 284-296.
- Lord, C. (1995). Follow-up of two-year-olds referred for possible autism. *Journal of Child Psychology and Psychiatry*, 36(8), 1365-1382.
- Lord, C., Shulman, C., & DiLavore, P. (2004). Regression and word loss in autistic spectrum disorders. *Journal of Child Psychology and Psychiatry*, 45(5), 936-955.
- MacDonald, R., Anderson, J., Dube, W.V., Geckeler, A., Green, G., Holcomb, W., ... & Sanchez, J. (2006). Behavioral assessment of joint attention: a methodological report. *Research in Developmental Disabilities*, 27(2), 138-150.
- Maksimović, S. & Nenadović, V. (2018). KSAFA sistem-značaj instrumentalne auditivne stimulacije za razvoj govorno-jezičke kompetencije. U M. Sovilj (Ur.), *Novi pristupi u tretmanu poremećaja verbalne komunikacije* (str. 185-217). Beograd: CUZA & IEFPG.
- Milačić Vidojević, I. (2007). Kako roditelji autistične dece prepoznaju rane promene u ponašanju? *Psihijatrija danas*, 39(2), 155-167.
- Muhle, R., Trentacoste, S.V., & Rapin, I. (2004). The genetics of autism. *Pediatrics*, 113(5).
- Mundy, P., Card, J., & Fox, N. (2000). EEG correlates of the development of infant joint attention skills. *Developmental Psychobiology*, 36(4), 325-338.
- Myers, S.M., Johnson, C.P., & American Academy of Pediatrics Council on Children With Disabilities (2007). Management of children with autism spectrum disorders. *Pediatrics*, 120(5), 1162-1182.
- Paparella, T., & Kasari, C. (2004). Joint attention skills and language development in special needs populations: translating research to practice. *Infants & Young Children*, 17(3), 269-280.
- Popović-Deušić S. (1992). Klasifikacija psihičkih poremećaja dece i omladine u svetlu nove MKB-10 klasifikacije. *Psihijatrija danas*, 24(3-4), 317-328.
- Sallows, G.O., & Graupner, T.D. (2005). Intensive behavioral treatment for children with autism: four-year outcome and predictors. *American journal of mental retardation*, 110(6), 417-438.
- Stefanatos, G.A. (2008). Regression in autistic spectrum disorders. *Neuropsychology Review*, 18(4), 305-319.
- Stone, W.L., Lee, E.B., Ashford, L., Brissie, J., Hepburn, S.L., Coonrod, E.E., Weiss, B.H. (1999). Can autism be diagnosed accurately in children under 3 years? *Journal of Child Psychology and Psychiatry*, 40(2), 219-226.
- Stone, W., Ousley, O., Yoder, P., Hogan, K., & Hepburn, S. (1999). Non-verbal communication in two- and three-year-old children with autism. *Journal of Autism and Developmental Disorders*, 27(6), 677-696.
- Taylor, L.J. & Whitehouse, A.J.O. (2016). Autism Spectrum Disorder, Language Disorder, and Social (Pragmatic) Communication Disorder: Overlaps, Distinguishing Features, and Clinical Implications. *Australian Psychologist*, 51(4), 287-295.
- Tomblin, B. (2011). Co-morbidity of autism and SLI: kinds, kin and complexity. *International journal of language & communication disorders*, 46(2), 127-137.
- Twachtman-Cullen, D. (2000). More able children with autism spectrum disorders. In: A.M. Wetherby & B.M. Prizant (Eds.), *Autism Spectrum Disorders* (pp. 225-249). Baltimore, MD: Paul H. Brookes.
- Volkmar, F., Chawarska, K., & Klin, A. (2005). Autism in infancy and early childhood. *Annual Review of Psychology*, 56, 315-336.
- Weiss, F.J. (2002). Self-Injurious Behaviours in Autism: A Literature Review. *Journal on Developmental Disabilities*, 9(2).
- Werner, E., & Dawson, G. (2005). Validation of the phenomenon of autistic regression using home videotapes. *Archives Of General Psychiatry*, 62(8), 889-895.
- Wetherby, A.M., Prizant, B.M., & Schuler, A.L. (2000). Understanding the nature of communication and language impairments. In A.M. Wetherby & B.M. Prizant (Eds.), *Autism Spectrum Disorders* (pp. 109-141). Baltimore, MD: Paul H. Brookes.
- Wiggins, L.D., Baio, J., & Rice, C. (2006). Examination of the time between first evaluation and first autism spectrum diagnosis in a population- based sample. *Journal of Developmental & Behavioral Pediatrics*, 27(2 Suppl), S79-

S87.

Zwaigenbaum, L., Bryson, S., Rogers, T., Roberts, W., Brian, J., & Szatmari, P. (2005). Behavioral manifestations of autism in the first year of life. *International Journal of Developmental Neuroscience*, 23(2-3), 143–152.

The Influence Of Genetic Conditions On Increasing Risk Of The Speech-Language Pathology At Children

Marijana Rakonjac^{1,2}, Ivana Bogavac^{1,2}, Miodrag Stokić^{1,2}, Marina Vujović¹

¹Institute for experimental phonetics and speech pathology, Belgrade, Serbia;

²Life activities advancement center, Belgrade, Serbia;
masadanicic@gmail.com

ABSTRACT

Over the past years, more and more scientific studies have been devoted to defining the biological and neurological mechanisms of speech-language disorders. Numerous studies suggest that speech-language pathology is significantly conditioned by genetic factors. However, genetic etiology is not precisely defined. The genes responsible for the development of speech and language disorders have not yet been accurately identified. Scientists have declared several syndromes with a known genetic cause (and many more with both a genetic and environmental etiology) that are seen in many speech - language pathologists' places of practice. Thanks to the modern methods used in the diagnosis of chromosomal aberrations, as well as DNA sequencing along the entire genome, speech and language specialist might significantly improve their theoretical knowledge and improve therapy of the of various forms of speech and language disorders with different genetic etiology. Namely, this knowledge from genetic studies may provide new approaching into early identification of children at-risk for specific speech, language, literacy, and hearing disorders, which would encourage earlier interventions and stimulations of communication deficits. Additionally, it is very important that speech and language pathologist understand a role of genetic factors in communication disorders so they can use a different methodology for different cognitive and communication capacity at different genetics conditions and syndromes.

Key words: speech-language pathology, genes, diagnostic

1 INTRODUCTION

In recent years, advances in genetic technology have also led to the identification of several different variants of chromosomal copies (CNVs) and individual genetic changes associated with abnormalities in speech and language development. Namely, research has focused on defining the biological and neurological mechanisms of speech-language disorders. Studies suggest that speech-language pathology is significantly conditioned by genetic factors (Barry et al., 2007). Analyzing the genetic basis of verbal communication development, we recently published a study evaluating speech and language development in children, monolingual speakers of Serbian with heterozygous chromosome deletion 22, locus q11.2, and showing that these children have language delays and speech disorders, and language despite their cognitive abilities (Rakonjac et al., 2016).

Also, numerous studies on twins have shown greater concordance (coincidence) among monozygotic twins than concordance among dizygotic twins, suggesting the influence of genetic factors on speech and language development (Bishop, 2002). The fifties of the twentieth century saw the development of reliable techniques for the analysis of chromosomes, which consequently led to the realization that a certain number of pathological conditions, known from earlier, was conditioned by an abnormal number of chromosomes. Causes of Down Syndrome, Klinefelter Syndrome and Turner Syndrome were discovered very quickly. Further analyzes shed light on other syndromes that essentially had excess or deficiency of chromosomal material.

Chromosomal aberrations - changes in the number or structure of chromosomes can be hereditary, when transmitted from parents to offspring and non-consecutive, when they occur for the first time and are not present in other family members - new. Chromosomal aberrations are divided into numerical and structural aberrations, and they can occur on both autosomal and sex chromosomes.

Numerical chromosomal aberrations refer to changes in the number of both individual chromosomes - aneuploidy and whole chromosome sets - polyploidy. Structural chromosome aberrations represent changes in the structure of the chromosome itself that result from interruption on the chromosome itself. When a chromosome breaks down, aberrations result. They can be balanced and unbalanced. Balanced chromosomal aberrations are characterized by the presence of a complete chromosomal material that is rearranged. It is important to emphasize that carriers of this type of aberration also carry the risk of producing offspring with unbalanced chromosomal complement. Unbalanced chromosomal aberrations are characterized by a deficiency or excess of genetic material, resulting in serious disorders and pathological clinical presentation. Structural chromosomal aberrations include deletions, duplications, inversions, translocations and, as a consequence, ring chromosomes and isochromosomes.

2 DELETION SYNDROMES

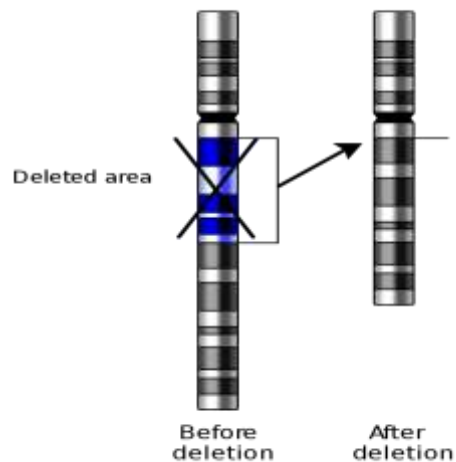
Deletions are characterized by the loss of part of a chromosome due to interruption on the same and consequently a monosomy occurs for that deleted chromosome segment. Depending on the size of the deletion, different diagnostic procedures are used, so deletions of less than 4Mb are called microdeletions and they require an additional diagnostic procedure.

Wolf-Hirschhorn syndrome is a consequence of deletion of short chromosome 4 cancer (del4p16.3). In 85% of cases it occurs as a de novo deletion, while the rest is caused by an unbalanced translocation affecting the 4p16 region. Congenital anomalies are numerous and include congenital heart, kidney, ophthalmic defects, skeletal anomalies. The most common complication is the onset of epilepsy in the presence of mental retardation (Shannon et al., 2001). Other malformations include muscular hypotonia, urinary tract malformations as well as frequent respiratory infections. The most pronounced feature of this syndrome is the craniofacial appearance, a term called the "Greek warrior helmet". These features are related to a very wide nasal bridge that continues to the forehead, high-forehead microcephaly (Battaglia, Filippi, & Carey, 2008; Pitt, Rogers, & Dank, 1984). The palate defects are present in most (Battaglia et al., 2008), as well as ear deformities and cochlear hearing loss (Battaglia et al., 2008).

Cri-du-chat is a rare syndrome that occurs as a result of deletion of the short arm of chromosome 5 (del5p) with an incidence of between 1: 15000-50000 live births. The magnitude of the deletion varies from the deletion of the entire short arm to the 5p15.3 region (Kristoffersen, 2015).

The clinical characteristics are quite variable. Mostly they involve very high-pitched crying in the infant and in childhood, as well as characteristic facial dysmorphism. In addition, hypotonia and hypertension, delayed motor development, microcephaly occur. Consequently, intellectual disabilities of varying degrees occur in these children. These individuals may have problems maintaining attention to the task, hyperactivity, stereotypes, as well as various forms of aggressive and auto-aggressive behavior (Collins & Cornish, 2002), speech and language disorders (Cornish & Munir, 1998; Kristoffersen, 2007).

Deletions are characterized by the loss of part of the chromosome due to interruption on the same and consequently a monosomy occurs for that deletion of the chromosome segment (Picture 1.). Depending on the size of the deletion, different diagnostic procedures are used, so deletions of less than 4Mb are called microdeletions and they require an additional diagnostic procedure



Picture 1. Chromosome before and after deletion (<https://en.wikipedia.org>)

Wolf-Hirschhorn syndrome is a consequence of deletion of the short arm of chromosome 4 (del4p16.3). In 85% of cases it occurs as a de novo deletion, while the rest is caused by an unbalanced translocation affecting the 4p16 region. Congenital anomalies are numerous and include congenital heart, kidney, ophthalmic defects, skeletal anomalies. The most common complication is the onset of epilepsy in the presence of mental retardation (Shannon et al., 2001). Other malformations include muscular hypotonia, urinary tract malformations as well as frequent respiratory infections. The most pronounced feature of this syndrome is the craniofacial appearance, a term called the "Greek warrior helmet". These features are related to a very wide nasal bridge that continues to the forehead, high-forehead microcephaly (Battaglia, Filippi, & Carey, 2008; Pitt, Rogers, & Dank, 1984). The palate defects are present in most (Battaglia et al., 2008), as well as ear deformities and cochlear hearing loss (Battaglia et al., 2008).

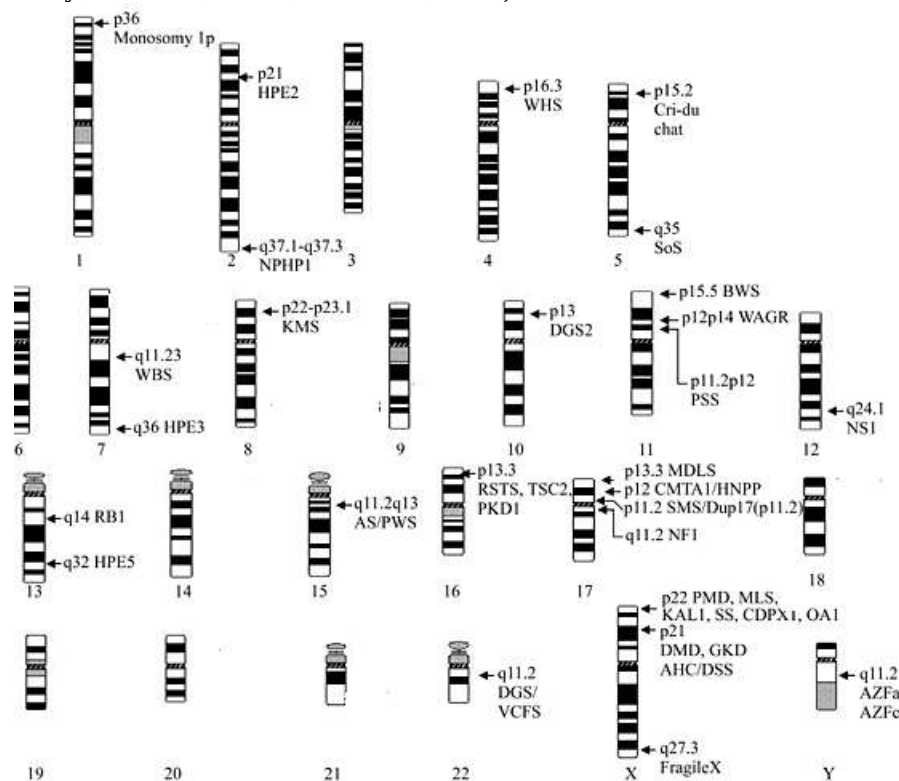
Cri-du-chat is a rare syndrome that occurs as a result of deletion of the short arm of chromosome 5 (del5p) with an incidence of between 1: 15000-50000 live births. The magnitude of the deletion varies from the deletion of the whole short arm to the 5p15.3 region (Kristoffersen, 2015). The clinical characteristics are quite variable. Mostly they involve very high-pitched crying in the infant and in childhood, as well as characteristic facial dysmorphism. In addition, hypotonia and hypertension, delayed motor development, microcephaly occur. Consequently, intellectual disabilities of varying degrees occur in these children. These individuals may have problems maintaining attention to the task, hyperactivity, stereotypes, as well as various forms of aggressive and auto-aggressive behavior (Collins & Cornish, 2002), speech and language disorders (Cornish & Munir, 1998; Kristoffersen, 2007).

3 MICRODELETION SYNDROMES

Prader-Willi syndrome is a multisystem disorder with an estimated prevalence of 1 in every 10,000 to 15,000 live births (Burd, Vesely, Martsolf, & Kerbeshian, 1990). It is characterized by hypotonia with difficulty sucking and feeding in early childhood, while in later childhood it is characterized by overeating and the gradual development of obesity if nutrition is not controlled. Motor and speech-language retardation are slow and almost all persons have some degree of cognitive impairment. Low growth is associated with a lack of growth hormone. They have characteristic facial dysmorphism, with strabismus and scoliosis. The literature indicates that for most individuals, the total IQ score ranges from 55 to 70 units (Curfs, Wiegers, Sommers, Borghgraef, & Fryns, 1991). Weaknesses have with auditory short-term memory, the processing of auditory verbal information (Curfs et al., 1991), which leads to better results on a manipulative scale. Linguistic deficits are observed as early as childhood. Difficult and reduced chatter, vocabulary

development is delayed and occurs from 18 months to six years (Lewis, Freebairn, Heeger, & Cassidy, 2002). Studies have also shown impairments of narrative abilities, language comprehension, and pragmatic abilities (Lewis et al., 2002).

This syndrome is due to the lack of expression of the paternal genes on chromosome 15q11.2-q13. The gene group in this region is imprinted and is normally only active on paternal chromosome 15; the same material chromosome alleles are inactive due to epigenetic factors and lack expression. Lack of expression of one or more genes from the paternal chromosome contributes to the Prader-Willi syndrome phenotype (Cassidy, Schwartz, Miller, & Driscoll, 2012).



Picture 2. A karyogram of genomic disorders. Picture 2. A karyogram of genomic disorders. WBS- Williams syndrome (7q11.23), DGS- DiGeorge syndrome (22q11.2), AS/PWS- Angelman syndrome/Prader-Wili syndrome (15q11.2-q13), Cri-du-chat (5p15.2), WHS-Wolf-Hirschhorn syndrome (4p16.3) (<http://dx.doi.org/10.1590/S1415-47572004000300001>). (<http://dx.doi.org/10.1590/S1415-47572004000300001>).

Angelman syndrome is a neurogenetic disorder caused by loss of gene expression on maternal chromosome 15 with an incidence of 1: 10000 to 1: 40000 (Kyllerman, 1995). Clinical features include developmental delays, learning disabilities, ataxia, a very low threshold for laughter, and 80-90% of these individuals have seizures (Conant, THibert, & Thiele, 2009). Most of them meet the diagnostic criteria for the diagnosis of autism (Lord et al, 2000). Facial dysmorphia includes a prominent beard, deep-set eyes, wide mouth with protrusion of the tongue, and microcephaly. They also have hypopigmentation with blond hair and blond eyes. The most significant feature is the absence of speech (Clayton-Smith & Laan, 2003). Most do not develop speech and most of these individuals have a vocabulary of two to three words (Andersen, Rasmussen, & Stromme, 2001). Understanding develop at the level of simple orders in the context of daily routine. Few manage to communicate in sign language, while others generally use gesture as a form of communication.

DiGeorge syndrome is a neurogenetic disorder that results from microdeletion on chromosome 22 (22q11.2). It is the most common microdeletion with an incidence of 1 in 2000 to 4000 live births and involves haplo-insufficiency over 50 genes resulting in multisystem disorder (Swillen & McDonald-McGinn, 2015). There is great variability in phenotypic expression from life-threatening conditions to individually related characteristics. The most common medical problem is manifested as congenital heart defects, palate abnormalities, most commonly velopharyngeal incompetence, immunodeficiency, hypocalcemia, genital tract abnormalities, gastrointestinal anomalies, and subtle facial features (McDonald-McGinn and Sullivan, 2001). The neurocognitive profile is also highly variable, both individually and developmentally. Motor delays and delays in speech and language development are often present (Rakonjac, et. al., 2016), at a later age, learning disorders are common during schooling. Most people with 22q11.2 deletion have borderline intellectual functioning, while one third have mild to moderate mental disabilities. These individuals carry the risk of developing psychiatric disorders including hyperactivity disorder (ADHD), autism spectrum disorders, anxiety, behavioral disorders, psychotic disorders and schizophrenia.

Williams syndrome is a rare neurodevelopmental disorder caused by the microdeletion of more than 26 genes on chromosome 7 (7q11.23) (Mervis & Velleman, 2011). The estimated prevalence is 1 in 7,500 live births (Stromme, Bjornstad, & Ramstad, 2002). This syndrome is characterized by facial dysmorphism, congenital heart disease, connective tissue abnormalities, frequent early childhood otitis, and unilateral or bilateral high frequency hearing impairment in school age (Marler, Sitcovsky, Mervis, Kistler, & Wightman, 2010). In young children, developmental delay is noticeable, whereas in older children, intellectual retardation, from moderate to mild mental retardation, can be observed. The cognitive and social phenotype have their characteristics. Paradoxically, individuals with this syndrome have been described with the normal development of linguistic abilities as opposed to marked intellectual deficits, as well as distinctly social although displaying a limited understanding of social norms (Mervis & John, 2010a, 2010b).

Although language skills are considered more developed in these children, there is still a pattern of weaknesses and better developed segments of language. Concrete vocabulary and phonological abilities are well developed, grammatical abilities are at the level of intellectual abilities, while pragmatics is evidently impaired (Mervis & Vellman, 2011).

4 CONCLUSION

Knowledge of the genetic basis of developmental and verbal communication disorders could provide new approaches to early identification of children at risk for specific speech, language, learning and hearing disorders, which would encourage earlier interventions and stimulation of verbal communication targeting specific verbal or nonverbal deficits (Felsenfeld & Plomin, 1997; Nevburi & Monaco, 2010). In addition, it is important for speech therapists to understand the role of genetic factors in communication disorders and their typical and atypical developmental trajectories so that they can use a different methodology for different cognitive and communication capacities in dealing with children diagnosed with genetic disorders. Knowledge of genetic principles in the onset of diseases and disorders can help speech therapists understand how additional medical interventions can affect the quality and duration of treatment, set realistic treatment goals for their patients, improve communication with parents, and increase the chances of collaboration with teachers, educators, and teachers that further contribute to the adoption of certain behaviors, emotional maturation, and the learning process in children with genetic syndrome or disorder.

ACKNOWLEDGEMENT: This work was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia (Grant No. 178027)

REFERENCES

- Andersen, W.H., Rasmussen, R. K., & Stromme, P. (2001). Levels of cognitive linguistic development in Angelman syndrome: a study of 20 children. *Logopedics, phoniatrics, vocology*, 26(1), 2–9.
- Barry J.G., Yasin I., Bishop D.V. Heritable risk factors associated with language impairments. *Genes Brain Behav.* 2007;6:66–76
- Battaglia, A., Filippi, T., & Carey, J. C. (2008). Update on the clinical features and natural history of Wolf-Hirschhorn (4p-) syndrome: experience with 87 patients and recommendations for routine health supervision. *American Journal of Medical Genetics Part C: Seminars in Medical Genetics*, 148C(4), 246–251.
- Baty, B. J., Jorde, L. B., Blackburn, B. L., & Carey, J. C. (1994). Natural history of trisomy 18 and trisomy 13. II. Psychomotor development. *American Journal of Medical Genetics* 49, 189–194.
- Bishop D.V. The role of genes in the etiology of specific language impairment. *J. Commun. Disord.* 2002;35:311–328
- Burd, L., Vesely, B., Martsof, J., & Kerbeshian, J. (1990). Prevalence study of Prader–Willi syndrome in North Dakota. *American Journal of Medical Genetics*, 37(1), 97–99.
- Cassidy, S. B., Schwarz, S., Miller, J. L., & Driscoll, D. J. (2012). Prader-Willi syndrome. *Genetics in Medicine*, 14(1), 10–26.
- Clayton-Smith, J., & Laan, L. (2003). Angelman syndrome: a review of the clinical and genetic aspects. *Journal of medical genetics* 40(2), 87–95.
- Collins, M. S. R., & Cornish, K. (2002). A survey of the prevalence of stereotypy, selfinjury and aggression in children and young adults with Cri du Chat syndrome. *Journal of Intellectual Disability Research*, 46, 133–140.
- Conant, K. D., Thibert, R. L., & Thiele, E. A. (2009). Epilepsy and the sleep-wake patterns found in Angelman syndrome. *Epilepsia*, 50, 2497–2500.
- Cornish, K., & Munir, F. (1998). Receptive and expressive language skills in children with cri du chat syndrome. *Journal of communication disorders*, 31, 73–81.
- Creda, A & Carey, J. C. (2012). The trisomy 18 syndrome. *Orphanet Journal of Rare Diseases*, 7, 81.
- Curfs, L. M., Wieggers, A., Sommers, J., Borghgraef, M., & Fryns, J. (1991). Strengths and weaknesses in the cognitive profile of youngsters with Prader–Willi syndrome. *Clinical Genetics*, 40(6), 430–434
- DeLisi, L. E., Maurizio, A. M., Svetina, C., Ardekani, B., Szulc, K., Nierenberg, J., Leonard, J., Harvey, P. D. (2005). Klinefelter’s syndrome(XXY) as a genetic model for psychotic disorders. *American Journal of Medical Genetics. Part B, Neuropsychiatric genetics*, 135B(1), 15–23.
- Edwards, J.H., Harnden, D.G., Cameron, A. H., Crosse, V. M., & Wolff, O. H. (1960). A new trisomic syndrome. *Lancet* 275(7128), 787–789.
- Fales, C. L., Knowlton, B. J., Holyoak, K. J., Geschwind, D. H., Swerdloff, R. S., & Gonzalo, I. G. (2003). Working memory and relational reasoning in Klinefelter syndrome. *Journal of the International Neuropsychological Society*, 9(6), 839–846.
- Graham, J. M., Bashir, A. S., Stark, R. E., Silbert, A., & Walzer, S. (1988). Oral and written language abilities of XXY boys: implications for anticipatory guidance. *Pediatrics*, 81(6), 795–806.
- Haka-Ikse, K., Stewart, D. A., & Cripps, M. H. (1978). Early development of children with sex chromosome aberrations. *Pediatrics*, 62(5), 761–766.
- Hong, D. S., & Reiss, A. L. (2012). Cognition and behavior in Turner syndrome: a brief review. *Pediatric Endocrinology Reviews : PER*, 9 Suppl 2(02), 710–712.
- Jahromi, L. B., Gulsrud, A., & Kasari, C. (2008). Emotional competence in children with Down syndrome: Negativity and regulation. *American Journal of Mental Retardation*, 113(1), 32–43.
- Kompus, K., Westerhausen, R., Nilsson, L.G., Hugdahl, K., Jongstra, S., Berglund, A., Arver, S., Savic, I. (2011). Deficits in inhibitory executive functions in Klinefelter (47,XXY) syndrome. *Psychiatry Research*, 189(1), 135–140.
- Kristoffersen, K. E. (2015). Speech and language development in cri du chat syndrome – a critical review. *Clinical Linguistics & Phonetics*, 22(6), 443–457.
- Kristoffersen, K.E. (2007). Consonants in Cri du chat syndrome: A case study. *Journal of Communication Disorders*, 41(3), 179–202.
- Kyllerman, M. (1995). On the prevalence of Angelman syndrome. *American Journal of Medical Genetics*, 59(3), 403–404.
- Levy, Y., & Eilam, A. (2013). Pathways to language: A naturalistic study of children with Williams syndrome and children with Down syndrome. *Journal of Child Language*, 40(1), 106–138.

- Lewis, B. A., Freebairn, L., Heeger, S., & Cassidy, S. (2002). Speech and language skills of individuals with Prader–Willi syndrome. *American Journal of Speech–Language Pathology*, 11(3), 285–294.
- Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Jr., Leventhal, B. L., DiLavore, P. C., Pickles, A., & Rutter, M. (2000). The autism diagnostic observation schedule-generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders*, 30(3), 205–223.
- Marler, J. A., Sitcovsky, J. L., Mervis, C. B., Kistler, D. J., & Wightman, F. L. (2010). Auditory function and hearing loss in children and adults with Williams syndrome: Cochlear impairment in individuals with otherwise normal hearing. *American Journal of Medical Genetics, Part C*, 154C, 249–265.
- Mazzocco, M. M. M. (2006). The cognitive phenotype of Turner syndrome: Specific learning disabilities. *International Congress Series*, 1298, 83–92.
- McDonald-McGinn, D. M., & Sullivan, K. E. (2001). Chromosome 22q11. 2 Deletion Syndrome (DiGeorge syndrome/Velocardiofacial syndrome). *Medicine*, 90, 1–18.
- Mervis, C. B., & John, A. E. (2010a). Cognitive and behaviour characteristic of children with Williams syndrome: Implications for intervention approaches. *American Journal of Medical Genetics Part C*, 154C, 229–248.
- Mervis, C. B., & John, A. E. (2010b). Williams syndrome: Psychological characteristics. In Shapiro, B., Accardo, P., editors. *Neurogenetics syndromes: Behavioral issues and their treatment*. Baltimore, MD: Brookes; p.81–98.
- Mervis, C. B., & Velleman, S. L. (2011). Children with Williams Syndrome: Language, Cognitive, and Behavioral Characteristics and their Implications for Intervention. *Percetives on Language Learning and Education*, 18(3), 98–107.
- Rakonjac, M., Čuturilo, G., Stevanovic, M., Jelcic, Lj., Subotic, M., Jovanovic, I., & Drakulic, D.. (2016). Differences in speech and language abilities between children with 22q11.2 deletion syndrome and children with phenotypic features of 22q11.2 deletion syndrome but without microdeletion. *Research in developmental disabilities*, 55, 322–329.
- Ratcliffe, S. (1999). Long-term outcome in children of sex chromosome abnormalities. *Archives of Disease in Childhood*, 80(2), 192–195.
- Rondal, J. A., & Comblain, A. (1996). Language in adults with Down syndrome. *Down szndrome research and practice*, 4(1), 3–14.
- Ross, J., Zinn, A., & McCauley, E. (2000). Neurodevelopmental and psychosocial aspects of turner syndrome. *Mental Retardation and Developmental Disabilities Research Reviews*, 6(2), 135–141.
- Schinzel, A. (2001). *Catalogue of Unbalance Chromosome Aberration in Man*. 2nd Ed, Walter de Gryter, Beril, New York, 505–510.
- Stromme, P., Bjornstad, P. G., Ramstad, K. (2002). Prevalence estimation of Williams syndrome. *Journal of Child Neurology*, 17, 269–271.
- Swillen, A., & McDonald-McGinn, D. (2015). Developmental Trajectories in 22q11.2 Deletion. *American Journal of Medical Genetics Part C*, 169(2), 172–181.
- Sybert, V. P., & Mccauley, E. (2004). Turner’s Syndrome. *The New England Journal of Medicine*, 351(12), 1227–1238.
- Thoradottir, E. T., Chapman, R. S., & Wagner, L. (2002). Complex sentence production by adolescents with Down syndrome. *Applied Psycholinguistics*, 23(2), 163–183.
- van Rijn, S., Aleman, A., Swaab, H., Krijn, T., Vingerhoets, G., & Kahn, R. (2007). What it is said versus how it is said: comprehension of affective prosody in men with Klinefelter (47,XXY) syndrome. *Journal of the International Neuropsychological Society*, 13(6), 1065–1070.

Language Lateralization During Auditory Perception in Left-handed Children

Saška Fatić^{1,2} Nina Stanojević^{1,2} Miodrag Stokić^{1,2}

¹ Institute for research and development „Life Activities Advancement Centre“, Belgrade, Serbia

² Institute for Experimental Phonetics and Speech Pathology “Đorđe Kostić”, Belgrade, Serbia
s.fatic@iefpg.org.rs

ABSTRACT

It is generally accepted that most people have left-hemispheric language dominance. The authors examined auditory language distribution in left and right-handed children during word listening. Sample is consisted of 20 children, aged 5-7 with normal speech and language development, divided into two groups: 10 right-handed children and 10 left-handed children. EEG recordings were performed using Nihon Kohen Corporation, EEG 1200K Neurofax apparatus by utilizing 10/20 International electrode positioning. We used Fractal Dimension (FD) in quantifying the complexity of EEG signals between both groups. FD was calculated by Higutchi algorithm, as one of the methods for FD evaluation. Also, spectral power of three brain rhythms were obtained. Results of our study showed differences in language processing but with statistics significance for lateralisation in auditory processing between both groups.
Keyword: language lateralisation, auditory perception, left-handed children

1 INTRODUCTION

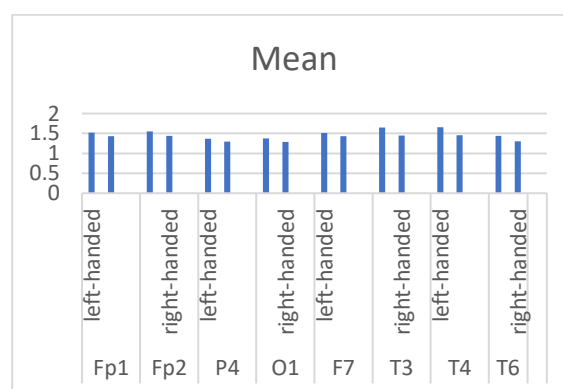
Many studies documented that left hemisphere is dominant in language functions (Gaillard, et al., 2003; Bishop, 2013; Goodglass and Quadfasel, 1954). But there is an evidence of bilaterally and left hemisphere lateralization for speech and language (Knecht, et al., 2000). But atypical lateralisation is obtained in non-right-handed children in fMRI studies (Szaflarski, 2012) or in studies used transcranial Doppler sonography (Haag, et al. 2010; Groen, Whitehouse, Badcock and Bishop, 2012). It is assumed that right handed people have left hemispheric language domination, while some studies approved that left-handed people have right hemisphere as a dominant hemisphere in language procession (Basic, Hajnsek, Poljakovic, Basic, Culic, Zadro, 2004). Also, different aspect of language may have different lateralisation. Speech production activate left hemisphere (Hickok and Poeppel, 2007), or may have bilateral activation (Poeppel, 2014). The same model is presented in publications for auditive perception (Hickok and Poeppel, 2007; Poeppel, 2014), same situation is in speech comprehension, but with strong evidence of left lateralisation (Peelle, 2012). But many studies generally accepted the fact that over 90 % of right-handed people have left hemisphere dominance in language skills and that 70 % of left-handed people have the same side of lateralisation (Knecht, et al., 2000; Lust et al. 2011; Whitehouse and Bishop, 2009).

2 METHODOLOGY

The aim of this study is to examine lateralisation of cortical activity during auditory stimulation in left and right-handed children using EEG recordings. Twenty children participated in this study divided in two groups according to hand use preferences: Group 1 consisted 10 children with left handedness and group 2 with 10 children with right handedness. All children are age-matched, and aged between 5-7 years old. All participants achieved the regular score on Wechsler intelligence scale for children. Also, all of them are native Serbian speakers. For handedness measure we used the Test of lateral domination for senses and motor skills. Children were without any kind of diagnosis (speech and language impairment, hearing impairment, neurological and psychological disorders). EEG recordings were recorded using the Nihon Kohden Corporation EEG 1200K Neurofax apparatus with Electrocap. Total of 19 EEG channels were recorded. Electrodes were positioned according to the 10/20 International system for electrode placement. The reference will be set offline to A1 and A2 (ear lobes). Impedance will be kept below 5 k Ω , with not more than 1 k Ω between electrodes. The EEG recording experiment was consisted of two parts: First part was consisted of resting state recording for two minutes with open eyes. The participants were asked to minimise the movement because of possible artefacts that may influence the quality of EEG trace. The second part of recording were verbal stimulation. Children were asked to listen word stimuli that were auditory represented. They listened 5 trials of word stimuli. Children were listening to 5 different stimuli of words. Stimuli were presented binaurally at 50 dB sound pressure level via earphones, with soft plastic ear-plugs. The participants listened to auditory presented words with an inter-stimulus interval of 1.5 seconds.

EEG signals (resting state and auditive stimulation) were examined using fractal dimension for EEG complexity and power spectra analysis to analyse three brain rhythms theta, alpha (low and high) and beta. Fractal dimension (FD) is a nonlinear measure of signal complexity in time domain. The FD of EEG was calculated by using Higuchi's algorithm (Higuchi 1988). Fractal analysis was performed by estimating FD values of EEG time series during resting state. We used IBM SPSS 23 program for statistical analysis Mean absolute spectral power was computed by using the descriptive statistics, and one-Way Anova with descriptive statistics.

3 RESULTS AND DISCUSSION



Graph 1. Mean value of fractal dimension (FD) in Fp1, Fp2, P4, O1, F7, T3, T4 and T6 electrode locations during resting state. Note – mean (M) of FD values are present in charts; only electrode locations where the statistically significant increase or decrease in FD with an increase in left-handed children are presented ($p < 0.01$).

We analysed differences in resting state between groups using one-way ANOVA in each 19 electrodes (Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6, Fz, Cz, Pz).

A one-way ANOVA showed statistically significant difference in FD values in Fp1, Fp2, P4, O1, F7, T3, T4, T6 between groups ($p < 0.01$) (Graph 1).

FD value is significantly higher in presented electrode in left-handed children (Table 1a). To evaluate the lateralization in FD values we compute FD values of the electrodes positioned left (Fp1, F3, C3, P3, O1, F7, T3, T5) or electrodes situated on right side of the head surface (Fp2, F4, C4, P4, O2, F8, T4, T6). Result is presented in table 1a and 1b. Complexion in EEG activity is higher in left than in right-handed children with no difference in part of brain hemisphere (Table 1b).

Table 1a. Mean values and St. Deviation of FD in resting state in left positioned electrodes

Left positioned electrodes average	Mean	Std. Deviation
left-handed	11.6511	.78660
right-handed	10.9703	.63372

Table 1b. Mean values and St. Deviation of FD in resting state in right positioned electrodes

Right positioned electrodes average	Mean	Std. Deviation
left-handed	11.7428	.82073
right-handed	10.9417	.70412

For spectral power evaluation the following cortical regions were analysed: Left Frontal (Fp1, F3, F7), Right Frontal (Fp2, F4, F8), Left Temporal (T3, T5), Right Temporal (T4, T6), Left Centro-Parietal (C3, P3), Right Centro-Parietal (C4, P4) and Central (Fz, Cz, Pz). The spontaneous (resting) EEG was recorded for 10 minutes. Resting state was used to determine mean spectral power values for theta (4–8 Hz), low alpha (8–10 Hz), high alpha (10–13 Hz), low beta (13–20 Hz) in frontal, temporal and parietal cortical regions. These four brain rhythms were obtained, and their spectral power was analysed. For each rhythm, the mean spectral power (averaged for epochs for each participant) in left frontal (LFR), right frontal (RFR), left temporal (LTR), right temporal (RTR), left Centro-parietal (LCPR), right Centro-parietal (RCPR) and central (CR) regions was further used in statistical analysis.

Table 2 Results for mean value and standard deviation of spectral power (μV^2) of all examined rhythms in different regions in resting state. Significant differences are showed with bolded letters ($p < 0.01$).

Regions		Theta		Low Alpha		High Alpha		Beta	
		M	St.D	M	St.D	M	St.D	M	St.D
LFR	LH	10.3506	2.285	4.8599	1.537	4.0808	1.048	5.0119	1.078
	RH	11.8974	1.678	7.8664	1.814	6.6175	3.886	6.2288	1.637
RFR	LH	9.9295	1.854	4.9677	1.180	4.1628	.933	5.5357	1.442
	RH	11.9029	1.913	7.1799	1.790	6.6579	4.347	6.2934	1.428
LTR	LH	6.9392	1.861	3.4838	.736	2.7710	.734	2.8769	.678
	RH	7.3974	1.038	5.6442	1.150	5.1271	3.164	.0261	703
RTR	LH	6.7516	1.471	4.0262	1.039	2.9919	.784	2.6230	.476
	RH	7.7865	1.306	6.9971	2.179	5.6074	4.021	3.7637	.637
LCPR	LH	5.2469	1.154	4.0262	1.039	2.5491	1.120	2.1526	.484
	RH	5.6397	1.675	6.9971	2.179	4.4283	2.724	2.9196	.636
RCPR	LH	5.6144	1.544	2.7186	.677	2.6997	.892	2.1749	.464
	RH	5.7719	1.444	5.8918	1.481	4.6190	3.256	2.9499	.89
CR	LH	9.3473	2.029	4.8286	1.097	4.0452	1.202	5.8382	1.778
	RH	10.8041	1.997	7.5271	1.405	6.5065	3.957	5.1093	1.005

Spectral power of low alpha showed significant differences between two groups (Table 2). Higher value of spectral power of low alpha was estimated in right-handed bilaterally. But High alpha showed

significantly higher values also in left temporal regions in right-handed participants. Beta rhythm also had higher values of spectral power in left but also in the right temporal regions in right-handed children.

Table 3 Results for mean value and standard deviation of spectral power (μV^2) of all examined rhythms in different regions in during word listening. Significant differences are showed with bolded letters ($p < 0.01$).

Regions	Hand	Theta		Low Alpha		High Alpha		Beta	
		M	St.D	M	St.D	M	St.D	M	St.D
LFR	LH	10.1825	2.393	3.8327	1.075	4.0237	1.178	4.2060	1.214
	RH	11.5902	6.340	5.6826	3.297	5.9395	3.951	5.0484	2.002
RFR	LH	9.7345	2.654	3.7033	1.265	4.0874	1.062	4.7651	1.219
	RH	11.8784	6.343	5.9038	3.917	1.2655	3.556	5.4082	1.977
LTR	LH	6.8785	2.176	2.5736	.728	3.9171	.820	2.5858	.985
	RH	7.9375	4.396	4.2730	2.265	4.1186	2.327	3.1768	1.176
RTR	LH	7.5818	3.630	3.2488	1.787	2.7874	.995	2.6476	1.005
	RH	7.8270	4.838	5.4859	2.528	4.6996	2.405	3.0797	1.268
LCPR	LH	5.0265	1.683	2.0975	.894	1.9473	.640	1.8457	.589
	RH	5.6728	4.987	3.4922	1.899	3.3801	1.935	2.2680	1.074
RCPR	LH	5.6092	2.132	2.2751	1.078	2.1253	.751	1.9435	.678
	RH	5.8909	4.777	4.1126	2.307	3.6116	2.026	2.3121	.894
CR	LH	9.3579	2.355	3.4991	1.193	3.6207	.867	4.7658	1.264
	RH	9.7481	6.898	5.4658	2.993	5.4144	2.914	4.4488	1.420

Table 3 shows that right-handed children and left-handed children have significant differences in spectral power of low alpha, high alpha and beta band during word listening, and differences are presented bilaterally with no highlighting of some hemisphere specially. But spectral power of high alpha is more frequent in right frontal regions in left-handed than in right-handed participants. If we look from the aspect of hemispheric activation bilaterally activation is presented in all examined regions for alpha and beta range. It can be concluded that left-handed children have bilaterally activation in age 5-7. Similar results were reported by transcranial magnetic stimulation study, that left handers have bilaterally language distribution (Tussis, Sollmann, Boeckh-Behrens, Meyer, Krieg, 2016).

Differences are obtained in these two conditions: resting state and word listening. Verbal stimulation is associated with high alpha activation and activation in beta range in both group with significant in left and right hemisphere. Spectral power of alpha range increases but theta band decreases with age in early childhood (Boersma, et al., 2011; Miskovic, Ma, Chou, Fan, Owens, Sayama, Gibb, 2015, Perone, et al., 2018).

4 CONCLUSION

We analysed the FD value and spectral power value in resting state between children with right or left handedness. Also, we analysed spectral power value between groups while they were listening serial of words.

It can be concluded that there is a bilaterally activation during word listening in our group of participants for different brain waves. Significant differences were in spectral power of alpha range and beta range in temporal, frontal and Centro-parietal brain regions. Also, differences were detected in high alpha and beta range of spectral power in auditive stimulation relative to resting state. The lack of this investigation may lie in small number of sample and also age of the participants. Because of the fact that multiple brain rhythms appear in diverse conditions during childhood (Perone, Palanisamy, Carlson, 2018).

ACKNOWLEDGMENT This study was supported by Ministry of Education, Science and Technological Development of the Republic of Serbia (Lj. Jeličić Grant No. OI178027 and I. Veselinović Grant No. 179055).

REFERENCES

- Basic S, Hajnsek S, Poljakovic Z, Basic M, Culic V, Zadro I. (2004). Determination of cortical language dominance using functional transcranial Doppler sonography in left-handers, *Clinical Neurophysiology*, 115(1):154-60.
- Bishop DVM. (2013). Cerebral asymmetry and language development: cause, correlate, or consequence? *Science* 340(6138):1230531 DOI 10.1126/science.1230531.
- Boersma, M., Smit, D. J. A., De Bie, H. M. A., Van Baal, G. C. M., Boomsma, D. I., De Geus, E. J. C., ... Stam, C. J. (2011). Network analysis of resting state EEG in the developing young brain: Structure comes with maturation. *Human Brain Mapping*, 32(3), 413–425. <https://doi.org/10.1002/hbm.21030>.
- Gaillard WD, Sachs BC, Whitnah JR, Ahmad Z, Balsamo LM, Petrella JR, Branietcki SH, McKinney CM, Hunter K, Xu B, Grandin CB. (2003). Developmental aspects of language processing: fMRI of verbal fluency in children and adults. *Human Brain Mapping* 18(3):176_185 DOI 10.1002/hbm.10091.
- Goodglass, H., & Quadfasel, F.A. (1954). Language laterality in lefthanded aphasics. *Brain*, 77, 521 – 548.
- Groen MA, Whitehouse AJO, Badcock NA, Bishop DVM (2012) Does cerebral lateralization develop? A study using functional transcranial Doppler ultrasound assessing lateralization for language production and visuospatial memory. *Brain Behav* 2: 256–269.
- Haag A, Moeller N, Knake S, Hermsen A, Oertel WH, et al. (2010) Language lateralization in children using functional transcranial Doppler sonography. *Dev Med Child Neurol* 52: 331–336.
- Hickok G, Poeppel D. (2007). The cortical organization of speech processing. *Nature Reviews Neuroscience* 8(5):393_402 DOI 10.1038/nrn2113.
- Higuchi, T. (1988). Approach to an irregular time series on the basis of the fractal theory. *Phys D*, 31(2), 277-283
- Knecht, S., Deppe, M., Dräger, B., Bobe, L., Lohmann, H., Ringelstein, E.-B., et al. (2000). Language lateralization in healthy right handers. *Brain*, 123, 74–81.
- Lust JM, Geuze RH, Groothuis AGG, Van der Zwan JE, Brouwer WH, et al. (2011). Driving performance during word generation—Testing the function of human brain lateralization using fTCD in an ecologically relevant context. *Neuropsychologia* 49: 2375–2383.
- Miskovic, V., Ma, X., Chou, C., Fan, M., Owens, M., Sayama, H., Gibb, B. (2015). Developmental changes in spontaneous electrocortical activity and network organization from early to late childhood, *NeuroImage* 118, 237–247 doi.org/10.1016/j.neuroimage.2015.06.013 Get rights and content
- Peelle J. (2012). The hemispheric lateralization of speech processing depends on what "speech" is: a hierarchical perspective. *Frontiers in Human Neuroscience* 6: Article 309 DOI 10.3389/fnhum.2012.00309.
- Perone, S., Palanisamy, J., Carlson, S. (2018). Age-related change in brain rhythms from early to middle childhood: Links to executive function, *Developmental Science*.21(6): e12691. doi: 10.1111/desc.12691
- Poeppel D. (2014). The neuroanatomic and neurophysiological infrastructure for speech and language. *Current Opinion in Neurobiology* 28:142_149 DOI 10.1016/j.conb.2014.07.005.
- Szaflarski JP, Rajagopal A, Altaye M, Byars AW, Jacola L, et al. (2012) Lefthandedness and language lateralization in children. *Brain Res* 1433: 85–97.
- Tussis, L., Sollmann, N., Boeckh-Behrens, T., Meyer, B., Krieg, S.(2016) Language function distribution in left-handers: A navigated transcranial magnetic stimulation study, *Neuropsychologia* 82 65–73
- Whitehouse AJO, Bishop DVM (2009). Hemispheric division of function is the result of independent probabilistic biases. *Neuropsychologia* 47: 1938–1943.

Evoking Lexical Units In Children With Specific Language Impairment And Irregular Patterns Of EEG Activity

Sunčičac Đorđević¹, Marija Đorđević^{1,2}, I. Bacić¹

¹Institute for Experimental Phonetics and Speech Pathology,
Gospodar Jovanova Street, 35, 11000 Belgrade

²Institute for Research and Development “Life Activities Advancement Centre”
Gospodar Jovanova Street, 35, 11000 Belgrade

ABSTRACT

This study shows the results of an evaluation of the ability to evoke the lexical units in children with specific language impairment. The research was carried out in order to determinate the difference in the ability to evoke the lexical units between children with specific language impairment and irregular patterns of electroencephalographic (EEG) findings compared with children who have a specific language impairment and normal EEG findings. The sample was taken from 10 children with specific language impairment and irregular patterns of electroencephalographic activity, and 10 children with specific language impairment and a normal EEG finding, ages 5 to 7 years. The ability of evoking the lexical units is estimated with the Test Dictionary for children aged 3 to 7 and the Test Verb. The study found that there is a significant difference in the ability to evoke the nouns in children with specific language impairment and irregular patterns of electroencephalographic findings compared to children with specific language impairment and normal EEG findings. There was no statistically significant difference between these groups in the ability to evoke the verbs.

Key words: lexical-semantic ability, specific language impairment, evoking lexical units, changes in electroencephalographic activity.

1 INTRODUCTION

The evoking of lexemes has been the topic of much research and represents a significant and evolutionary area in the study of children with Specific Language Impairment (SLI). Research in this area has found differences in the nomination of lexemes in children with SLI. The results also show that on nomination tasks children with SLI tend to adopt verbs more difficult than nouns (Sheng, McGregor, 2010; Kambanaros et al., 2014).

A lexeme (word) is a complete and self-contained unit of meaning, created in the conventional conjunction of sound and meaning by the attachment of certain relatively constant conceptual content to particular phonemes or combinations of phonemes. The lexeme is largely independent of larger units, that is, constructs such as syntagms or sentences, as it can stand on its own, as the smallest free linguistic unit that can form a complete expression (Bugarski, 1996).

There are 10 types of lexemes in Serbian. These are: nouns, pronouns, adjectives, numbers, verbs, conjunctions, exclamations, adverbs, prepositions and words. Nouns represent the first kind of words that children adopt in their lexicon (Kostić, Vladislavljević, 1983). Considering the difference between verbs and nouns, it is pointed out that in its simplest form the verb denotes an action or condition, while a noun denotes a being or thing (Bird et al., 2003). In addition, the semantic representations of the verb are more complex than nouns (Genter, 1981). Research findings indicate that nouns in children with SLI are nominated faster than verbs (Tyler et al, 2001), both in younger and older children with SLI (Andreu et al., 2012).

SLI is characterized by a delay or atypical pattern in the development of expressive and / or receptive language abilities, in the absence of general cognitive deficits, autism, auditory impairments, social and emotional disorders and severe environmental deprivation (Drljan, Vuković, 2017). SLI is a speech and language disorder in which the child's ability to understand speech is below what is expected for his or her mental age (Sovilj, 2013).

The clinical picture of SLI consists of the following deficits:

- auditory perception deficits
- phoneme perception deficits
- adult fast speech tracking deficits
- sequence deficits
- verbal memory deficits
- visual perception deficits
- spatial orientations and attention
- speech production and speech comprehension deficits
- phonological and articulatory deficits
- morphological and grammatical deficit
- pragmatic deficit
-

The syntax, semantics and structure of words are age-appropriate. Echolalia and metathesis are possible, while paralinguistic signs are normal and responses to acoustic signals are adequate. Phonemic hearing is not sufficiently mature for the child's age, the development of the meaning of words is the level of understanding of frequency lexemes, while understanding the language statements exists for a simple verbal tasks (Golubović, 2016). This data is in line with previous research in this area showing that the clinical picture of SLI is characterized by a scarce vocabulary (Vladisavljević, 1987). Children with SJP exhibit difficulty in adopting a lexicon, which is manifested by deficits in word comprehension and use (Rappin, Allen, 1983), as well as in the ability to name and impede the acquisition of lexical structure (Milošević, Vuković, 2017).

EEG can be viewed as a complex composite signal (a set of brain waves), which is characterized by a certain amplitude, frequency and location of origin localization (topographic with respect to the position of the measuring electrode on the scalp). Given these parameters, brain waves are divided into α - waves (alpha), β - waves (beta), γ - waves (gamma), θ - waves (theta), δ - waves (delta). The frequency of irregular patterns in electroencephalographic activities in children with SLI ranges from 1.5% to 8.7% (Maccario et al, 1982). However, more recent studies indicate that irregular patterns in electroencephalographic activity can be found in 15% of children with SLI (Nasr et al., 2001) and the frequency of focal epileptiform discharges without concomitant paroxysmal symptoms in children with SLI is 12.3% (Vuković, 2017).

2 AIM OF THE RESEARCH

The aim of this study is to determine the ability to evoke lexical units in children with SLI and irregular patterns electroencephalographic activities compared with children with SLI and a normal EEG finding.

Research Hypotheses

1. It is expected that children with SLI and irregular patterns of EEG findings show lower achievement evoking of concrete nouns on the Vocabulary Test in relation to children with SLI and normal EEG findings. Children with SLI mainly use nouns, most notably those that designate specific terms or terms that are often used. Nouns are usually used in the singular to the first grammatical (Golubović, 2016). Research findings in children with SLI show that there is a deficit in the naming of concrete nouns (Škara and Vuković, 2017).

2. It is expected that children with SLI and irregular patterns of EEG findings show lower achievement evoking of abstract nouns on the Vocabulary Test in relation to children with SLI and normal EEG findings. Children with SLI have a very difficult time mastering words that express abstract concepts. If there is a need to express such a term then it is expressed by a verb or an adjective (Golubović, 2016).

3. It is expected that children with SLI and irregular patterns of EEG findings show lower achievement evoking of verbs on the verb test in relation to children with SLI and normal EEG findings. According to the literature, SLI children most commonly use the verb in the third person singular, followed by the use of the first person singular. In particular, interference with the use of auxiliary verbs of all complex forms and the pronoun “se” are manifested (Golubović, 2016). Children with SLI find it easier to evoke verbs that are more frequently used in speech than to less frequent used verbs (Kambanaros, Grohmann, 2015).

3 METHOD

The study was conducted at the Institute for Experimental Phonetics and Speech Pathology (IEFPG) ‘Đorđe Kostić’, in June 2018. The sample consisted of 20 respondents, aged 4 to 6 years, divided into two groups by the EEG findings. There were 10 respondents in both groups. Groups were balanced in both: age and gender. The first group (E1) consisted of respondents diagnosed with SLI and irregular patterns of EEG findings. The EEG findings of the children of the first experimental group are very similar or completely the same. The second group (E2) consisted of respondents with SLI and normal EEG findings. Each subject who participated in this research is in intensive speech and language treatment at the Institute for Experimental Phonetics and Speech Pathology ‘Đorđe Kostić’ in Belgrade. The diagnosis of SLI was made on the basis of a quantitative analysis of the responses obtained from the results of the IEFPG Test Battery, anamnestic data, and supplementary tests. On the basis of medical records and anamnestic data, auditory, intellectual and neurological impairment were excluded as a possible cause of language impairment.

The criteria for inclusion of the respondents in the group of children with SLI were:

- 1) Diagnosed with SLI;
- 2) The average (or above-average) intellectual status of the child;
- 3) Absence of hearing and vision impairment;
- 4) Absence of severe motor and physical damage;
- 5) Absence of psychotic disorder;
- 6) Absence of visible cerebral pathology;

All subjects included in this study were tested in the same way, individually.

Data processing

After data collection, statistical processing was applied in the SPSS 23 data processing software. Central tendency and variability measures (arithmetic mean, standard deviation, minimum and maximum values) were used to represent the basic statistical indicators. The following is a data processing plan containing the specification of the statistical tests that were used for each research hypothesis. T-test for independent samples was used to check H1, H2 and H3.

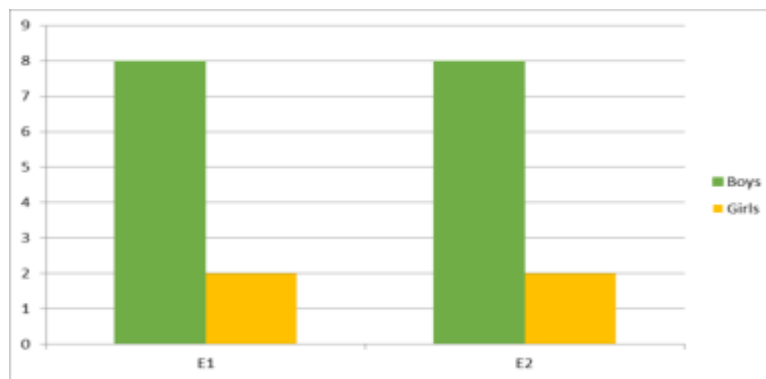
4 RESULTS OF THE RESEARCH

The data in Table 1. shows basic statistical parameters for the experimental and control groups. The Student's t-test shows that there is no statistically significant difference in the age of these two groups of children, which gives the possibility and meaning to compare the two groups.

Table 1 - Comparison of groups by their age

	E1	E2	Total
N	10	10	20
M	4.9	4.9	
Max age	6	6	
Min age	4	4	
SD	0.538	0.700	
t (t)	p=1.00 p>0.05		

Both experimental groups are balanced according to gender, what is shown in Graph 1. Each group included two girls and eight boys. This relationship is consistent with the fact that SLI occur more frequently in boys (Golubović, 2012).



Graph 1- Gender of subjects

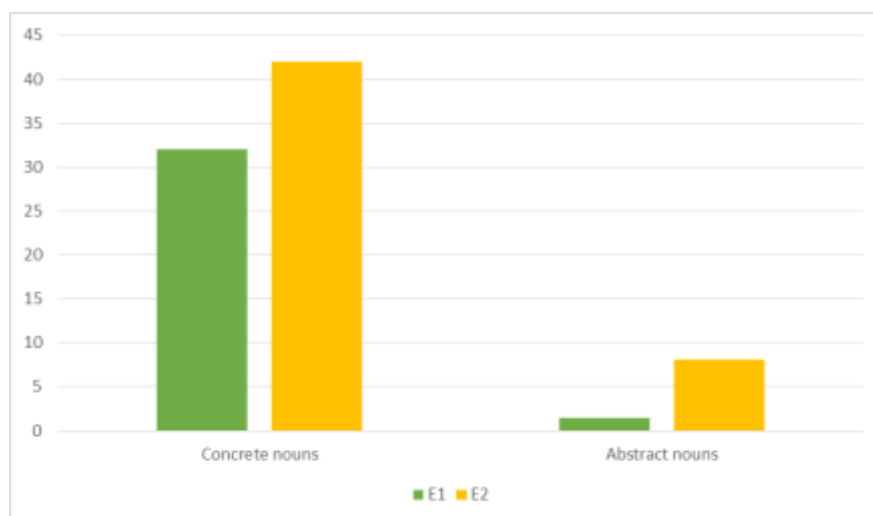
Results of the assessment of the evoking of specific nouns in children with SLI and irregular patterns electroencephalographic activities and respondents with SLI and normal EEG findings are shown in Table 2.

Table 2. Score distribution – Vocabulary Test for children 3 to 7 years - group with SLI and regular EEG findings (N = 10)

	Min	Max	M	SD
Vocabulary test total	27	38	33.40	4.871
Vocabulary test concrete nouns	27	36	32.00	2.863
Vocabulary test abstract nouns	0	6	1.40	2.009

On all subtests of the Vocabulary Test for children 3 to 7 years old, a statistically significant difference was registered between the group of children with SLI and irregular patterns of electroencephalographic activities and the control group (Graph 2). Children with SLI and irregular patterns

of EEG activities evoke a significantly lower number, both abstract and concrete nouns, indicating that they also have a poorer vocabulary than children with SLI and normal EEG findings. Examination of the ability to evoke nouns (Test Dictionary for children from 3 to 7 years) showed that children with SLI and irregular patterns of electroencephalographic activities were statistically significantly different from the control group ($t = -5.661$; $df = 12.223$; $p < .05$). There was a statistically significant difference both in the domain of evoking concrete nouns ($t = -6.546$; $df = 18$; $p < .05$) and in the domain of evoking abstract nouns ($t = -3.686$; $df = 17,762$; $p < .05$) between the experimental and control groups.



Graph 2: Test vocabulary for children from 3 to 7 years

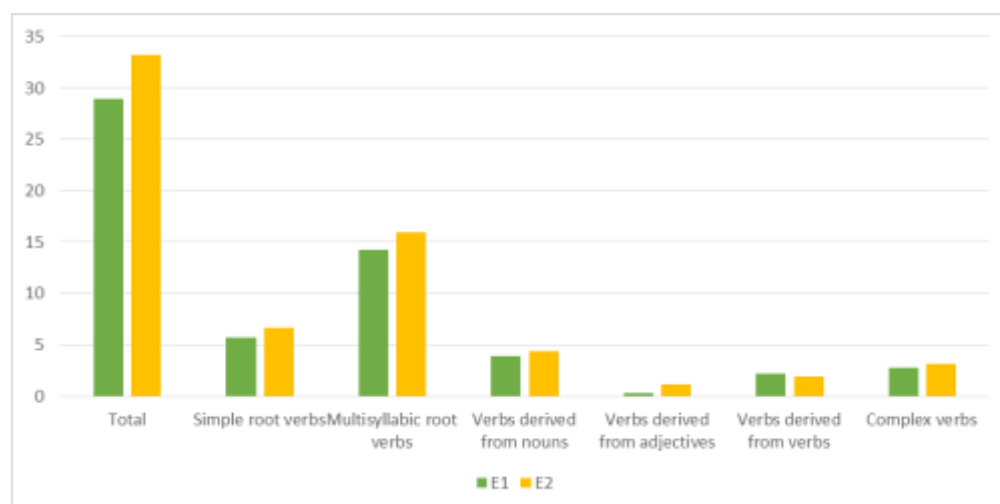
Results of verb naming assessment for subjects with SLI and irregular patterns of EEG findings and subject with SLI and normal EEG findings are given in Table 3.

Table 3 Total verb evoking ability score- presentation of t-test results

	Min	Max	M	SD
Verb test total	20	38	28.90	5.430
Simple root verbs	4	8	5.70	1.187
Multisyllabic root verbs	10	18	14.20	2.675
Verbs derived from nouns	1	7	3.90	1.700
Verbs derived from adjectives	0	1	0.30	0.458
Verbs derived from verbs	0	4	2.20	1.077
Complex verbs	0	5	2.80	1.536

In only one subtest of the Verb Test, a statistically significant difference was registered between the group of children with SLI and irregular patterns of electroencephalographic activities and children with SLI and a normal EEG finding (Graph 3). Children with SLI and irregular patterns of EEG activities evoke significantly fewer adjective-derived verbs, compared to children with SLI and normal EEG findings. However, in the other subtests of the Verb Test, there is no statistically significant difference between the experimental and control groups. The verb evocation test (Verb test) showed no statistically significant

difference between children with SLI and irregular patterns of electroencephalographic activities and the control group ($t = -2.091$; $df = 13.819$; $p > 0.05$). There was a statistically significant difference on the subtest of evoking verbs derived from adjectives between the experimental and control groups ($t = -2.869$; $df = 15.507$; $p > .05$)



Graph 3: Verb test

5 DISCUSSION

The aim of this paper was to examine the ability to evoke lexical units in children with SLI and irregular patterns of EEG findings. The test was performed in the domain of evoking nouns (Test dictionary for children from 3 to 7 years), and in the domain of evoking verbs (Test of verbs). Hypothesis 1 - A test of the noun evoking ability (Test Dictionary for children 3 to 7 years) showed that children with impaired language development and irregular patterns of electroencephalographic activities were statistically significantly different from the control group. There was a statistically significant difference both in the domain of evoking concrete nouns ($t = -11.26$, $df = 38$, $p < .05$) and in the domain of evoking abstract nouns ($t = -11.26$, $df = 38$, $p < .05$) between the experimental and control groups. Earlier studies have shown that children with SLI and irregular patterns of EEG findings express greater deficits in lexical-semantics compared to children with SLI and normal EEG findings (Milošević & Vuković, 2011). The results of the study confirmed Hypothesis 1 and Hypothesis 2 and showed a statistically significant difference between the groups, a lower level of achievement in subjects with irregular patterns of EEG findings. Hypothesis 3 - Test of verb evocation ability (Verb test) showed statistically significant difference between children with SLI and irregular patterns of electroencephalographic activities and control group ($t = -4.83$, $df = 38$, $p < .01$). Hypothesis 3 was not confirmed.

6 CONCLUSION

The study attempted to deepen the knowledge of the ability to evoke lexical units in children with SLI and irregular patterns of EEG findings. Based on the goal set, working hypotheses and tasks described in the research, as well as the results obtained by investigating the ability to evoke lexical units in children with SLI and irregular patterns of EEG findings, the following can be concluded: children with SLI and normal EEG findings have better noun evocation abilities than children with SLI and irregular patterns of electroencephalographic findings. In children with SLI and irregular patterns of EEG findings there is less achievement in the field of evoking nouns, manifested by a significantly lower number of evoking of

concrete and abstract nouns, compared to children with SLI and irregular patterns of EEG findings. Also, there is no a statistically significant difference between these two groups of children in their ability to evoke verbs. We expect that further research in this area will contribute to a greater illumination of the evoking ability of lexical units in children with SLI and irregular patterns of EEG findings. We hope that this research will serve as a starting point for future research in this area. We believe that such research is forthcoming.

REFERENCES

- Andreu, L., Sanz-Torrent, M., Legaz, L. B. & MacWhinney, B. (2012). Effect of verb argument structure on picture naming in children with and without specific language impairment (SLI). *International Journal of Language & Communication Disorders*, 47(6), 637–653.
- Bird, H., Howard, D. & Franklin, S. (2003). Verbs and nouns: the importance of being imageable. *Journal of Neurolinguistics*, 16(2-3), 113–149.
- Bugarški, R. (1996). *Uvod u opštu lingvistiku*. Beograd: Zavod za udžbenike i nastavna sredstva.
- Drljan, B. i Vuković, M. (2017). Leksička raznovrsnost u narativnom diskursu dece sa specifičnim jezičkim poremećajem. *Specijalna edukacija i rehabilitacija*, 16(3), 261–287.
- Gentner, D. (1981). Some interesting differences between verbs and nouns. *Cognition and Brain Theory*, 4, 161–178.
- Golubović, S. (2016). *Razvojni jezički poremećaji*. Beograd: Društvo defektologa Srbije.
- Kampanaros, M. & Grohmann, K. (2015). Grammatical Class Effects Across Impaired Child and Adult Populations. *Frontiers in Psychology*, 6.
- Kampanaros, M. (2014). Context effects on verb production in specific language impairment (SLI): Confrontation naming versus connected speech. *Clinical Linguistics & Phonetics*, 28(11), 826–843.
- Kampanaros, M., Grohmann, K., Michaelides, M. & Theodorou, E. (2014). On the nature of verb–noun dissociations in bilingual SLI: A psycholinguistic perspective from Greek. *Bilingualism: Language and Cognition*, 17, 169–188.
- Kostić, Đ. i Vladislavljević, S. (1983). *Testovi za ispitivanje govora i jezika*. Beograd: Zavod za udžbenike i nastavna sredstva.
- Milošević, N. i Vuković, M. (2011). Leksičko semantičke sposobnosti dece sa specifičnim jezičkim poremećajem i nespecifičnim promenama elektroencefalografskih aktivnosti. *Specijalna edukacija i rehabilitacija*, 10(3), 435–443.
- Milošević, M. (2001). *Gramatika srpskog jezika*. Beograd: Izdavačka kuća „Draganić”.
- Rapin, I. & Alen, D. (1983). Developmental language disorder: Nosologic consideration. In U Kirk (Ed.) *Neuropsychology of reading, language, and spelling* (pp.155-184). New York: Academic press
- Sheng, L. & McGregor K. (2010). Object and action naming in children with specific language impairment. *Journal of Speech, Language, and Hearing Research*, 53, 1704–1719.
- Skipp, A., Windfuhr, K. L., & Conti-Ramsden, G. (2002). Children’s grammatical categories of verb and noun: a comparative look at children with specific language impairment (SLI) and normal language (NL). *International Journal of Language & Communication Disorders*, 37(3), 253–271.
- Sovilj, M. (2003). *Baterija testova IEFPG*. Beograd: Institut za eksperimentalnu fonetiku i patologiju govora "Đorđe Kostić".
- Sovilj, M. (2013). *Protokol za optimizaciju dečijih potencijala za učenje*. Beograd: CUŽA- IEFPG.
- Tyler, L., Russel, R., Fadili, J. & Moss, H. (2001). The neural representations of nouns and verbs: PET studies. *Brain*, 124, 1619–1634.
- Vasić, S. (1991). *Veština govorenja*. Beograd: Pedagoška akademija za obrazovanje učitelja.
- Vladislavljević, S. (1997). *Govor i jezik, jezik i govor*. Beograd: Zavod za udžbenike i nastavna sredstva.
- Škara, Z. i Vuković, M. (2017). Procena sposobnosti razumevanja jezik kod dece sa specifičnim jezičkim poremećajem ipromenama elektroencefalografskih aktivnosti: preliminarno ispitivanja. *Beogradska defektološka škola*, 23 (1), 27–40.

Salience and Situatedness in Croatian Sign Language

Dijana Posedi¹, Renata Geld², Diana Tomić²

¹Primary School Davorin Trstenjak
Krčka 3, 10000 Zagreb, Croatia

²Faculty of Humanities and Social Sciences, University of Zagreb
Ivana Lučića 3, 10000 Zagreb, Croatia
dtomic@gmail.com

ABSTRACT

This paper examines cognitive linguistics' concepts of salience and situatedness in Croatian Sign Language used by three groups of hearing impaired participants: profoundly deaf, cochlear implant users and participants who are hard of hearing. The results showed that the discussed cognitive concepts cannot be traced systematically in the linguistic expressions of the hearing impaired participants and that their verbal ability and communicative competence depend severely on their hearing status. Surprisingly, CI participants produced less, raising question about their rehabilitation. *Key words:* salience, situatedness, sign language, hearing impairment, cochlear implant.

1 INTRODUCTION

When observing people coming from different countries or communities one will often see differences in traditions and social behaviour and above all, differences in their language. Definition of language is rather simple when we are dealing with spoken languages, however when we wish to address sign languages there are numerous complications. First of all, unfortunately, sign languages are not always considered official languages but simply a signed representation of the spoken language. Moreover, signs are often considered the only part of the sign language. However, sign languages consist of many different components such as; body language, facial expressions, posture and gestures, while eye contact and touch also have an important role in communication among the deaf and hard of hearing. Thus, it is clear there are similarities as well as differences between spoken and sign languages, Swisher explains "Sign languages are different in some ways from spoken languages because of the constraints and possibilities afforded by the visual-gestural modality (...) Sign languages like spoken ones have syntactic, semantic, morphological, and phonological levels of analysis, and they are used to accomplish the same communicative functions." (1988, p. 343)

Since some of the signs are iconic, it is a widespread misconception that there is a unique sign language in the world. However, although the structures of different sign languages might be similar, they greatly differ from one another and they are a system of their own. In other words, just like spoken languages can have similarities and share words, so can sign languages. For example, while American English and British English are quite similar, British Sign Language and American Sign Language share some similarities in structure but differ in their lexicons.

Croatian sign language is considered an official form of communication of the deaf, deafblind and hard of hearing people in Croatia since 2015. According to the law, *Zakon o hrvatskom znakovnom jeziku i ostalim sustavima komunikacije gluhih i gluhoslijepih osoba u Republici Hrvatskoj*, sign language users have the right to be educated using Croatian sign language. However, such educational institutions which use sign language do not exist in Croatia. Educational centres usually provide services not only to deaf and

hard of hearing but also to children and young people with multiple disorders and therefore do not use sign language as their official language of communication.

Salience and Situatedness

This paper is rooted in the fundamental cognitive linguistic premise that language is not an independent cognitive faculty, but a complex experiential phenomenon that reflects our interaction with the world as well as intimately communicates with general cognitive processes (see Langacker 1987, 2000, Lakoff 1987, Croft and Wood 2000, Talmy 2000, Croft and Cruse 2004). Furthermore, it assumes that grammar and lexicon form a continuum, and serve as a conceptual tool in the process of meaning construction. Within this constructivist, usage-based framework, meaning is subjective, dynamic, and embodied. In other words, we cannot examine linguistic phenomena without addressing the fundamental triad – language, experience, and cognition (Geld and Stanojević 2018). Sign languages are in no way exempt from this triad. On the contrary, they are cognitively motivated and natural systems of communication that have a largely unexplored potential to provide insights into the human mind, its architecture and its organization. They reflect speaker's conceptualization and sophisticated ways of how cognitive processes are coded in language.

Even though research in cognitive linguistics had persistently addressed various construal operations that organically emerged from individual ideas, studies and theoretical constructs - from Fillmore's framing (1985) to Langacker's focal adjustments (1987), Talmy's schematic systems (2000), and Lakoff and Johnson's theory of conceptual metaphor (1980), the theoretical framework in terms of classification of construal operations was systematized in the early 2000s by Croft and Wood (2000) and Croft and Cruse (2004). They looked at a large body of research and theoretical constructs that had shaped the cognitive linguistic theoretical framework, and identified four cognitive processes, together with an elaborate taxonomy of subprocesses, that are coded in all natural languages: attention or salience, judgement or comparison, situatedness or perspective, and constitution or gestalt.

The key characteristic of salience or attention is its dynamic (or static) nature. In language this dynamics is evident in linguistically coded opposition between sequential or summary scanning (Langacker 1987). According to Langacker, summary scanning refers to a holistic conceptualization of a scene in its entirety, as opposed to sequential scanning that pertains to a scene in conceived time, which is not the same as objective time (Langacker 1987). This opposition can be illustrated by the following sentences:

(1) She is happy because her mother has returned home.

(2) She is happy because of her mother's return home.

Dynamic attention is also evident in the examples of fictive motion, as in the following sentence:

(3) A lot of roads climb over the rocky mountains of Velebit.

The roads themselves are not moving, but they are conceptualized as if they are – it is the speaker's mind's eye that is actually moving along the imaginary path. As proposed by Talmy (2000), fictive motion is a construal of a static scene in a dynamic manner.

Another cognitive process relevant for our study is situatedness or perspective. Our language has a rich inventory of constructions to reflect the conceptualization of the scene that codes the speaker's and hearer's position, as exemplified in the following sentences:

(4) The bus station is three stops away from where I am now.

(5) The bus station is three stops away from the main train station.

In example (4), the vantage point is explicitly described, whereas in example (5), the vantage point is conventionally identified with the speaker's vantage point.

The question that logically follows from this is whether we can identify these processes in sign languages, or, more specifically, in the Croatian Sign Language (CSL, *hrv. HZJ*). What we wish to propose is that not only are these processes identifiable in CSL, they are crucial in the process of meaning construal. Let us consider the following example:

(6) inform you (sg.) ≠ inform you (pl.)

(INFORM I $\longrightarrow$ YOU) $\neq$ (INFORM I $\longleftarrow$ YOU)

In CSL there is no schematic, that is, grammatical, coding of plural. In this particular example, the meaning is constructed by the conceptualizer's attention fictively moving from one object to another. The sign coding the dynamics of attention is symbolically represented by two arrows.

In the examples that follow grammatical persons are coded through changes in perspective:

(7a) I am asking you when you are coming.

(ASK I $\longrightarrow$ YOU WHEN COME)

(7b) You are asking me when I am coming.

(ASK YOU $\longrightarrow$ I WHEN COME)

Naturally, the above described processes can co-occur in cases where both number and grammatical person need to be coded, as in the examples that follow:

(8a) I am asking you when you are coming.

(ASK I $\longleftarrow$ YOU (pl.) WHEN COME)

(8b) You are asking us when we are coming.

(ASK YOU (sg.) $\longleftarrow$ WE WHEN COME.)

What all of these examples illustrate is that the Croatian Sign Language is a motivated system that reflects previously mentioned triad, that is, the user's complex conceptualization of the objective scene that he/she is describing and experiencing, as well as intricate interrelationship between language and general cognitive processes. The latter prompted the study we shall describe in the sections that follow.

2 AIM

The aim of this study is to examine the expression of spatial directions among three groups of hearing impaired participants and to interpret them within cognitive linguistics as a theoretical framework.

3 MATERIAL AND METHOD

Participants

The study included 18 participants (8M and 10F) aged between 20 and 48. They were recruited through the Croatian sport federation of the deaf and questioned during a football competition in Slavonski Brod. Most of the participants were in their twenties and active athletes. 15 participants were from Croatia, one from Bosnia and Herzegovina, one from Austria and one from Hungary. Four participants used more Croatian SL and two or more SLs. Regarding their hearing status, nine were profoundly deaf (PD), five were hard of hearing (HOH) and four were using cochlear implant (CI). The CI subgroup was responding

more like the profoundly deaf group (PD), both in verbal responses and SL use implying that the hearing did not develop after the implantation so that they start to use listening as they first communication choice.

Tasks

The participants were given three tasks. The first one was to describe a route reachable on foot. Usually it was a route they used often, to go to work or something similar. The second task was to describe a marked route on a faculty floor map (Figure 1 below).

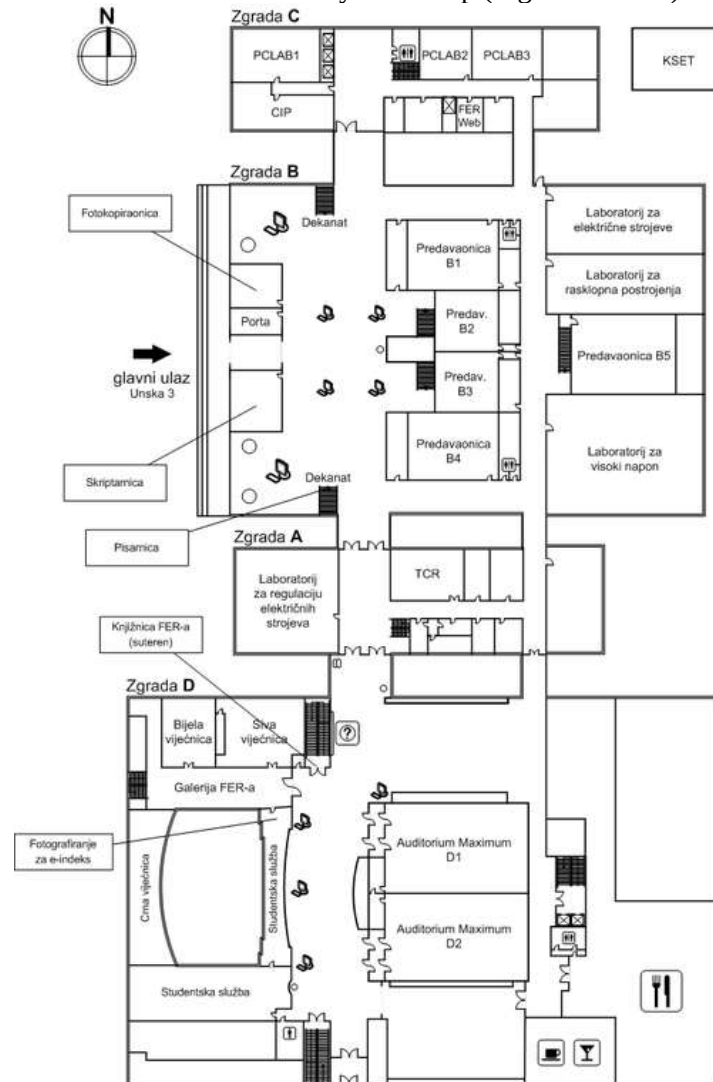


Figure 2: Faculty floor map used in task 2

The third task was to describe a marked route on a town map. Zagreb City Center was used. The map was made for this study by using Google maps.

Procedure and Analysis

All participants were individually tested. After a brief interview about their demographics, they were asked about their hearing status and use of sign languages. After that the three tasks were administered, the

second and the third with visual prompts. The answers were recorded, transcribed and assessed by the authors.

Due to the sample size and heterogeneous hearing status qualitative analysis was applied.

4 RESULTS AND DISCUSSION

Two groups of participants (PD and CI) mostly talk about the type of transportation (bus, car, bicycle, on foot) in Task 1, although they were asked to describe a route reachable on foot. Some included information about accompanying person (a friend, an interpreter) or emphasized it's not a complicated route so they go alone, implying that in other, more complicated cases, they would need some help. Sometimes it seemed as if they did not understand the question or don't know how else to describe the route.

Exp. 1

Ja živim u selu. Škola je blizu. Poslije mature vozim se tramvajem. Idem do naselja. Treba 25 minuta, ovisi o prometu. Ako je gužva. Onda, puno putujem. Ali, po selu kombijem. Ili svojim biciklom. Pješke ne volim, biciklom idem.

/I live in a village. The school is close. After graduation I take the tram and go to my suburb. It takes 25 minutes depending on the traffic. If there is a traffic jam I travel a lot. But in the village I use van. Or my bike. I don't like to walk. I ride bike./

Exp. 2

Ja vozim auto. Vozim u trgovinu, u grad. Ne idem busom. Idem u kupovinu za odjeću, hranu. Ja živim u selu, onda idem u trgovinu i povremeno vozim ili idem biciklom ili pješke. U gradu isto vozim, malo idem pješice.

/I drive a car. I drive to the store, in the city. I don't take bus. I go shopping, clothes, food. I live in a village and go to shop and occasionally drive or go by bike or on foot. In the city I also drive, or walk./

Exp. 3

*Zagreb do Split autobusom. Zagreb do autobusni kolodvor. Pa autobus do Split.
/Zagreb to Split by bus. Zagreb to the bus station. And bus to Split./*

Exp. 4

*Ja se dogovorim s prijateljem. Čujem zvono, onda se spustim. Otvorim vrata.
/I arrange with my friend. I hear the doorbell, come down. Open the door./*

The participants from PD or CI groups responded either by longer or shorter narrative, but, as shown in the previous examples, the narrative often did not include answer to the question but described the context of the routine route they were supposed to describe. The sequencing concept in route description, either special or temporal, can be interpreted as a key information for that specific task and it was not communicated. There are several possible explanations, one is the importance of hearing for spatial orientation, therefore PD participants had no such experience and do not need to communicate it nor use SL structure for the language construal. Additional feature noted in their answers is that the sentences are short and function words are missing. This finding is confirmed by numerous studies on hearing impairment, because grammatical words are less informative, therefore less perceptually prominent, shorter and with unstressed vowels making them even less perceivable.

Another interesting case was that a female participant explained that she goes to school by bus and when she enters the bus, she gives the driver a piece of paper where it says what her stop is.

Exp. 5

Ja idem sama na autobus. Kada sam imala tri godine, ja idem sama na autobus. Nije problem. Autobus stane, otvori vrata. Ja se penjem po stepenicama u autobus. Vozač me pita kuda idem, na primjer Odak, onda ja napišem i dam mu papirić. Mogu ići do škole, fakulteta. Ja hodam po autobusu i sjednem. Onda izađem i pješice idem do škole. Išla sam do osnovne škole sama vlakom. Vlak dođe, ja sjednem. Kondukter dođe, ja dam kartu, nije problem. Onda idem sama pješice u školu. Osijek do Zagreb idem autobusom. Onda tramvajem idem dalje.

/I'm on the bus alone. When I was three years old, I went on the bus alone. Not a problem. The bus stops, opens the door. I climb the stairs on the bus. The driver asks me where I'm going, for example Odak, then I write it down and give him the of paper. I can go to school, college. I walk on the bus and sit down. Then I go out and walk to school on foot. I went to elementary school by train alone. The train comes, I sit down. The conductor comes, I give the ticket, no problem. Then I go to school on foot. Osijek to Zagreb by bus. Then I take the tram./

We looked into the responses from CI group. Surprisingly the utterances were shorter and did not provide any additional information, which is unusual because CI should give its users ability to experience more and form their knowledge on richer auditive experience.

Exp. 6

Autobus, tramvaj, pješke. Isto. Do dućana do objasnim? U Osijeku? To je blizu. Idem pješice isto i tramvajem. (Ispitivač moli da objasni put). Baš je blizu kuće. Baš blizu.

/Bus, tram, walk. It is the same. To the shop, I should explain? In Osijek. It is close. (The examiner asks to explain the route). It is really close to home. Really close./

Exp. 7

Na primjer idem u klub. Idem s tramvajem, a u dućan idem pješke. Idem samo ravno i gore. To je to. Jednostavno.

/I go to club for example. I take the tram and I walk to the shop. I go straight and up. That's it. Simple./

Exp. 8

Kuća ideš ravno, onda lijevo. Onda desno i tamo je trgovina.

/House go straight, then left. Then right and there is the store./

The second and the third tasks were even more challenging, yielding scarce verbal results. The participants would often just follow the path on the map with their finger, without the SL or use very simple instructions: go left, right, straight and you are there. Some of them used street names for the town map, but did not include all of them (Frankopanska, right, left, Sportska).

Exp. 9

Da objasnim naziv? Laboratorij za regulaciju električnih strojeva. Vrata pa izađeš. Lijevo hodnik, onda dva vrata. Ravno, onda malo desno. Ravno hodnikom. Skreni lijevo i hodaš ravno. (Prva-druga-treća) Četvrta vrata vidiš natpis Laboratorij za električne strojeve i uđeš unutra.

/Explain the name? Laboratory for Regulation of Electrical Machines. Door and out. Left hallway, then two doors. Straight, then a little to the right. Straight down the hall. Turn left and walk straight. (First-Second-Third) The fourth door you see the sign Laboratory for Electrical Machines and go inside./

Exp. 10

Ja sam sada u ulici Frankopanska. Ne, oprostite, u Sportska. Ideš Sportska pa skreneš, malo hodaš i vidiš natpis Dragutina Trstenjaka. Onda ideš lijevo skreneš, hodaš i vidiš natpis Obrtnička. Onda vidiš ulica Nikole Šipuća i ulica Franje Lovrića. Onda desno skreneš ulica Franje Lovrića. I prva cesta Frankopanska.

/I'm on Frankopanska Street now. No, sorry, in Sports. You go Sports and you turn, walk a little and see the inscription of Dragutin Trstenjak. Then you turn left, walk, and see the sign Obrtnička. Then you see Nikola Šipuč Street and Franjo Lovrić Street. Then turn right onto Franjo Lovrić Street. And the first Frankopan road./

Although used rarely, one participant used cardinal directions (South), one used counting: first, second, third door and one explained she would rely on the interpreter to take her to the lab, she also adds she would show the address on the paper.

The responses from participants whose hearing status was better (hard of hearing – HOH) confirmed better spoken language. When describing a route reachable on foot (Task 1), they used greater details in describing both their routines (I wake up, take my bag, go out of the house, enter the store...) and the route. They used quantified distance (1km, 100m) and specific landmarks while describing (a bridge, a light pole, a roundabout) the route.

Exp. 11

Sjednem u auto i dođem do trgovine. Vozim se. Detaljno? (Ispitivač potvrđuje). Ustanem iz kreveta, hodam, uzmem vreću, uzmem novčanik. Vrata otvorim, zatvorim. Hodam dolje po stepenicama, uzmem bicikl. Izađem iz dvorišta, otvorim vrata. Idem cestom, vozim biciklom nekih kilometar i pol do trgovine. Uđem u trgovinu i kažem dobar dan. Jer treba još. Treba još? (Ispitivač daje znak da je dovoljno).

I sit in the car and go to the store. I'm driving. In detail? (Examiner confirms). I get out of bed, walk, get my bag, get my wallet. I open the door, close it. I walk down the stairs, take my bike. I walk out of the yard, open the door. I take the road, bike a kilometer and a half to the store. I go into the store and say good afternoon. Because there is more to come. Need more? (The examiner indicates that it is sufficient).

Exp. 12

Većinom idem s autom, a ponekad biciklom. Idem u grad, u klub, vozim se po gradu. Izađem van iz kuće, skrenem desno. Idem ravno do kružnog toka, idem lijevo pa samo ravno do kraja ceste. Tamo je stup. Desno je ulaz u klub.

Most often I take the car and sometimes the bike. I'm going to town, club, driving around town. I get out of the house, turn right. I go straight to the roundabout, go left then just straight to the end of the road. There's a pole. To the right is the entrance to the club.

Tasks 2 and 3 showed that they were slightly better compared to PD and CI groups. One female person asked who is she explaining it to (a deaf person?), she also added if the person she is describing the route to cannot find the lab he or she should ask somebody for direction. Generally, the descriptions included more detail (hall, 4 doors, first/second/third door, there is a sign on the door) and even some questions to the researcher i.e. *if they are inside the lab A*.

Exp. 13

Gluhoj osobi objašnjavam? (Ispitivač: Da). Pokažem ovo je zgrada A i trebaš ići do Laboratorija za električne strojeve. Onda ideš ravno pa lijevo. Vidjet ćeš vrata, onda desno. Ravno, ne možeš fulati. Opet ideš lijevo do kraja vidjet ćeš da piše Laboratorij za električne strojeve. Ako ne znaš, ne vidiš, pitaj druge.

I explain to a deaf person? (Examiner: Yes). I show him/her this is Building A and you need to go to the Laboratory for Electrical Machines. Then you go straight and left. You will see the door, then to the right. Straight, you can't miss it. Go left again to the end you will see that it says Laboratory for Electrical Machines. If you don't know, don't see, ask others.

5 CONCLUSION

The task including description of spatial movement proved to be rather difficult for people without impairments, and it turned out to be rather difficult to all three groups of hearing impaired. They often responded with an unspecific answer or even missed the point. Their utterances were short and in Tasks 2 and 3 they just showed the rout with their finger, confirming that their verbal abilities are not suitable more communication.

CI group showed the most reduced verbal utterances raising question about the implant purpose and rehabilitation. HOH group gave more elaborate answers, however some of them also missed the point in Task 1 or reduced the utterance.

Although the expected results were not confirmed, this study gave us a more detailed insight into the linguistic and cognitive abilities of various hearing impaired participants on the complex tasks which include spatial and temporal linguistic information based on human experience and perception. They can serve as a focus point for formal or informal rehabilitation (due to age) and a basis for further studies examining the addressed concepts.

REFERENCES

- Croft, W. & Cruse, D. A. (2004). *Cognitive Linguistics*. Cambridge: Cambridge University Press.
- Croft, W. & Wood, E. J. (2000). Construal operations in linguistics and artificial intelligence. In Albertazzi, L. (ed.). *Meaning and Cognition, A multidisciplinary approach* (pp. 51-78). Amsterdam/ Philadelphia: John Benjamins.
- Fillmore, C. J. (1985). Frame and semantics of understanding. *Quaderni di semantica*, 6:2, 222-253.
- Lakoff, G. (1987). *Women, Fire and Dangerous Things: What Categories Reveal About the Mind*. Chicago/London: University of Chicago Press.
- Lakoff, G. & Johnson, M. (1980). *Metaphors We Live By*. Chicago: Chicago University Press.
- Langacker, R. W. (1987). *Foundations of Cognitive Grammar*, Vol. 1, *Theoretical Prerequisites*. Stanford: Stanford University Press.
- Langacker, R. W. (2000). *Grammar and Conceptualization*. Berlin/New York: Mouton de Gruyter.
- Virginia Swisher, M. (1988). Similarities and Differences between Spoken Languages and Natural Sign Languages. *Applied Linguistics*, 9(4), 343–356.
- Talmy, L. (2000). *Toward a Cognitive Semantics, vol. 1: Concept Structuring Systems*. Cambridge, Mass.: MIT Press.

The Impact of Group Psychotherapy Workshop on the Emotional State

Vesnica Kljajević, Dragana Sovilj

Institute of Experimental Phonetics and Speech Pathology “Djordje Kostić”

Gospodar Jovanova 35, Belgrade

vesnica_kljajevic@yahoo.com,

ABSTRACT

The document presents the impact that group psychotherapy has on the emotional development of a mother who is bringing her child to the Institute. The condition of the mother when she was assigned to the institute was observed, when she was first confronted with working with her child, her condition during therapy, as well as after determining the working time within group psychotherapy. The results show that mothers in group therapy have an increase in experiencing positive emotional states, such as having self-confidence, feeling safety by free expression of emotions, sharing of emotional states with other persons and positive interpersonal relationships, as well as additional improvement in the mother- child relationship

Key words: mother- child relationship, emotions, psychotherapy group, emotional state

1 INTRODUCTION

To improve the therapeutic work with children and their parents, a group psychotherapy work with mothers of children with pathologies in the field of speech, language, behavior, learning and socialization is being held in the IEFPS. One of the goals of this type of the psychotherapy work is to achieve essential bond between mothers and their children, and is also intended for mothers who are interested in personal inner growth and development as well as discovering their hidden potentials through a variety of hands-on exercises and experimenting, resulting in learning more about themselves.

The treatment of these children is a long-term process that involves the participation of parents, most often mothers in their therapy sessions. Given the increase and complexity of children's problems in the past few years, there is also a need to work with mothers on their personal development plan and to make them aware of their personal role in their children's therapy process.

Regarding this, in addition to the audio-linguistic treatment of children, occupational daily care with the aim of sensorimotor integration and / or children's participation in workshops in order to become better prepared for primary school education, individual and group psychotherapy work with mothers also takes place.

Group psychotherapy work with mothers has a great advantage compared to individual therapy. The first important aspect of this form of work is that the parents learn new, more appropriate behaviour interacting with other parents; they also develop motivation as a basic life-moving energy, and change the wrong image they have of themselves and the others.

During the group therapy sessions, the interaction that occurs is different than behaviour in the everyday environment. This interaction allows parents to better understand the behaviours and problems of other people, and gives them an insight into their own personality and behaviour. After each therapy session, the therapist helps the parents (mothers) to adopt new behaviour patterns that are more beneficial to themselves, their children and the rest of their families, supporting them in maintaining this new and better behaviour.

Another important aspect of group therapy work is to meet the basic human need to belong to a group. Within the group, mothers (parents) have the opportunity to meet others who have the same or similar problems. The benefits of being a member of such group are reflected in the fact that mothers share their experiences with each other, realizing they are not alone and the only ones with those kind of problems, but that there are other mothers (parents) who share the same "fate" as them. After experiencing the group session for the first time, mothers already have the willingness to help each other, to develop solidarity. In doing so, they satisfy their basic human need - to be members of the group and be accepted in it without being judged. The affiliate need is one of the aspects that are satisfied by being the member of the group, as well as the need for acceptance, the need to engage one's inner potentials, to develop one's own personality and to create a better life in general.

As said before, group therapy session is a unique and powerful tool of the occupational therapy, which gives the opportunity to mothers for change and growth that is simply not possible during individual psychotherapy. The task of the therapist in this process is to help mothers realize and understand the truth, to help them find all blocked paths, to help them develop their full potential as human beings. Two separate but interconnected ideas come into focus: consciousness and responsibility. The biggest part of therapeutic assistance is focusing on raising awareness of each group member, and the therapist does this by helping them focus on the "here and now," the present moment. The therapist tries to keep the attention of the members on what is currently happening, therefore, "here and now". He advises them to learn the most from their experiences within the group if they allow themselves to realize how they survive within the group from one moment to the other; with all the thoughts, feelings and actions they express in every new situation. The therapist's job is to actively encourage the group members, using whatever means he/she sees fit, so they could rediscover, sometimes the undesirable fact that they are the only ones responsible for themselves, whether they feel happy, sad, scared, lively, bold, angry; that is part of their experience. Having feelings and behaviours is an important aspect of "taking responsibility". Mothers, who begin to take responsibility for their actions and experiences "here and now", are on their way to learn how to free themselves in order to live fuller and better lives.

Group psychotherapy work, among other things, aims at elevating the self-esteem and self-value of mothers, to make their emotional state better, as well as improving and intensifying social activities in interpersonal relationships with other mothers. Also, a very important part of the program is empowering mothers to become better and more adequate leaders for their children, to develop their emotional intelligence and competence, to know how their own emotions affect them and their environment; the goal is to facilitate the work of the child's therapist and to become good co-therapist themselves. By gradually introducing mothers to group treatments, the therapists and the mothers become associates on the path of self-discovery to overcome or alleviate the disorders of the children.

Most of the problems they bring to therapy sessions are in connection with social adjustment issues. They are under tremendous pressure to adjust; the pressure coming from their families, friends, institutions, most often in the form of negating and minimizing children's problems.

When they return to their homes, what they experience is often very different. In order to be able to adopt and apply what they have learned in the group, they are assigned individual homework to be completed and reported on at the next meeting (session). They often give feedbacks that they are astonished at the effects of their experiment, and so they encourage themselves and others to continue to experiment outside the group.

Within the group, they learn how to better become aware of their feelings and to develop new, more appropriate ways of thinking and behavior, as well as new strategies for coping with problems. Besides that, mothers should improve their social skills, such as expressing their own desires and needs, develop critical thinking, the ability to say "no" in certain situations and deal with conflicts in an appropriate manner.

Through sharing their impressions and experiences within the group, mothers also learn to empathize with others and better perceive their own and other people's feelings. Noticing the behaviors of other members of the group, each of them has the opportunity to express their positive change and to notice that change with other members.

Relations in the group often reflect the behaviors that mothers have in their own families. In this social interaction, each mother individually is being helped by the group to recognize her position within her family and, thus, by bringing awareness to it, create the opportunity for her to change that position. Together with the therapist and other members of the group, the mother has the opportunity to analyze her own experiences and to help herself identify the typical behaviors she exhibits in certain life situations, primarily in relation to her child and then the environment. Becoming aware of behavioral patterns that are culturally conditioned, forced by tradition or are matter of their own choices, mothers can address experiences from their childhoods and develop new ones, more appropriate behaviors. Through group interaction, mothers get help and guidance in solving problems within their families, where they are aware, as said above, of their position and the amount of obedience instilled in them.

One of the most important factors that determine the goal of each group session is to empower the mothers so that they can implement successfully into their families and their natural environment everything they have learned (or found out) about themselves and relationships with their children. From this point of view, a very effective way of encouraging this behavior is to give them "homework", which encourage every mother to work on them between two sessions.

Thus, the goal is for the mother to have a better relationship with her child, to achieve a better form of communication between herself and the child, as well as herself and her environment, while respecting the uniqueness and individuality of that relationship. The group is organized in the way that it represents an absolutely safe environment supporting everything that's happening within the group. Through the experience of working in such a framework, the mother is given a unique opportunity to learn through her own experience, living the emotions that occur in the process, in order to achieve the appearance of her own unique authentic being and because of all that, give a good foundation to her child for healthy and continuous development.

At the same time, during the group work, the focus is on the physical, emotional, intellectual, social and spiritual plan. The goal of any intervention, whether it has verbal or non-verbal / experimental character, is to unite the mind, heart and body with spiritual potentials. A privileged place is given to physical experiences. Therapists are equally interested in the receptive power of the senses: "What are you feeling at this moment?" as much as the motoric activity of the body: "I suggest you get up and take a few steps." A holistic approach takes into consideration the whole body, not just words, voice, action. The therapists focus their attention toward non-verbal cues of communication that in most cases reveal unconscious, repressed patterns of behavior. Experiments that are part of the Gestalt psychotherapy approach are often used.

One of the more important elements of the group therapy work is development of emotional intelligence of the mother. By creating a safe environment within the group where each member has the opportunity to express their emotions without judgment from other members, the mother learns more about herself, her emotions, learns to verbalize those emotions accordingly, understands them, and understands their effect on herself and her own environment, especially on her child. It is a very common occurrence that mothers, who are in the process of suppression as a defense mechanism, have so deeply suppressed their emotional experiences that they are no longer even aware of them. They are not able to feel their emotions, thus becoming emotionally flat individuals who show mechanical, robotic way of solving tasks or activities during interaction with their own children.

2 AIM

The goal of the work is to show how the group psychotherapy sessions with mothers affect their relationship with children, themselves and their environment.

3 METHODOLOGY

The group work takes place alongside therapeutic work with mothers and is scheduled once a week for two hours. The group is formed on a voluntary basis. The case study was conducted on a sample of N = 10 mothers who were in the process of group work of at least 12 sessions over a of three months period.

In order to monitor emotional states over a period of time, as well as the progress of each mother individually, a separate questionnaire had been created that covered questions regarding personal emotional states and assessment of them, as well as an assessment of the degree of emotions expression in the environment and in relation to the child. The mothers completed their questionnaires upon arrival at the first group meeting and then after a number of group therapy sessions (at least 12). The questions were grouped into several categories: 1. General emotional status of the mother, 2. Emotional status before coming to the Institute, 3. Emotional status during the group therapy work, 4. Attitude to their child's problem, 5. Attitude to group work and 6. Attitude toward expression of emotions. The Likert scale was used to measure and categorize the condition: 1 disagrees completely, 2 partially disagree, 3 not sure, 4 partially agree and 5 completely agree.

4 RESULTS AND DISCUSSION

The analysis of the Questionnaire results revealed that a group of N = 10 mothers:

In the question category No.1: General emotional status of the mother, the results showed that mothers generally felt fairly neutral (AS = 2.95), that certain emotions were only occasionally expressed, of medium intensity.

In question category No. 2: Emotional status prior to joining the Institute, the results showed that mothers felt worse comparing to their general emotional state (AS = 2.27).

In Question category No. 3: Emotional status for the duration of group therapy work, the results showed that there was an improvement in emotional status, where the score on experiencing positive emotional states increased (AS = 3.23)

From all these results it could be concluded that their emotional states in general and at the time of therapy were significantly better than their emotional status before joining the Institute.

In Question Category No. 4: "Attitude towards your child", high scores were shown in the following statements:

- "I am aware that I cannot help my child until I feel better myself" (AS = 4.8)
- "I deeply believe that my own change for the better will have a positive effect on my child's development" (AS = 5.0),
- "I deeply believe that my hard work and work with my child will pay off" (AS = 5.0)

The mothers' awareness and willingness to change and improve themselves are very pronounced. Sometimes mothers are exposed to the enormous pressure and expectations of their families and environment. Often, they have to take great responsibility for their own health and that of their child. Taking responsibility for themselves and their children triggers the great potential they have in them and that potential is usually aimed towards their children's progress.

Awareness of their part in the therapy work is usually the trigger for them to mobilize all of their strengths toward their own, personal change, and makes them believe deeply that a positive change in them would lead to a positive change in their children. They enter the change process boldly and with the awareness that every change requires great engagement, awareness and consistency. The results also show that a positive attitude towards themselves, towards their own progress, is in relation to their children's development and that their level of motivation will depend on the children's progress.

In question category No. 5: Attitudes towards group work, high scores appear in the statements:

- "being a part of the group therapy sessions has a very positive impact on me in general" (AM> 4.37);
- "feel better after group therapy work" (AM = 4.5);
- "group work gives me the skills I need" (AM = 4.8);
- "encourages me to be content with myself and to believe strongly" (AM = 4.6).

This shows that the group, for almost all members, is a place where they can open up showing a lot of trust, that their presence in the group evokes positive feelings, that there is a strong need for learning within the group and that each member is capable to observe a problem in an optimistic way and to be able to make a positive change in the future.

In question category No. 6: Attitude towards expression of emotions, high scores appear in the statements:

- "when I face a stressful situation, I think positively" (AM = 4.8)
- "able to channel my anger and rage" (AM= 4.4)
- "I have enough reason to be a happy and fulfilled woman" (AM = 4.7)

Each of the mothers who were part of the group psychotherapy work at the Institute shared their experiences within the group concerning this moment in their lives.

They talk about the level of their helplessness, the fear of how they would cope with the problem, the discouragement, they talk about not having any desires related to themselves at those moments, but only their wish for the children to be well. All their focus is on the children, which puts an additional burden on them (children).

Many of them talk about states of insomnia, deep fear, the growing pressure from environment, judgement coming from other people, and most of all – self judgement. Angry, crying, without the willingness to socialize, sad, with a loss of appetite, anxious, without any hope that the future may be better, hopeless, even to the point where they start using medicines so that they could, somehow, survive a day without many feelings; yet they find ways to be the greatest support to themselves and their children.

By being a part of the group therapy work for, at least, twelve sessions, as well as during the therapeutic work with the children, the mothers led themselves to more positive states where they felt more independent, more confident, valued themselves more, smiled, were feeling more freely, more mature, with a higher level of confidence, more aware of their maternal roles, had a sense of responsibility and an awareness of their role, were better organized, more fulfilled and happier because of the feeling that they were not alone with their problem, but that they belonged to a group that supported them, where they could express themselves in an authentic way, had a very positive attitude towards socializing that was carried out outside the sessions, the loss of fear, the return of the feeling "being myself", the feeling of love, joy, satisfaction, awareness and faith in one's own strengths, one's own virtues,

Becoming aware of a child's disorder is a traumatic experience for the mother. Additional uncertainty in therapeutic work induces natural anxious responses. Being overwhelmed with fear is dominant feeling during the period when she is without professional support or just before she enters the diagnostic process, because that is when she is confronted with the fact that her child has a problem, receiving confirmation from a specialist. Mothers having children with disorders can respond with a wide variety of reactions, from extremely unconstructive, to adequate, constructive ones that lead to improvement of the current state. Non-constructive reactions of the mother include distrustful attitudes, disbelief, suspicion, as well as a manifestation of the defense mechanisms (negation, suppression, projection) that occur as reactions to unbearable feelings caused by the awareness of children's disorder. By observing mothers, one can see the visible presence of fear, sadness, helplessness, which are somatically expressed as weight in the chest, lump in the throat, tightness in the neck, tightness of the back muscles, sweaty palms, tension in the body, ... They experience emotional sensations that are sometimes of extremely intensity. Mothers participating in group therapy are able to change their behavior and experience, sometimes dramatically during the existence of the group.

Compared to individual therapy, group therapy has several advantages. The experiences exchanged within the group between mothers who have similar problems with their children's development, create a mutual exchange that can contribute to faster and more effective changes. In this way, therapeutic goals could be achieved more quickly. Some mothers find it difficult to open up within the group, to talk about their personal situations and problems, and actively listen to other people's problems and participate in group events. That is why the group dynamics are organized to be a supportive and safe platform for expressing everything that is needed to become visible. Of course, there is always an option to voluntarily leave the group, which again has its healing character like manifesting its personality where the mother acts in accordance with her capacities, affinities and capabilities.

These results indicate that mothers in the group therapy work, as well as during individual work with their children, managed to put themselves into more positive states where they felt: more independent, more confident, valued themselves more, smiled more, felt freer, more mature, with a greater level of self-esteem, more aware of their maternal roles, had sense of responsibility and awareness, were better organized, more fulfilled and happier because of the feeling that they were not left alone with their problem, but that they belonged to the group that supported them, where they could express themselves in an authentic way. An important factor was the positive attitude towards socializing outside the sessions, the loss of fear, the return of feeling "I own myself", the feeling of love, joy, satisfaction, awareness and faith in their own strengths, their own virtues,...

5 CONCLUSION

The human heart longs for contact, above all, longs for an honest dialogue, each one of us secretly and desperately longs for someone to "meet" us and to recognize us in our uniqueness, our fullness and vulnerability. Knowing this, the therapist brings all of himself into the meeting, being present and ready to meet each mother honestly and authentically.

A wide variety of self-expressive and creative activities are appreciated and used in group therapy work, believing that suffering is not a necessary precondition for change, as opposed to general belief. A lot of things within the group are expressed through laughter; mothers love to have fun because laughter is a natural cure and a way to express the joy of living.

Respecting the uniqueness of the mother-child relationship, therapists, influencing each mother individually and within the group, tend to develop authenticity in the mother and help her to express that authenticity in a courageous way. Each of the mothers has the task of becoming a natural authority to herself and her child, to become responsible for every thought, word or deed. Losing the feeling of guilt, whether conscious or unconscious, is one of the key steps in taking responsibility for her own life and that of her child.

The mutual path of comprehension of both the therapist and each mother individually, is to realize together that each problem is a challenge that's been given as an opportunity for each of them to improve and recreate themselves. Observing each situation, even the illness of your own child, as a challenge and opportunity for your own development and advancement, means taking responsibility to start full and powerful life, without the possibility for any situation to cause great suffering and helplessness.

Working with mothers in a group has had a positive effect on their lives and the lives of their children. Taking responsibility for everything that happens to their children creates new sources of power in them which help them create a deeper, more honest and stronger relationship with their children.

This pilot case study shows us that group work with mothers has a positive effect on changing their emotional state upon the arrival at the Institute and that their emotional state improved significantly during their stay in the group. It also shows us that mothers' willingness to work on themselves and their potentials, create the faith and belief that they would help their children by doing this for themselves. Regarding their ability to express their emotions freely and without judgment of the environment, group work helps each of them to express themselves and to have a more positive attitude towards experiencing and expressing emotions. During the therapy, mothers understand and accept that they develop their emotional relationship

with their children in a unique way. The whole human existence is based on this unique relationship, which was given to each individual, from which she is able to create her identity, future, her own being.

REFERENCES

Peter Philipson, John Bernard Harris, *Gestalt Group Work*, Manchester Gestalt Centre 1992.

Nikola Rot, *Psychology of Group*, Institute for Textbooks, Belgrade, 2010.

Serge Ginger, *Gestalt therapy, the art of contacts*, Hycner @ Jacobs 1995.

Maksimović S., Punišić S., Fatić S., Stanojević N., *Victoria's diary of speech development*, Belgrade, CUŽA- IEFPS, 2017.

Valery Sinelnikov, *Love your disease*, ID Leo commerce, Belgrade, 2007.

Communication Of The Deaf Employees

Ivana Mitrović Đorđević, Vojislav Todorović

“Dušan Dugalić” Primary school
19 Đerdapska, 11 000 Belgrade, Serbia
mitrovicdjordjevic@gmail.com,

ABSTRACT

Communication can be defined as a dynamic and complex process in which people receive and send verbal and non-verbal messages to understand others and for others to understand them.

The factors of communication are: a) the sender - the person sending the message, b) the information - the message being transmitted, v) the channel - the path the message crosses, g) the recipient - the person or persons receiving the message.

Feedback or feedback indicates how the message was interpreted and accepted by the recipient and what impact the message had on the recipient. They can take many different forms, from smiling or frowning, nodding, to verbal reactions or behavioral changes.

Research indicates that words participate with 7% of communication, voice with 38%, mimicry, gesture with 55%, or 93% of the message is non-verbal.

Hearing loss greatly affects communication, educational attainment, and social interactions (Boutin, 2010; Boutin & Wilson, 2009), and reduces job opportunities, that is, leads to unemployment or lower-level employment (Bradley, Ebener, & Geyer. 2013; Smith, 2011).

Inadequate communication strategies may be associated with depression, social introversion, loneliness, and social anxiety.

The results of the research presented in this paper show that the barrier to communication remains the greatest challenge employers face in seeking to hire hearing impaired people. On the one hand, employers believe that hearing impaired people are reliable and competent to perform their job duties, as well as people who do not have hearing problems. On the other hand, employers (100%) point out that they do not know how to communicate or have received training in the needs of hearing impaired people.

Key words: communication, verbal and nonverbal messages, hearing impaired, communication strategies, factors of communication

1 INTRODUCTION

In his / her work environment, a deaf person may have difficulty communicating with colleagues, supervisors, and customers (Foster & MacLeod, 2003; Geyer & Schroedel, 1999). In addition, communication difficulties also affect the social interactions of the deaf in the workplace (Luft, 2000). In these circumstances, communication difficulties can lead to the deaf person's isolation as well as limit their ability to perform their work tasks in the best possible way (Foster & MacLeod, 2003; Luft, 2000; Shuler & al., 2014).

2 COMMUNICATION BARRIERS

Two barriers to employment to which the respondents attached the highest importance are:

- communication difficulties (28.8%) and
- the employer's lack of information about hearing impairment (18.4%).

Text based strategies should be used to make the workplace more relevant to the needs of deaf people. Qualified interpreters should also be present at the meeting for maximum effects (Haynes, 2014).

Berke found that with the advancement of technology, communication between employers and employees of deaf people is easier than ever. It has been found that the use of e-mail, instant messaging, chat programs and pagers is very effective. In addition, it was found that using the phone was no longer a barrier because of the ability to use a relay service. The problem with spoken language has been identified as existing to some extent because many hearing impaired applicants have a problem with using spoken language correctly. However, Berke found that employers should keep in mind that the level of proficiency in spoken language does not reflect the intelligence of a deaf person. Thus, employers are encouraged to look beyond spoken language and to encourage hearing impaired employees who have poor language skills to continue working to improve their language proficiency.

Punch, Hyde & Power, 2007 presented a wide range of barriers and job difficulties encountered by their respondents, as well as the solutions and strategies they found. They found that there were differences in the type of employment, job search activities, ways of overcoming difficulties at work, and the use of adaptation as to whether the communication method was exclusively in sign language or exclusively in the verbal-verbal model.

Statistical significance

High statistical significance ($\chi^2 = 76,840$; $p \leq 0,000$) was found in the knowledge of communication rules with deaf persons, namely 59 (84.3%) respondents from sheltered workshops (SW) and 11 (15.7%) respondents from open economy (OE) environment know communication rules with deaf people.

Table 1 - Knowledge of communication rules with deaf persons

Item			Do I know the rules of communication with deaf people?			Σ
			No	Not sure	Yes	
Group	Sheltered workshops	N	0	11	59	70
		%	0,0%	15,7%	84,3%	100,0%
	Open economy environment	N	43	16	11	70
		%	61,4%	22,9%	15,7%	100,0%
Σ		N	43	27	70	140
		%	30,7%	19,3%	50,0%	100,0%

From Table 1 we find out that 59 (84.3%) respondents from SW and 11 (15.7%) respondents from OE know the rules of communication with deaf persons. 43 (61.4%) respondents from the OE do not know the rules of communication, while in SW there were no such answers.

Statistical data processing showed high statistical significance ($\chi^2 = 76,840$; $p \leq 0,000$).

The communication rules are not known to 43 (61.4%) respondents from the OP, while in SW there were no such answers. The situations that make it difficult for deaf people to communicate in the workplace are group work, the noise coming from the environment, the mouth shut to the speaker. Adaptation strategies such as amplifying the voice of the speaker or text-based alternatives are used for successful communication. Nevertheless, more recent studies have shown that the communication problem of deaf persons in the workplace persists (Haynes, 2014). This is supported by the results of our study, which show the extent to which respondents are interested in attending a sign communication course, who say that 52 (74.3%) respondents from SW and 31 (44.3%) respondents from OE would attend a sign course communication, while 5 (7.1%) respondents from SW and 15 (21.4%) respondents from OE would not attend the mentioned course.

Table 2 - Possibility of establishing better communication with deaf counterpart

Item			I would attend a gesture communication course			Σ
			No	Do not know	Yes	
Group	Sheltered workshops	N	5	13	52	70
		%	7,1%	18,6%	74,3%	100,0%
	Open economy environment	N	15	24	31	70
		%	21,4%	34,3%	44,3%	100,0%
Σ	N		20	37	83	140
	%		14,3%	26,4%	59,3%	100,0%

From Table 2 we find out that 52 (74.3%) respondents from SW and 31 (44.3%) respondents from OE would attend a gesture communication course, while 5 (7.1%) respondents from SW and 15 (21.4%)) respondents from the OE would not attend a gesture communication course. Statistical data processing showed high statistical significance ($\chi^2 = 13,584$; $p = 0.001$).

3 FACTORS INFLUENCING RESPONDENTS ATTITUDES TOWARD SOCIAL COMPETENCIES OF DEAF PERSONS

Henrik et al. (Henrick, & al., 2003) have concluded that hearing impairment affects greatly reduces opportunities for social integration of deaf persons.

Studies to date show (Foster & Macleod, 2003) that deaf individuals who use the verbal communication method have difficulties in socialization in the work environment. Social experiences are very important for creating friendships at work and career advancement. Deaf people often blame themselves and their impairment for not engaging in group interaction, poor information sharing, and not understanding that information.

A survey conducted by Jones & Stone (Jones & Stone, 1995) found that 69% of respondents expressed a willingness to associate with colleagues with disabilities during breaks. The results of our study indicate that 71.4% of respondents from SW and 78.6% of respondents from OE would hang out with their deaf colleague at a break or work meeting. Our respondents also showed a willingness to assist the deaf colleague in the workplace in 97.1% of the SW cases and 92.9% of the OE cases. These results are promising for the deaf and hard of hearing and their inclusion in the workplace.

Communication difficulties and conflicts caused by insufficient awareness of employers and hearing employees about the Deaf culture are cited as the biggest problems faced by deaf people in the work environment (Houston et al., 2010; McCrone, 2011). According to the results of our study, 31.4% of TP respondents from SW and 5.7% from OE perceive deaf workers as conflict persons. However, a higher percentage of respondents from both SW (44.3%) and OE (57.1%) had the opposite opinion.

Table 3 - Conversation with deaf workers

Item			Afraid to enter into conversation with deaf workers?			Σ
			No	Do not know	Yes	
Group	Sheltered workshops	N	52	8	10	70
		%	74,3%	11,4%	14,3%	100,0%
	Open economy	N	50	11	9	70
		%	71,4%	15,7%	12,9%	100,0%
Σ		N	102	19	19	140
		%	72,9%	13,6%	13,6%	100,0%

In 14.3% (10) cases, SW respondents and 12.9% (9) OE respondents fear engaging in conversation with deaf workers. 52 (74.3%) respondents from SW and 50 (71.4%) respondents from OE do not have this fear (Table 3). Statistical data processing did not show statistical significance ($\chi^2 = 0.566$; $p = 0.754$).

A number of foreign studies have highlighted that hearing and deaf colleagues have difficulty understanding each other during a work meeting or agreement. Deaf workers indicated that they were generally expected to obtain notes from a hearing colleague after the meeting, or to contact the supervisor directly for necessary information (Houston et al., 2010; McCrone, 2011).

Table 4 - Deaf employee follow interactions in the company

Item			Deaf workers can not follow interactions in company?			Σ
			No	Do not know	Yes	
Group	Sheltered workshops	N	27	18	25	70
		%	38,6%	25,7%	35,7%	100,0%
	Open economy	N	32	31	7	70
		%	45,7%	44,3%	10,0%	100,0%
Σ		N	59	49	32	140
		%	42,1%	35,0%	22,9%	100,0%

Table 4 shows that 25 (35.7%) respondents from SW and 7 (10%) respondents from OE consider that deaf workers cannot follow the events in the company. 27 (38.6%) respondents from SW and 32 (45.7%) respondents from OE are opposed. Statistical data processing showed high statistical significance ($\chi^2 = 13,998$; $p = 0.001$).

4 CONCLUSION

Deaf people have their own system of values, common history and developed a sense of community. Engagement in an inclusive environment sometimes brings deaf people in a situation of marginalization and neglects their diversity. Deafness becomes a drawback, and the existence of deaf culture is completely ignored.

Acceptance of deaf culture is important because of its position in relation to the dominant culture. Acceptance prevents marginalization, stigmatization and exclusion of its members from the society. Considering the results of communication competencies deaf people at the level of items (communication

skills, social and emotional aspects of social competencies) we found that typical employees know the rules of communication with deaf persons, the typical employees of OE have a more positive opinion on whether the deaf persons can follow events in the company ($p = 0.001$), and employees are willing to attend the course of sign language ($p = 0.001$).

Social experiences are very important for making friends at work and career advancement. Deaf and hard of hearing people usually are accused for non-participation in group interaction, poor exchange of information and lack of understanding of that information. However, they do not dare to demand the adaptation of the workplace, although by law they have that option because they fear the reaction of hearing colleagues. Equal ratio deaf and typical peers in an inclusive work environment is possible if the typical employees learned a sign language. Being familiar with the rules of communication and sign language with deaf and hard of hearing people by the typical employee would enable successful mutual work and social interaction.

Education should be established on the basis of the real needs and the social model of disability in order to raise awareness about the opportunities and professional potential of people with disabilities.

REFERENCES

- Boutin, D. L. (2010). Occupational outcomes for vocational rehabilitation consumers with hearing impairments. *Journal of Rehabilitation*, 76(3), 40-46.
- Boutin, D.L. & Wilson, K. (2009). Professional Jobs and Hearing Loss: A Comparison of Deaf and hard of Hearing Professional Jobs and Hearing Loss: A Comparison of Deaf and hard of Hearing Consumers, *Journal of Rehabilitation* 2009, Volume 75, No 1, 36-40
- Bradley, C. F., Ebener, D. J., & Geyer, P. D. (2013). Contributors to successful VR outcomes among non-Latino (Caucasian) and Latino consumers with hearing loss. *Journal of Rehabilitation*, 79(2), 24-33.
- Foster, S., & MacLeod, J. (2003). Deaf people at work: assessment of communication among deaf and hearing persons in work settings. *International journal of audiology*, 42, S128-S139.
- Geyer, P. D., & Schroedel, J. G. (1999). Conditions influencing the availability of accommodations for workers who are deaf or hard-of-hearing. *Journal of Rehabilitation*, 65(2), 42-50.
- Haynes, S. (2014). Effectiveness of communication strategies for deaf or hard of hearing workers in group settings. *Work*, 48(2), 193-202.
- Hendrick, H (2003) *Child Welfare: Historical dimensions, contemporary debate*, Bristol, The Policy Press
- Houston, K., Lammers, H. B., & Svorny, S. (2010). Perceptions of the effect of public policy on employment opportunities for individuals who are deaf or hard of hearing. *Journal of Disability Policy Studies*, 21(1), 9-21. doi: 10.1177/1044207309357428
- Jones, M. K., & Sloane, P. (2012). Disability and social exclusion. In G. Parodi & D. Sciulli (Eds.), *Social exclusion. Short and long term causes and consequences* (pp. 128–148). AIEL Series in Labour Economics. Berlin: Physica-Verlag-Springer.
- Luft, P. (2000). Communication barriers for deaf employees: Needs assessment and problem-solving strategies. *Work*, 14 (1), 51-59.
- McCrone, W. P. (2011). Practical implications of the 2008 Americans with Disabilities Act Amendments (Title I) for rehabilitation counselors and deaf job seekers. *Journal of the American*
- Punch, M. Hyde, D. Power. (2007) Career and Workplace Experiences of Australian University Graduates Who are Deaf or Hard to Hearing. *The Journal of Deaf Studies and Deaf Education*, Volume 12, Issue 4, Pages 504–517
- Shuler, G. K., Mistler, L. A., Torrey, K., & Depukat, R. (2014). More than signing: Communicating with deaf. *Nursing Management*, 45(3), 20-27.
- Smith, C.S, Ferrier, F., Burke, G., Schofield, K., Long, M. & Shah, C. (2002). *Lifelong learning and the world of work: CEET's surveys for the ACCI, ACTU and ANTA*. Melbourne: Monash University-ACER Centre for the Economics of Education and Training

Risk Factors Prevalence in Children with Speech and Language Disorders

Ivana Bogavac, Marija Tešović, Ljiljana Jeličić

Life Activities Advancement Center

35 Gospodar Jovanova St., Belgrade, Serbia

ivbogavac@gmail.com, marijamaki7vukic@gmail.com, lilijen@ymail.com

ABSTRACT

Risk factor refers to any characteristics or event which can contribute to the development of some form of disorder or disease. The link can be only associative one by no means causative. This concept is very important for cases with heterogenic etiology, especially multifactorial disorders or diseases. Literature has already shown some links between certain risk factors and speech and language disorders. The research aim was to estimate the prevalence of risk factors in the group of children with speech and language disorders. The research sample included 1286 children with speech and language disorders. The data was collected from their case-history fails in the Institute for Experimental Phonetic and Speech Pathology (IEPSP) in Belgrade. Obtained results were further analyzed and were discussed according to the frequency of risk factors.

Keywords: risk factors, prevalence, speech and language disorders.

1 INTRODUCTION

The risk factor concept is well developed in medicine and it refers to any characteristics, incident, or exposure which can contribute to developing a disorder, disease, or injury. For this concept is important to emphasize that it can contribute to, but it cannot cause certain disorder, disease or injury. Risk factors can only have an association relation not causal one with a certain disorder or disease. They are very important for complex, heterogeneous disorders and diseases regarding their etiology. The risk factors measurement reveals important associations (Bogavac, Rakonjac, & Fatić, 2016).

Human development is a very complex process on which a great number of different factors can have an impact. During that time some of the present factors can have a negative effect and lead to atypical development or leave some form of consequences. These factors can be biological or environmental and according to time, it can be prenatal, perinatal, or postnatal risk factors. All the circumstances that are present during intrauterine development, different circumstances during the time of delivery, and in the period after delivery, create a child's basis capacity. This basis capacity is the start point for the further child's development and its ability to receive and use all other environmental factors (Barlov, Jeličić, Sovilj, & Vujović, 2007).

In the same way, speech and language development can be affected by numerous risk factors. These factors usually have an impact on motor, cognitive, and social development as well. Some authors tried to estimate the severity of certain risk factors regarding the level of their risk and the way they affect development (Velisavljev, Korać, & Juretić, 1987; Levine, Holroyde, Woods, Siddiqi, Scott, & Miodovnik, 1984). But more significant is the critical period of development when a certain risk factor is active. That means that the same risk factor will not have the same consequences on development if it is present in the first trimester of pregnancy, or in second, or maybe in the third. Every function has a particular time in development when it is most vulnerable to the influence of other factors.

Speech and language system development starts with conception and lasts until person mastery skills of verbal communication (Radičević, Vujović, Jeličić, & Sovilj, 2008) and in that path goes to the prenatal, perinatal and postnatal period. During these periods different kinds of risk factors influence the ontogenesis of the language system, can affect central nervous system development and lead to specific, non-adaptive responses to environmental stimuli. Literature shows genetics, mother's chronic diseases, mother's virus infections, quality of mother's life during pregnancy, the way of mother's life, stress as prenatal risk factors. Perinatal risk factors refer to all circumstances during the delivery (preterm delivery, asphyxia, hypoxia, hyperbilirubinemia, low APGAR score, respiratory distress syndrome, low birth weight, hemorrhage, etc.). Risk factors from the postnatal period are secretory otitis media, encephalitis, meningitis, different kinds of medicaments, infections, injuries, non-stimulant environment, excessive media exposure, and others.

The concept of risk factors is essential for prevention programs and early intervention. Children born with any form of risk can, later in lifespan, develop problems in the field receptive and expressive communication skills and in the areas of attention, playing, gesture, vocal development, social communication, vocabulary, concepts, language structure, integrative language skills, and phonological awareness (Bogavac, Rakonjac, & Tešović, 2017).

2 METHOD

The examined group consisted of 1286 children born in the period of twelve years, from 2000. to 2012. All children were diagnosed with speech and language disorder according to estimation by IEPSP Test Battery. Speech and language evaluation were done by a speech therapist from IEPSP with IEPSP Test Battery. The following criteria were used:

- ☐ the child was diagnosed with speech and language disorder
- ☐ the child was under six years of age in the time of making a diagnosis
- ☐ the child had complete medical documentation needed
- ☐ child's mother did not have chronic illness during pregnancy
- ☐ the child was born healthy in the term
- ☐ the child does not have any neurological, mental or other diseases.

The main data source was medical documentation and anamnestic data given by parents. After gathering and comparing the data from different sources, a detailed analysis was done.

Sample

The research sample consisted of N=1286 children with speech and language disorder and with no other neurological, mental, social problems. The N=364 were girls, approximatively 28%, and N=922 were boys, approximately 72%. It is important to emphasize that all children did have at least one, and a great number did have more risk factors. Certain risk factors are the consequence of others and they appear together in children.

3 RESULTS AND DISCUSSION

Analyzing this heterogeneous group of children with speech and language disorders it is noticed that all of the children had at least one of risk factors registered pre, peri or postnatal. Also, it is noticed, like in a previous study (Bogavac, Jeličić Dobrijević, Vujović, 2014) that certain risk factors emerge together because they are interdependent. Figure 1. shows the prevalence of each risk factor that was observed. Hereditary data refers to parents' acknowledgment of speech and language disorders in close family members and it was confirmed in 61% of children' families in this sample. The next parameter that was taken into consideration is the medicaments that healthy mothers needed to use during pregnancy. As Figure

1. shows the 44% of mothers used drugs to keep pregnancy till the end and 34% of them delivered a baby by Caesarian Section. Approximatively, one-third of children were delivered in that way. After the birth child gets the Apgar score, as an indicator of a child's vitality. In the literature, the Apgar score equals 7 and less indicates potential neurological problems (Kičić, 1989; Nelson, 1981). In our study, the analysis of Apgar scores shows that 10% of children had values 7 and less. These values had been cited as risk factors for speech and language disorders (Stanton-Chapman, 2002).

Complication during the delivery can be isolated cases or can be together and be causal. Asphyxia is the most common complication after is oxygen therapy which is usually accompanied. In our sample, 10% of children had asphyxia while 12% had oxygen therapy at birth. Other birth complications were present in the smaller percent, the umbilical cord wrapped around the neck of baby and hematoma was around 5%, while intensive care baby stay was around 7%. All these factors can be manifested on birth and potentially influence further development. In the first days after birth child can have a high level of bilirubin. Because of heterogeneous data (different hospitals, time of blood analysis), we included in the analysis only children with bilirubin levels that were over the physiological level and it was present in 32.4% of children.

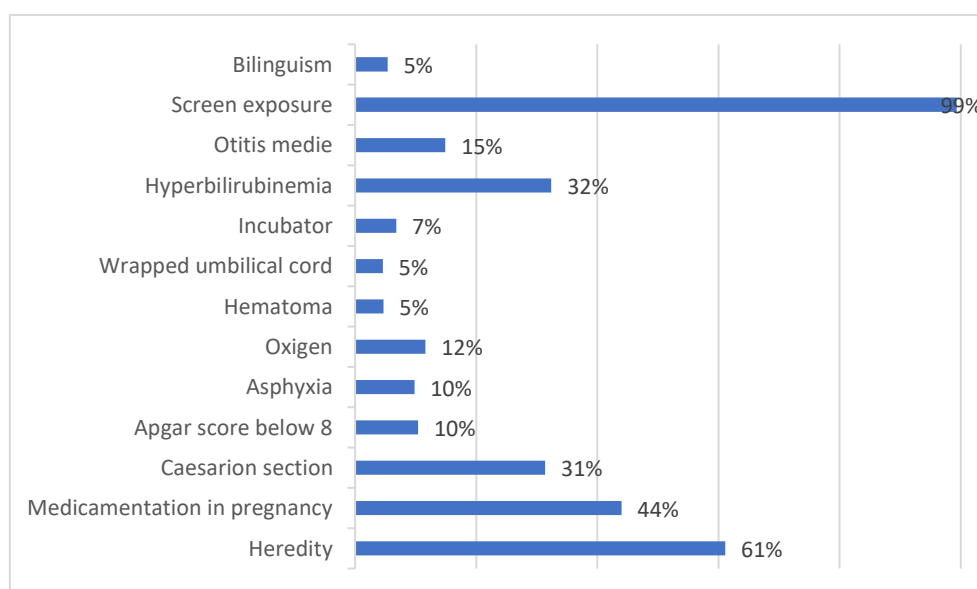


Figure 1. Prevalence of risk factors.

Postnatal factors are very complex with a great number of interdependent variables. Recurrent otitis media is noticed in 15% of children with speech and language disorders while growing up in a bilingual environment was present in 5% of them. The most disturbing data was that 99% of children were exposed to any type of screen for more than one hour a day.

4 CONCLUSION

The speech and language acquisition are co-dependent and prenatal, perinatal and early postnatal periods play a key role in it. Risk factors are present in every period and can have a negative impact. Early detection is important because early intervention can prevent possible disorders and later possible complications in the cognitive and emotional life of a child.

REFERENCES

- Barlov, I., Jelcic, Lj., Sovilj, M., & Vujovic, M. (2007). Influence of risk factors during pregnancy on speech and language development. *The 17th International Congress of the International Society of Pre- and Perinatal Psychology & Medicine (ISPPM)*, Proceeding, (pp 172-177), Moscow, Russia.
- Bogavac, I., Rakonjac, M., & Tešović, M. (2017). Hyperbilirubinemia as potential predictor of speech and language deficits expression. *Conference Speech and Language, VI International Conference on Fundamental and Applied Aspects of Speech and Language Proceedings* (pp. 238-241). Belgrade, Serbia: LAAC & IEPSP.
- Bogavac, I., Rakonjac, M., & Fatić, S. (2016). Biological and environmental risk factors associated with verbal communication development. In: M. Sovilj, S. Maksimović, & S. Punišić (Eds) *Multidisciplinary approach to diagnosis of verbal communication disorders* (pp. 43-103). Belgrade: LAAC & IEPSP.
- Bogavac, I., Jeličić Dobrijević, Lj., & Vujović, M. (2014). Risk factors associated with developmental articulation disorders. *Belgrade school of special education and rehabilitation*, 20(1), 119-126.
- Kicic, M., Kraincanic, B., *Medicinska genetika*. (1989). Zavod za udzbenike I nastavna sredstva, Beograd, (In Serbian).
- Levine, M. G., Holroyde, J., Woods, J. R. Jr., Siddiqi, T. A., Scott, T. A., & Miodovnik, M. (1984). Birth trauma: incidence and predisposing factors. *Obstetrics and Gynecology*, 63(6), 792-795.
- Nelson, E. (1983). *Pediatrics*, 12th Ed. W. B. Saunders Company, Philadelphia, London.
- Radičević, Z., Vujović, M., Jeličić, Lj., & Sovilj, M. (2008). Comparative findings of voice and speech: language processing at an early ontogenetic age in quantitative EEG mapping, *Experimental Brain Research*, 184, 529-532.
- Stanton-Chapman, T. L., Chapman, D. A., Bainbridge, N. L., Scott, K. G. (2002). Identification of early risk factors for language impairment. *Res. Dev. Disability*, 23(6), 390-405.
- Velisavljev, M., Korać, D., & Juretić, M. (1987). *Klinička pedijatrija. (Clinical paediatrics)*. Belgrade-Zagreb: Medicinska knjiga.

Alexia Without Agraphia - Case Study

Gordana Tomić¹, Jelena Nikolić², Silvana Punišić^{2,3}, Miško Subotić^{2,3}, Jasna Zidverc-Trajković¹

¹Clinic for Neurology, Clinical Center of Serbia, Belgrade, Serbia

²Institute for Experimental Phonetics and Speech Pathology, Belgrade, Serbia

³Life Activities Advancement Center, Belgrade, Serbia

gocanps@yahoo.com

ABSTRACT

Introduction: The neuroanatomic basis of alexia without agraphia was described by Dejerine in 1892., after a dominant angular gyrus lesion. Alexia without agraphia is manifested by the impairment of reading ability. Speech, auditory comprehension, repetition and writing are relatively intact. Because of the damaged splenium of the corpus callosum, alexia without agraphia is considered an example of an interhemispheric disconnection syndrome.

Case study: We presented a 71-year-old male, with chronic hypertension, diabetes mellitus and dyslipidemia. The MRI shows a lesion in the left mediotemporal region, which also covers equilateral thalamus, posterior cingulate gyrus, splenium of corpus callosum, lingual occipital gyrus, and the tail of the hippocampus. On the right part of cerebellar, lacunar ischemia is present.

Neurolinguistic diagnostic protocol includes Mini Mental Test, Boston Diagnostic Aphasia Examination, Boston Naming Test and phonemic and category fluency tests. We have also structured a clinical protocol for the color recognition assessment. The results shows a mild cognitive impairment related to the disturbance of time and space orientation, delayed memory and reading. On the speech and language level, we registered a severe degree of acquired alexia without agraphia which does not interfere with other modalities of language.

Conclusion: The application of neurolinguistic tests and clinical techniques provides more reliable diagnostic criteria, which represents the basis for procreation of neurorehabilitation. The rehabilitation protocol refers to the training techniques: tactile-kinesthetic recognition of graphemes and the application of various reading techniques, such as "Letter by Letter", Multiple Oral Re-reading and melodically intonated oral reading technique in aim of the restitution of the reading disorder.

Key words: Alexia without agraphia, Stroke, Hemianopsia, Neurolinguistics, Neurorehabilitation

1 INTRODUCTION

Pure alexia is a selective impairment of reading in the absence of other language deficits and occurs as a consequence of brain injury in previously literate individuals (Starrfelt, Shallice, 2014). The neuroanatomic basis of alexia without agraphia was described by Dejerine in 1892., after a dominant angular gyrus lesion. It is thought to result from the disruption or the disconnection of the visual word form area (VWFA), a region reproducibly located within the left occipito-temporal sulcus, and encoding the abstract identity of strings of visual letters (Montant, Behrmann, 2001; Cohen et al., 2004). Alexic patients often retain effective single letter recognition abilities, and develop an effortful letter-by-letter reading strategy which is the basis of most rehabilitation techniques (Cohen et al., 2004). Occipital alexia (alexia without agraphia) is considered an example of interhemispheric disconnection syndrome (Očić, 1998). It manifests itself in impairment of reading ability with complete preservation of other modalities of language function: spontaneous speech, auditory comprehension, repetition and writing (Vuković, 2012). Although other language functions are generally preserved, these patients have a severe form of alexia manifested in reading deficits aloud, as well as a marked impairment of reading comprehension (Vuković, 2012). It is characteristic that these patients cannot read even what they have written themselves (Pavlovic, 2012;

Tomic et al., 2018). Alexia is most commonly manifested by the type of verbal alexia, the inability to read words, and in the most severe cases, literary alexia also exists as an inability to read the letters. Patients mostly write words read letter by letter, in order to decode the word through the auditory verbal channel (Pavlovic, 2016). Common symptoms of Alexia without agraphia are hemianopsia and color anomia (Tomić et al., 2018).

The aim of this study is to present reading rehabilitation in a patient with Alexia without agraphia syndrome, vascular etiology.

2 CASE STUDY

We are presenting a 71-year-old male, with clinical Aleksije without agraphia. The first symptoms the patient described were inability to recognize numbers and letters.

Magnetic resonance (MRI) indicated the presence of a lesion in the left mediotemporal region, which also covers equilateral thalamus, posterior cingulate gyrus, splenium of corpus callosum, lingual occipital gyrus, and the tail of the hippocampus. The lesion had an ischemic etiology. On the right part of the cerebellar, lacunar ischemia was present.

Neurolinguistic diagnostic protocol used for the assessment of speech and language status (Tomić et al., 2009; Tomić et al., 2018) includes Mini Mental Test MMSE (Folstein et al., 1975), Boston Diagnostic Aphasia Examination BDAE (Goodglass, Kaplan, 1983), Boston Naming Test BNT (Kaplan et al., 1978) and Phonemic and Category fluency tests (Thurstone, Thurstone, 1962). For the purposes of this research, we structured a specific protocol for the assessment of the ability for recognition and naming of colors (ARNC) (verbal-verbal, visual-visual and visual-verbal tasks).

The analysis of the results shows mild cognitive impairment (MMSE 23/30) which refers to the time and space orientation, delayed memory and reading disorder (Table 1). Neurolinguistic evaluation shows mildly reduced fluency in spontaneous speech, difficulties in spontaneous naming, delayed initiation and tempo, regular articulation and preserved grammar. The voice is slightly rough and hypophonic. Evaluation of different modalities of auditory comprehension measured by BDAE subtests shows that the patient recognizes images of auditory presented object names slowly and heavily, while the motor performance of complex verbal commands and the comprehension of complex ideational material (CIM) remained preserved. Repetitive speech are intact. The analysis of the results of BDAE subtests, which examine different modalities of reading shows clinical picture of severe degree of alexia without agraphia. Partially preserved analytic–synthetic ability enabled the patient to use the “letter by letter” reading technique and to read five out of ten given words. Reading of longer words and sentences was completely unsuccessful (Table 1). Also, patient was not even able to read his own writing although, just before that, he was writing correctly by the dictation. The writing mechanism is preserved. Transcription is significantly impaired with the tendency for omission, substitution and transposition of graphemes.

Based on the clinical examinations, it is confirmed that the patient has visual agnosia for numbers and objects. The assessment of tactile numbers recognition (graphesthesia) was completely preserved (10/10). Confrontational naming (BNT) is preserved, even though a large number of visual-perceptive errors was present, which confirms the clinical picture of visual agnosia for objects.

Table 1: Neurolinguistic testing

Mini Mental State Examination MMSE	23/30 Loss of points: time orientation (3), space orientation (2), memory (1), reading (1)
BDAE	Achievement:
Words differentiation	62/72 >15SD
Body parts repetition	20/20
Commands	15/15
Complex ideational material (CIM)	8/12 >2SD
Oral nonverbal skill	9/12
Oral verbal skill	14/14
Automatized sequences	8/8
Word repetition	10/10
Great probability sentences repetition	8/8
Small probability sentences repetition	8/8
Words reading	11/30
Sentences reading	0/10 >20SD
Naming induced by questions	30/30
Naming induces by images	89/114
Sentences and paragraph reading	0/10 >10SD
BNT: correct answers	47/60
Semantic support	28
Correct answers after semantic support	13
Phonemic support	17
Correct answers after phonemic support	8
Mistakes by educational nature	6
Visual perceptive mistakes	17
Verbal paraphasia	/
Phonological paraphasia	/

Table 2: Results in recognition and naming colors achievement

VERBAL-VERBAL TASKS		
Color fluency	10/1 min.	successful
Familiar colors naming stimuli	9/10	90%
Given color units naming	3,3,2,3	difficult
VISUAL-VISUAL TASKS		
Color adjustment-same quality stimulus	3/6	50%
Color adjustment-different quality stimulus	6/10	60%
Linking images and matching colors	3/5	60%
VERBAL-VISUAL TASKS		
Color naming	3/7	43%
Color names comprehension	4/9	44%
Pointing the colors of the familiar stimulus	3/8	37.5%

For the clinical examination needs, we have structured special tasks for the assessment of abilities of recognition and naming of colors (ARNC) (Table 2). The difficulty in solving these tasks confirms the assumption that, in our patient, the clinical picture of alexia without agraphia is accompanied by color agnosia. By assessing this disorder in visual perception, discrimination, and colors naming, we noted difficulties in verbal-visual tasks when the patient was asked to name the visually presented colors. He also had difficulties to understand the color names when he was asked to find the named color on the offered color palette, and failed to show the color of audibly presented familiar stimuli (for example: a pallet of ten colors is placed before the patient, and he is required to show the color of the sun, tomato, sky...) (Table 2).

3 DISCUSSION

Reading disorder in our patient is manifested as a severe degree of verbal alexia (inability of reading words) and as a literal alexia (inability of reading individual graphemes). Detailed quantitative (Table 1 and Table 2) and qualitative analysis of achievements on applied neurolinguistic tests (BDAE, BNT) and clinical examination (ARNC) determined techniques for neurorehabilitation of the reading disorder.

Right after the stroke, our patient was not able to recognize most of the presented individual graphemes. The first phase of rehabilitation was the recognition of individual graphemes. According to that, we focused on two types of rehabilitation, tactile and kinesthetic. Tactile treatment uses sense of touch, by imprinting graphemes on the patient's skin, with the request to name the imprinted grapheme. Kinesthetic treatment for graphemes identification uses muscle movements, and is applied by imprinting or scanning a grapheme by patient's finger (Starrfelt et al., 2013). The daily practice of recognizing graphemes presented in visual, audible and tactile ways resulted in the restoration of the ability to name all the graphemes of the mother tongue. We especially structured exercises of pairing the same graphemes written differently and orthographically similar graphemes and pairing the same graphemes but one little and one big. Emphasis is also placed on analytical-synthetic exercises. Further, the tasks were more and more complicated, so the patient was asked to read the syllables, then monosyllabic and afterwards multisyllabic words. In the initial phase of the rehabilitation, patient was using only the "letter by letter" strategy (LBL) of reading. The next phase represented "syllabic reading". Multiple oral re-reading technique was used (MOR) on the higher levels of rehabilitation. After mastering the reading of multisyllabic words, patient was given a task to read simple, and then complex sentences. Specifically, the tasks of reading and supplementing the sentence are constructed, as well as the tasks of finding the correct spelled sentence among several wrong ones. After that, he was requested to read short stories, using melodically intonated oral reading technique (MIORT), and had a task of direct and delayed recall. In the final stages of rehabilitation, the patient was tasked with telling the story after reading and answering questions about the story.

4 CONCLUSION

We have presented a detailed analysis of speech-language deficits in a patient with infarction-induced alexia without agraphia in the left occipital lobe and the corpus callosum splenium. Neuropsychological evaluation shows impaired attention, memory, visuospatial and visuo-structural functions. In addition to alexia without agraphia, the clinical picture consists of right-sided homonymous hemianopsia, color agnosia, alexia for numbers, and anomia most pronounced for the visuo-verbal modality of perception. These disorders are due to dysfunction or interruption of associative and commissural pathways that connect functionally specialized cortical regions of the brain and result in disconnection syndrome.

Intensive neuropsychological and speech-language treatments conducted daily during hospitalization, with particular emphasis on reading rehabilitation, such as "letter by letter" (LBL) technique, multiple oral re-reading technique (MOR) and melodically intonated oral reading technique (MIORT), have produced significant results.

REFERENCES

- Cohen, L., Henry, C., Dehaene, S., Martinaud, O., Lehericy, S., Lemer, C., Ferrieux, S. (2004). The pathophysiology of letter-by-letter reading. *Neuropsychologia*, 42(13), 1768-80.
- Folstein, M.F., Folstein, S.E., McHugh, P.R. Mini-Mental State. (1975). *J Psychiatr Res*, 12, 189-198.
- Goodglas, H., Kaplan, E. (1983). The assessment of aphasia and related disorders. *Lea & Febige*, Philadelphia.
- Kaplan, E.F., Goodglas, H., Weintraub, S. (1978). The Boston naming test. Kaplan, E., Goodglas, H., Boston.
- Montant M, Behrmann M. (2001). Phonological activation in pure alexia. *Cogn Neuropsychol*, 18(8), 697-727.
- Očić G. (1998). *Klinička neuropsihologija*. Zavod za udžbenike inastavna sredstva, Beograd.
- Pavlović D. (2012). *Neurologija*. Orionart, Beograd.
- Pavlović D, Pavlović A. (2016). *Više kortikalne funkcije*. Orionart, Beograd.
- Starrfelt, R., Ros Olafsdottir, R., Arendt, I. (2013). Rehabilitation of pure alexia: A review. *Neuropsychol Rehabil*, 23, 755-779.
- Starrfelt, R., Shallice, T. (2014). What's in a name? The characterization of pure alexia. *Cogn Neuropsychol*, 31(5-6), 367-377.
- Thurstone, L.L., Thurstone, T.G. (1962). Primary mental abilities (Rev). Science Research Associates, Chicago.
- Tomić, G., Nikolić, J., Punišić, S., Subotić, M., Zidverc-Trajković, J. (2018). Neurorehabilitation of alexia without agraphia - Case study. *Med Pregl*, 71(9-10), 309-313.
- Tomić G, Stojanović M, Pavlović A, Stanković P, Zidverc-Trajković J, Pavlović D, Marković-Jovanović Z, Čovićković-Šternić N. (2009). Speech and language disorders secondary to diffuse subcortical vascular lesions: Neurolinguistic and acoustic analysis. A case report. *Journal of the Neurological Sciences*, 163-169.
- Vuković M. (2011). *Afaziologija*. Arhipelag, Beograd.

Использование пренатального дозированного звукового воздействия для оценки состояния плода и прогнозирования дезадаптации новорождённого.

Л.Г.Назаренко, Л.А.Гук, И.А.Семеринская,

Украина. Харьковская медицинская академия последипломного образования

ABSTRACT

Цель исследования – уточнить диагностическое и прогностическое значение функционального теста с акустической стимуляцией (ТАС) при некоторых видах патологии беременности, определяющих повышенный перинатальный риск. Кроме того, мы выполнили сопоставление реакции фетального мозгового кровотока с показателями, характеризующими психоэмоциональный статус беременной женщины

Материалы и методы. Обследовано 174 женщины с одноплодной беременностью без врождённых пороков развития плода, в сроке 34-40 недель, которые разделены на четыре клинические группы: с неосложнённой доношенной беременностью, родами через естественные родовые пути в сроке 38-41 нед.; три группы с повышенным перинатальным риском за счёт гипертензивных осложнений; кесарева сечения в анамнезе; тазового предлежания плода. Для проведения ТАС использована методика, разработанная M.Sovilj, A.Ljubic, известная как «пренатальный скрининг слуха». Оценивались показатели сосудистого сопротивления в средней мозговой артерии плода до и после подачи звукового стимула (интенсивностью 90 Дб, частотой 1500-4500 Гц, продолжительностью 0,2 с.) под прямым углом на расстоянии 5 см от живота беременной в проекции аурикулы плода. По результатам измерений вычисляли коэффициент сосудистой реактивности.

Результаты. Средние показатели исходной (фоновой) резистентности фетального мозгового кровотока в группе низкого перинатального риска и группах повышенного перинатального риска не имели различий. Реактивный ТАС наблюдался в 73% случаев от общего числа женщин. Большая доля ареактивного ТАС определена в группе женщин с тазовым предлежанием плода (каждое второе наблюдение). Общей тенденцией, было увеличение сосудистой резистентности в группах повышенного перинатального риска, что подтвердилось достоверными отличиями коэффициента сосудистой реактивности. Индивидуальный анализ наблюдений показал, что реакция в ТАС в сторону максимального повышения сосудистой резистентности совпадает с нарушениями ранней неонатальной адаптации у родившихся детей, что проявилось преходящими и персистирующими кардиореспираторными и неврологическими расстройствами.

Заключение. Тест с акустической стимуляцией плода открывает новые возможности повышения качества прогнозирования и оценивания состояния плода при беременности низкого и высокого риска. Целесообразность распространения практики проведения функциональных тестов продиктовано потребностями эффективной реализации стратегии перинатального риска.

Ключевые слова: акустическая стимуляция, перинатальная патология, прогнозирование

К числу приоритетных направлений современной медицины, направленных на улучшение качества здоровья будущих поколений, относится создание программ наблюдения за состоянием плода при беременности высокого риска, позволяющих определить вероятность неблагоприятного внутриутробного ребёнка [1].

В последние десятилетия надежды на достоверную оценку состояния плода связывались с электронными и биохимическими методами, определяющими *страдание* плода. В их числе - доплерометрия сосудов фето-плацентарной системы, кардиотокографический тест, оценка биофизического профиля плода [2]. Однако выводы в отношении диагностических возможностей этих тестов на практике весьма противоречивы. Большинство специалистов признаёт, что

диагностика истинных гипоксемических состояний плода выходит за пределы возможностей этих тестов, является трудной задачей, характеризуется высокой частотой гипердиагностики, что ведёт к неоправданному изменению акушерской и перинатальной тактики [3]. Чаще всего это кесарево сечение, по сути, далеко не всегда обоснованное клинической необходимостью.

Особые сложности вызывают вопросы на дородовом этапе дать прогнозы в отношении психоневрологического статуса, перспектив психоэмоционального развития ребёнка. Перечисленные выше методы антенатального наблюдения за плодом на рутинной основе не дают ответа на эти вопросы. Наиболее «острым» ракурсом этой проблемы является роль акушерской практики, которую ассоциируют с вопросом о том, почему число детей с психоневрологическими отклонениями не только не уменьшается, но даже растёт в последние годы. И это несмотря на высокие технологии, которые стали доступными акушерским стационарам, обеспечение их современными ультразвуковыми аппаратами, кардиомониторами с компьютерными блоками, биохимическими исследованиями, внедрение компьютерной томографии, несмотря на эпидемический рост частоты кесаревых сечений по перинатальным показаниям.

Проведение экспертного анализа перинатального периода у детей с психоневрологической патологией позволило нам подтвердить известный тезис: проблемы, которые манифестируют в детском возрасте – отклонения психофизиологического развития, неврологические расстройства, нарушения слуха, речи, поведения – берут начало в антенатальном периоде. И для того, чтобы их предвидеть и предотвратить, недостаточно рутинного наблюдения.

Наиболее драматичными являются клинические ситуации не предвиденного рождения ребёнка в неудовлетворительном состоянии или мертворождения, в случаях отсутствия очевидных признаков нездоровья женщины, не имеющий экстрагенитальной патологии, доносивший беременность до доношенного срока, предполагающего хорошую жизнеспособность ребёнка. Отчасти поэтому не утратило правомочности понятие «идиопатическая плацентарная недостаточность», как временная категория, побуждающая к углублённому поиску и уточнению причин [2]. Неблагоприятный перинатальный исход рождения больного или мёртвого ребёнка в реальной жизни, с учётом невысокой приверженности современников предгравидарной подготовке, является нередко *первым «симптомом»*, сигналом о неблагополучии супружеской пары в медицинском, психоэмоциональном, социо-культурном аспекте. Следует признать, что поиск причин перинатальных неудач в формате обратной связи (*feedback effect*) в большинстве приносит результат в понимании истоков неблагоприятного исхода беременности. Идя по этому пути, специалист как бы следует библейской истине: «По плодам их узнаете их. ...Так всякое дерево доброе приносит плоды добрые, а худое дерево приносит и плоды худые» (Евангелие от Матфея. Глава 7). При этом в современном мире, при нынешней кризисной демографической ситуации в большинстве европейских стран, в частности, в Украине, состоянию здоровья плода (внутриутробного ребёнка) следует уделять внимание до его рождения, в том числе, используя его как «ключ» к состоянию здоровья матери.

Многолетние наблюдения за детьми, родившимися живыми у женщин с плацентарной недостаточностью, в том числе без задержки внутриутробного роста, показали, что в первые годы жизни у них весьма вероятны нарушения здоровья, неврологические расстройства, отклонения психо-физиологического и умственного развития, повышена частота соматической и инфекционной заболеваемости [4].

При соблюдении стандартов наблюдения беременных женщин, включающем скрининговые УЗИ и оценку состояния плода с помощью КТГ, не принято задаваться вопросом, насколько плод устойчив к неизбежной во время родов через естественные родовые пути гипоксии, оставляя без должного внимания адаптационный потенциал в условиях дефицита кислорода [3]. Как известно, высокая чувствительность нервной ткани к изменениям газового и энергетического гомеостаза крови составляет основу уязвимости сосудистой системы мозга [5]. В перинатальном аспекте особое значение имеет характер кровоснабжения мозга во внутриутробном периоде развития. Структурная реорганизация сосудистого русла головного мозга в антенатальном периоде с высокой

долей вероятности сопровождается изменением резистентности мозговых сосудов, что является условием реакций мозгового кровотока к концу внутриутробного периода развития и в родах.

Перспективу усовершенствования оценки устойчивости плода к гипоксии можно связать с функциональным тестированием в условиях акустической стимуляции плода. Акустическая стимуляция при определённых условиях является фактором прямого действия на плод, позволяя оценить *непосредственно сенсорный ответ плода* на звуковой стимул, реально *предъявляемый непосредственно плоду* [3]. В отличие от этого, другие функциональные пробы, в частности, окситоциновый тест, способ Гаускнехт, основаны на индуцированных изменениях интенсивности маточно-плацентарной гемодинамики, что опосредованно сказывается на сердечной деятельности плода [6].

История разработки и первых попыток использования акустического теста в его начальных модификациях более 30 лет назад заложила теоретические основы и продемонстрировала возможность получения представлений об уровне координации центральной нервной системы и полноценности адаптационных реакций по изменениям сердечного ритма. С тех пор многое изменилось, и в практику вошла доплерометрическая оценка фетального мозгового кровотока. Изолированная доплерометрия кровотока средней мозговой артерии (СМА), как тест на дородовой дистресс плода, в свете последних исследований, имеет ограниченное значение [7]. При этом вопрос о возможностях акустического теста с оценкой параметров, характеризующих реактивность мозговых сосудов, остаётся открытым.

Цель работы – уточнить диагностическое и прогностическое значение функционального теста с акустической стимуляцией (ТАС) при некоторых видах патологии беременности, определяющих повышенный перинатальный риск. Кроме того, мы выполнили сопоставление реакции фетального мозгового кровотока с показателями, характеризующими психоэмоциональный статус беременной женщины

Материалы и методы исследования. Исследования выполнены у 174 женщин с одноплодной беременностью без врождённых пороков развития плода, в сроке 34-40 недель. Первобеременными были 96 женщин, 78 – повторнобеременными, из них 48 рожали впервые и 30 – повторно. При проведении обследования женщин соблюдались стандарты, предусмотренные «Этическими принципами проведения научно-медицинских исследований с участием человека». Беременные женщины составили четыре клинические группы: 1 - 55 женщин с неосложнённой доношенной беременностью, родами через естественные родовые пути в сроке 38-41 нед.; 2 – 48 женщин с гипертензивными осложнениями, включающими мягкую преэклампсию, гестационную гипертензию или гипертоническую болезнь IА ст.; 3 – 45 беременных с одним кесаревым сечением в анамнезе; 4 - 26 женщин с тазовым предлежанием плода.

Основным методом для достижения цели был избран тест «пренатальный скрининг слуха» M.Sovilj, A.Ljubic (1992) [8,9]. Исследования выполняли на аппарате Mindray DC-T6 (КНР) с автоматическим компьютерным блоком, с конвексным трансабдоминальным датчиком с частотой излучения 3,5 МГц. Оценку кровотока проводили в периоды отсутствия у плода дыхательной и двигательной активности. Исходные параметры кровотока регистрировали трижды, взяв за основу среднее значение. Для анализа выбирали наиболее чётко зарегистрированный цикл доплерограммы. Качественный анализ полученных доплерограмм включал определение традиционных показателей сосудистого сопротивления: систоло-диастолического отношения (СДО), пульсационного индекса (ПИ), индекса резистентности (ИР)

Процедура проведения ТАС состояла из следующих основных моментов:

- расположение антифонов на уши беременной женщины, чтобы исключить влияние звуковой стимуляции через слуховую систему матери;
- определение позиции головки плода;
- детекция аурикулы плода максимально близко к стенке живота матери;
- выбор расположения генератора звука;
- запись базовой кривой доплерограммы СМА;

- подача звукового стимула (интенсивностью 90 Дб, частотой 1500-4500 Гц, продолжительностью 0,2 с.) под прямым углом на расстоянии 5 см от живота беременной;
- запись кривой доплерограммы СМА;
- оценка реактивности.

Для оценки реакции фетального мозгового кровотока в ответ на функциональный тест использовали коэффициент сосудистой реактивности (КСР) - отношение исходной величины СДО СМА к СДО этого же сосуда после подачи акустического сигнала: $КСР = \text{СДО}_{\text{исходное}} / \text{СДО}_{\text{после акустического воздействия}}$. При интерпретации происходящих в каждом наблюдении изменений принимали во внимание, что КСР >1 отражала уменьшение сосудистого сопротивления СМА, и, соответственно, КСР <1 – увеличение.

Расчёт изменений фетального мозгового кровотока на основании СДО, выбранного из перечня индексов, характеризующих сосудистую реактивность, представлялся нам предпочтительным, поскольку именно этот индекс наиболее прост в расчёте, отличается большим численным значением, что даёт определённые удобства для исследователя.

С учётом известной связи пренатального стрессового воздействия на здоровье, существование механизмов передачи стресса от поколения к поколению [10], было интересно сопоставить результаты ТАС плода и психоэмоционального статуса матери.

Психодиагностическое обследование проводили в объёме: многофакторный личностный опросник FPI “Freiburg Personality Inventory”, тестовый опросник измерения уровней тревожности Дж.Тейлор, адаптированный Т.А.Немчиновым, самооценка уровня реактивной и личностной тревожности Ч.Д.Спилбергера и Ю.Л.Ханина, экспресс-диагностика тревожного состояния в проективном тесте цветных выборов Люшера.

В качестве первичной конечной точки оценивали развитие дистресса плода в родах, рождение ребёнка с низкой оценкой по шкале Апгар, потребность в неонатальной помощи и интенсивной терапии.

Статистическую обработку полученных данных проводили с помощью пакета программ Statistica 6.0 методами: вариационным, с использованием при нормальном распределении t-критерия Стьюдента, при ненормальном – непараметрические критерии – Т-критерий Уилкоксона и U-критерий Уилкоксона.

Результаты исследования и обсуждение.

Во всех группах кривые доплерограмм продемонстрировали типичную двухфазную форму, состоящую из фазы акцелерации (восходящая часть), отражая повышение скорости кровотока соответственно систоле сердца, и фазы децелерации (нисходящая ветвь), отображая диастолическое снижение кровотока. Средние исходные показатели резистентности фетального мозгового кровотока (таблица 1) не выявили различий в группах, подтверждая отчасти невысокую ценность изолированного определения кровотока в СМА [7,11] и отсутствие связи с фоновой патологией, определяющей перинатальный риск.

Таблица 1

Показатели сосудистой резистентности в средней мозговой артерии плода в группах женщин с низкой и высокой степенью перинатального риска

<i>Группа</i>	<i>Систолическое-диастолическое отношение</i>	<i>Пульсационный индекс</i>	<i>Индекс резистентности</i>
1	4,99±0,133	1,52±0,05	0,78±0,05
2	5,0±0,141	1,6±0,04	0,8±0,04
3	4,63±0,123	1,5±0,04	0,82±0,05
4	5,02±0,138	1,49±0,06	0,81±0,05

Общую оценку результатов ответной реакции со стороны плода нам представлялось целесообразным разделить на категории реактивного и ареактивного ТАС.

Ареактивный тест, по определению, характеризовался отсутствием значимых изменений показателей сосудистого сопротивления в СМА до и после акустического стимула. *Реактивный тест* состоял в получении реакции в форме изменения параметров сосудистого сопротивления в СМА. При этом увеличения параметров сосудистого сопротивления, отражающее снижение интенсивности кровотока по отношению к исходному (базовому) уровню мы рассматриваем как *негативную реакцию*. Соответственно, снижение сосудистого сопротивления, означающее увеличение кровотока, характеризует *позитивную реакцию*. Мы полагаем, что для практического врача удобнее и понятнее констатировать как позитивную реакцию – возрастание кровотока. Это совпадает с расчётными показателями церебро-плацентарного отношения.

При повторении доплерометрии в интервале 10-15 мин. после акустической стимуляции нами отмечен обратимый характер изменений.

Реактивный ТАС нами наблюдался в 127 случаях (73% от общего числа женщин). Ареактивный ТАС мы наблюдали у плодов при беременности с гипертензивными расстройствами (12 наблюдений - 25%), с рубцом после кесарева сечения (13 наблюдений – 28,9%), а также при тазовом предлежании плода (13 наблюдений - 50%). Ареактивный тест в 1 группе продемонстрировали плоды 9 женщин, у которых родились дети с оценкой по Апгар 5-7 баллов в связи с различными клиническими ситуациями в родах (16%).

Следует отметить, что ареактивный тест не обнаруживает достоверной связи с конкретной исследуемой нами акушерской ситуацией и перинатальной патологией.

Представлял интерес сравнительный анализ изменений показателей резистентности кровотока в СМА по клиническим группам, который представлен в таблице 2.

Таблица 2

Сравнительный анализ изменений сосудистой реактивности средней мозговой артерии плода в тесте с акустической стимуляцией

Группа	N	Систола-диастолическое отношение		КСР
		Исходный показатель	Ответ в ТАС	
1	46	5,01±0,121	4,8±0,11	1,04±0,021
2	36	5,02±0,139	5,8±0,095	0,87±0,025*
3	32	4,9±0,096	5,6±0,121	0,87±0,022*
4	13	5,01±0,116	5,62±0,122	0,89±0,032*

Примечание: * - показатель достоверности отличий при $p < 0,001$ при сравнении групп 1-2, 1-3, 1-4,

Как видно, общей тенденцией, выявленной нами, было увеличение сосудистой резистентности в группах повышенного перинатального риска. Индивидуальный анализ клинических наблюдений позволил нам отметить, что реакция в ТАС в сторону максимального повышения сосудистой резистентности совпадает с нарушениями ранней неонатальной адаптации у родившихся детей, что проявилось синдромом возбуждения или, напротив, угнетения ЦНС, патологической потерей массы та и замедленным её восстановлением, наблюдениями транзиторного тахипноэ.

Анализ результатов функционального ТАС плода и кардиотокографического исследования позволило нам отметить, что комплексное использование обоих тестов даёт определённые преимущества в отношении адекватности оценки состояния плода, прежде всего, в том, что уменьшается число случаев ареактивной КТГ при повторных исследованиях. Немаловажным фактом следует считать возможность прогнозирования состояния нервной системы новорождённых, что способствует выбору оптимальной модели родоразрешения, а также выделению группы риска по нарушению слуха.

Следует отметить, что ареактивный тест совпадает с более высоким уровнем реактивной и личностной тревожности у женщин и не имеет связи с конкретной акушерской ситуацией и патологией. И это, по нашему мнению, вполне объяснимо, поскольку преэклампсия и другие гипертензивные нарушения при беременности рассматриваются как синдром психоэмоциональной дезадаптации. Тазовые предлежания, по нашим данным, также ассоциированы с психоэмоциональным напряжением матери и расстройствами у неё в аффективно-волевой сфере. У женщин с оперированной маткой накануне родов типично повышенное психоэмоциональное напряжение в связи с мифической угрозой разрыва, которая бытует среди пациентов и многих врачей.

Выводы. Функциональный тест с акустической стимуляцией плода открывает новые возможности повышения качества прогнозирования и оценивания состояния плода при беременности низкого и высокого риска. Преимуществами его мы считаем уменьшение числа случаев ареактивной кардиотокографии, углубление представлений о состоянии нервной системы плода, что имеет значение в выборе оптимальной модели родоразрешения. Результаты теста позволяют объективно оценивать необходимость обучения родителей технологиям пренатальных коммуникаций. Раннее прогнозирование состояния слуха является необходимым условием предупредительного подхода к социальной адаптации ребёнка в постнатальном онтогенезе.

The use of prenatal graded sound stimulation in the evaluation of the fetal status and for predicting newborn desadaptation.

L. Nazarenko, L. Huk, I. Semerinskaja. Kharkov. Ukraine.

The objective: Clarify the diagnostic and prognostic value of the functional test with acoustic stimulation (TAS) for some types of pregnancy pathologies that determine an increased perinatal risk. In addition, we performed a comparison of the reaction of fetal cerebral blood flow with indicators characterizing the psychoemotional status of a pregnant woman.

Materials and methods. A total of 174 women with a single pregnancy without congenital malformations of the fetus were examined in 34–40 weeks, which were divided into four clinical groups: with an uncomplicated full-term pregnancy, childbirth through the natural birth canal in a period of 38–41 weeks; and three groups with increased perinatal risk due to hypertensive complications; history of cesarean section; pelvic presentation of the fetus. For TAS, a technique developed by M.Sovilj, A.Ljubic, known as “prenatal hearing screening” was used. Vascular resistance indices were estimated in the middle cerebral artery of the fetus before and after the delivery of a sound stimulus (intensity 90 dB, frequency 1500-4500 Hz, duration 0.2 s) at a right angle at a distance of 5 cm from the pregnant woman’s abdomen in the projection of the fetal auricular. According to the measurement results, the coefficient of vascular reactivity was calculated.

Results. The average indices of the initial (background) resistance of fetal cerebral blood flow to the low perinatal risk group and high perinatal risk did not differ in the groups. Reactive TAS was observed in 73% of the total number of women. A large proportion of reactive TAS was determined in a group of women with pelvic presentation of the fetus (every second observation). A general trend was an increase in vascular resistance in high perinatal risk groups, which was confirmed by significant differences in the vascular reactivity coefficient. An individual analysis of the observations showed that the reaction in the TAS towards the maximum increase in vascular resistance coincides with impaired early neonatal adaptation in children born, which was manifested by transient and persistent cardiorespiratory and neurological disorders.

Conclusion. A functional test with acoustic stimulation of the fetus opens up new possibilities for improving the quality of prediction and assessment of the condition of the fetus during pregnancy of low and high risk. We consider its advantages to be a reduction in the number of cases of reactive cardiotocography, a better understanding of the state of the nervous system of the fetus, which is important in choosing the optimal delivery model. The test results allow you to objectively assess the need for parents to teach prenatal communication technologies. Early prediction of the state of hearing is a prerequisite for a precautionary approach to the social adaptation of the child in postnatal ontogenesis.

Key words: *acoustic stimulation, perinatal pathology, prognosis*

Литература

1. Акушерская агрессия , ч. 2.0 / В.Е.Радзинской. – М.: Изд-во журнала Status Praesens? 2017. - 872 с.
2. Воскресенский С. Л. Длительность безопасной инфузии утеротоников при родах в срок / С. Л. Воскресенский, Е. Н. Луканская, М. Л.Тесакова и др. // Журнал акушерства и женских болезней. – 2013. – Том LXII, Вып. 4.–С.22-28.
3. Воскресенский С. Л. Оценка состояния плода. Кардиотокография. Допплерметрия. Биофизический профиль: учеб. пособие. – Мн.: Книжный Дом, 2004. – 304 с.
4. Kaur J. Condition behind fetal distress / J. Kaur, K. Kaur // Annals Biological Research. – 2012. – Vol.3 (10). – P.4845-4851.
5. Хананашвили Я.А. Характер реакций сосудов мозга в антенатальный период развития организма / Я.А.Хананашвили, А.Э. Амамчян // Кубанский научный медицинский вестник. – 2012, - №4. – С.111-113.
6. Радзинский В. Е. Проба Гаускнехт как способ прогнозирования кесарева сечения и реанимации новорожденного / В. Е. Радзинский, Н. А. Уракова, А. Л. Ураков, Д. Б. Никитюк // Архив акушерства и гинекологии им. В.Ф.Снегирёва.– 2014. – №2. – С.14-18.
7. Сафонова И.Н. Особенности антенатальных эхографических мониторингов и перинатальных результатов при дородовом дистрессе плода / И.Н.Сафонова // Експериментальна і клінічна медицина. – 2016. - №1 (70). – С.131-138.
8. Тан К.Х. Виброакустическая стимуляция плода для облегчения результатов оценки состояния плода. Cochrane Systematic Review - **Intervention** Version published: 07 December 2013 - Кельвін Х Тан, Ребекка М.Д., Сін Вей <https://doi.org/10.1002/14651858.CD002963.pub2>
9. Sovili M. Possibilities of Prenatal Examination of Reaction to Sound in fetuses with Congenital Infections / M. Sovili, A. Ljubic // Journal of Perinatal Medicine section, Serbian Medical Society. – 1992. – P.17-18.
10. Entringer S. Prenatal stress, development, health and disease risk: A psychobiological perspective—2015 Curt Richter Award Paper / S. Entringer, C. Buss, P. Wadhwa // Psychoneuroendocrinology Volume 62, December 2015, Pages 366-375.
11. O'Neill E. Antepartum evaluation of the Fetus and Fetal Well Being / E. O'Neill, J. Thorp // Clin. Obstet.Gynecol. – 2012. – Vol. 55 (3). – P.722-730.

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

81'234-053.2(082)
159.943-053.2(082)
81'233-053.2(082)
81'33(082)

THE Internacional Conference on Fundamental and Applied Aspects of Speech and Language (7 ; Beograd ; 2019)

Speech and Language 2019 [Elektronski izvor] : proceedings / 7th International Conference on Fundamental and Applied Aspects of Speech and Language Belgrade 01-02 November, 2019 ; [editors Miško Subotić Slavica Maksimović]. - Belgrade : Life Activities Advancement Center : The Institute for Experimental Phonetics and Speech Pathology "Đorđe Kostić" ; Athens : Cosmoanelixis - Prenatal and Life Sciences, 2019 (Belgrade : Draslar). - 1 elektronski optički disk (CD-ROM) : tekst ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovnog ekrana. - Radovi na srp. , rus i engl. jeziku. - Tiraž 300. - Napomene i bibliografske reference uz tekst. - Bibliografija uz svaki rad.

ISBN 978-86-89431-39-1 (LAAC)

1. Maksimović, Slavica, 1968- [уредник]

а) Говорни поремећаји -- Деца -- Зборници б) Вербална комуникација -- Дефектолошки аспект -- Зборници в) Деца -- Психомоторни развој -- Зборници г) Примењена лингвистика -- Зборници

COBISS.SR-ID 282123532
