

## NEUROPSYCHOLOGICAL PECULIARITIES OF COGNITIVE FUNCTIONS OF SPEECH-IMPAIRED JUNIOR PUPILS

### *PECULIARIDADES NEUROPSICOLÓGICAS DAS FUNÇÕES COGNITIVAS DE ALUNOS JÚNIORES COM DIFICULDADES DE FALA*

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#### **Yuliia Shevchenko**

Doctor of Pedagogical Sciences, Professor of the Department of Primary and Special Education, Educational and Scientific Institute of Social-Pedagogical and Artistic Education, Bogdan Khmelnytsky Melitopol State Pedagogical University, Melitopol, Ukraine.

[Shevchenko\\_Yuliya@mstu.edu.ua](mailto:Shevchenko_Yuliya@mstu.edu.ua)

#### **Svitlana Dubiaha**

Candidate of Pedagogical Sciences, Associate Professor of the Department of Primary and Special Education, Educational and Scientific Institute of Social-Pedagogical and Artistic Education, Bogdan Khmelnytsky Melitopol State Pedagogical University, Melitopol, Ukraine.

[svetlana\\_107@ukr.net](mailto:svetlana_107@ukr.net)

#### **Olha Kovalova**

Doctor of Psychology, Professor of the Department of Psychology, Educational and Scientific Institute of Social-Pedagogical and Artistic Education, Bogdan Khmelnytsky Melitopol State Pedagogical University, Melitopol, Ukraine.

[kovalova.ov.mdpu@gmail.com](mailto:kovalova.ov.mdpu@gmail.com)

#### **Hanna Varina**

Master of Psychology, Senior Lecturer of the Department of Psychology, Educational and Scientific Institute of Social-Pedagogical and Artistic Education, Bogdan Khmelnytsky Melitopol State Pedagogical University, Melitopol, Ukraine.

[varina\\_hanna@mdpu.org.ua](mailto:varina_hanna@mdpu.org.ua)

#### **Hanna Svyrydenko**

Assistant, Departments of Primary and Special Education, Educational and Scientific Institute of Social-Pedagogical and Artistic Education, Bogdan Khmelnytsky Melitopol State Pedagogical University, Melitopol, Ukraine.

[anutaanna30@gmail.com](mailto:anutaanna30@gmail.com)

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### **ABSTRACT**

The connection between speech and cognitive impairments may be the key to understanding more general mechanisms of children's brain development. The identification, analysis, and understanding of speech impairments open up opportunities for the development of new teaching methods, rehabilitation programs, and support for children and their families in overcoming such difficulties. Particular attention should be paid to a multidisciplinary approach to the study of this issue. This approach combines the efforts of psychologists, educators, speech therapists, and medical professionals. This study aimed to investigate the neuropsychological features of cognitive functions of junior pupils with speech impairment. The research employed a comprehensive methodology based on neuropsychological tests and theoretical studies. The authors found that speech disorders among junior pupils indicate the presence of speech difficulties. Moreover, they can also be indicators of certain cognitive developmental disorders. Such peculiarities in speech and cognitive functions can lead to problems in learning, social integration, and emotional well-being. A timely detection of these features and their subsequent correction are the keys to ensuring optimal conditions for the child's development and successful societal adaptation. The main value of this study comes from the fact that it offers a holistic view of the problem. Moreover, it focuses on the broad context of influence shaping speech and cognitive development. The article is recommended for consideration by specialists in the fields of education, psychology, and medicine who are interested in expanding their knowledge and improving their practical skills in working with children with special needs.

**Keywords:** Cognitive development, Communication, Education, Emotional development, Junior pupils, Rehabilitation, Social adaptation, Speech impairment.

### **RESUMO**

A conexão entre a fala e as deficiências cognitivas pode ser a chave para a compreensão dos mecanismos mais gerais do desenvolvimento do cérebro das crianças. A identificação, análise e compreensão das deficiências de fala abrem oportunidades para o desenvolvimento de novos métodos de ensino, programas de reabilitação e apoio às crianças e suas famílias na superação de tais dificuldades. Deve ser dada especial atenção a uma abordagem multidisciplinar ao estudo desta questão. Essa abordagem combina os esforços de psicólogos, educadores, fonoaudiólogos e profissionais médicos. Este estudo teve como objetivo investigar as características neuropsicológicas das funções cognitivas de alunos do ensino fundamental com comprometimento de fala. A pesquisa empregou uma metodologia abrangente baseada em testes neuropsicológicos e estudos teóricos. Os autores descobriram que os distúrbios de fala entre os alunos do ensino fundamental indicam a presença de dificuldades de fala. Além disso, também podem ser indicadores de certos distúrbios do desenvolvimento cognitivo. Tais peculiaridades na fala e nas funções cognitivas podem levar a problemas de aprendizagem, integração social e bem-estar emocional. A detecção atempada destas características e a sua subsequente correção são a chave para garantir condições ótimas para o desenvolvimento da criança e uma adaptação social bem sucedida. O principal valor deste estudo vem do fato de oferecer uma visão holística do problema. Além disso, concentra-se no amplo contexto de influência que molda a fala e o desenvolvimento cognitivo. O artigo é recomendado para apreciação de especialistas das áreas de educação, psicologia e medicina que tenham interesse em ampliar seus conhecimentos e aprimorar suas habilidades práticas no trabalho com crianças com necessidades especiais.

**Palavras-chave:** Desenvolvimento cognitivo, Comunicação, Educação, Desenvolvimento emocional, Alunos juniores, Reabilitação, Adaptação social, Comprometimento da fala.

## Introduction

Speech impairments among junior pupils are an essential issue that requires a deep understanding and proper attention from the scientific community. Based on years of research in neuropsychology and neurophysiology, speech impairments are not merely external symptoms but reflect more profound neurological changes.

Junior pupils facing speech impairments may experience difficulties not only in the sphere of communication but also in cognitive processes such as attention, memory, and logical thinking. This can lead to challenges in learning, social interactions, and emotional well-being. It is essential to understand that the brain is an incredibly complex system where various areas interact, shaping both speech and cognitive functions. Therefore, a deep understanding of the neuropsychological characteristics of children with speech impairments is critical to developing effective methods of diagnosis, treatment, and correction.

Speech disorders and cognitive functions are closely interrelated. They reflect the intricate structure of the brain's neural networks. Every speech action, from a simple word pronunciation to complex sentences, requires the activation of various brain regions, which also play a role in cognitive processes. Speech and memory are often intertwined since the ability to store and retrieve information is crucial for the speech process. Children with speech impairments often struggle with short-term memory, affecting their ability to acquire new vocabulary or construct complex sentences. An effective speech requires focused attention.

For this reason, attention instability can lead to communication gaps and difficulties in understanding others. Purposefulness, planning, and monitoring of speech activities also play a vital role, and impairments in this area can hinder the construction of logical sentences and coherent thought expression. Even spatial and motor skills, especially articulatory skills, are crucial for proper pronunciation.

Considering these connections, it can be argued that speech impairments are not isolated challenges. They may indicate a broader spectrum of cognitive difficulties. This, in turn, requires a comprehensive approach to diagnosis and correction. Speech impairments are a widespread issue, and as a result, scientists on

both sides of the Atlantic have shown significant interest in them. Recently, neuropsychology has begun to develop rapidly in Asian countries as well, uniting the civilized world in scientific exploration.

The main leitmotif of the proposed material is the testing of three key hypotheses:

- Junior pupils with speech impairments exhibit deviations in cognitive functions (attention, memory, and executive control functions) compared to their peers without such disorders.
- Structural and functional changes in specific brain sectors correlate with the nature and degree of speech impairments that affect the cognitive performance of junior pupils.
- The intensity and specificity of speech impairments in junior pupils are directly linked to the efficiency of their cognitive processes, and speech disorder correction can contribute to the improvement of cognitive functions.

Verification of these assumptions will provide opportunities for generating recommendations regarding the treatment of speech impairments.

This study aims to systematize, analyze, and evaluate modern research works on the neuropsychology of children that have been presented over the past decades. For this purpose, we have set several tasks, each of which has its own instrumental role in the overall context:

- to analyze the methods used in modern research on speech impairments and their effectiveness;
- to evaluate the main conclusions reached by scientists in our chosen field of study;
- to identify possible shortcomings or gaps in modern research that could serve as a basis for future scientific work.

In addition, we will offer recommendations for further research in this area.

## Literature review

The study of neuropsychological characteristics of cognitive functions in junior pupils with speech impairments has been the subject of numerous scientific works. Research on the interplay of genetic and neuropsychological aspects of speech impairments occupies a key place in this context. For instance, the result of Peterson and colleagues (2007) reveals a profound connection between genetics and neuropsychology of speech impairments (Peterson et. al., 2007). In contrast, Bishop (1997) explores the specifics of the interaction between cognitive neuropsychology and developmental disorders, emphasizing the challenges that arise in this context (Bishop, 1997).

Paçhalska and colleagues (2007) extensively investigate specific language disorders from the perspective of neuropsychology and neurolinguistics. Temple (1997), in his research, focuses on the application of cognitive neuropsychology to a pediatric audience (Temple, 1997).

The research by Williams and colleagues (2000) emphasizes specific speech impairments in the context of hyperactivity (Williams et. al., 2000). Additionally, we mention the work of Minshew and colleagues (1995), where language and speech characteristics of high-functioning individuals with autism were studied (Minshew et. al., 1995).

Another important aspect of this issue is the role of developmental speech disorders in the neuropsychological context. Tallal's study (1987) extensively delves into the neuropsychology of developmental speech impairments (Tallal, 1987). Thomas and Vissers (2019) examine the scene of developmental speech impairments, highlighting the importance of neuropsychological tools in addressing this issue (Thomas & Vissers, 2019).

An overview of Faust's work (2011) provides a general perspective on the field of neuropsychology of speech, which can be beneficial for understanding the broader context of this research (Faust, 2011). Conrad and colleagues' study (2014) analyzes the relationship between speech, listening, and neuropsychological skills in subjects with developmental disorders of the mouth and throat (Conrad et al.,

2014). Anderson, Northam, and Wrennall (2018) examine issues of pediatric neuropsychology from a practical standpoint (Anderson et. al., 2018).

An interesting study on the neuropsychological characteristics of children with dyslexia is presented by Cruz-Rodrigues and colleagues (2014). Borchgrevink and Ba (2013) focus on the brain processes underlying neuropsychological and neuromotor disorders in children with attention deficit disorders (Borchgrevink et. al., 2013). In this context, Ponsford's approach (2017), which emphasizes international development in neuropsychology, is also noteworthy (Ponsford, 2017).

Research focusing on the developmental neuropsychology of children plays a significant role in understanding speech impairments. For example, Glozman (2013) provides a general overview of developmental neuropsychology (Glozman, 2013). Another researcher, Korkman (1999), emphasizes the application of Luria's diagnostic principles in the neuropsychological assessment of children (Korkman, 1999). Battista and colleagues (2017) focus on the study of primary progressive aphasia, particularly the evaluation of speech impairments (Battista et al., 2017).

In the context of specific conditions and disorders, Cotton and colleagues (1998) investigate the neuropsychological profile in Duchenne muscular dystrophy (Cotton et al., 1998). On the other hand, Paul-Brown and Ricker (2003) shed light on approaches to direction and collaboration in the fields of speech-language pathology and clinical neuropsychology (Paul-Brown & Ricker, 2003).

Bellinger and Newburger (2010) focus on the neuropsychological and social consequences for children and adolescents with congenital heart diseases (Bellinger & Newburger, 2010). The study by Beauchamp, Boneh, and Anderson (2009) examines profiles of children with glutaric aciduria type I, identified in the early stages (Beauchamp et al., 2009). On the other hand, Justus and Ivry (2001) explore the neuropsychology of the cerebellum (Justus & Ivry, 2001).

Another noteworthy research is the work of Lassaletta and colleagues (2015). It examines the functional and neuropsychological late effects following posterior fossa surgeries in children (Lassaletta et al., 2015).

Recent scientific articles and studies continue to expand our understanding of children's neuropsychology. Vinten and colleagues (2005) investigate the neuropsychological effects of anticonvulsant medication exposure on the fetus (Vinten et al., 2005). In the context of practice, Bigler, Nussbaum, and Foli (1997) draw attention to pediatric neuropsychology in private medical practice (Bigler, 1997).

Temple (2014) presents a collection on developmental cognitive neuropsychology (Temple, 2014). Meanwhile, Joo and colleagues (2015) analyze the neuropsychological consequences of preterm birth in children without major neurodevelopmental disorders in the early stages (Joo et al., 2015).

Minavvarovna (2023) investigates the psycho-physiological aspects of language-impaired children's development (Minavvarovna, 2023). Brown and Adams (2023) highlight the perspectives of clinical neuropsychology (Brown & Adams, 2023).

Bonthrone and others (2023) examine attention and motor profiles in children with developmental coordination disorder through neuropsychological and neuroimaging research (Bonthrone et al., 2023). Smith and colleagues (2023) review neurophysiology, neuropsychology, and epilepsy, emphasizing achievements and future challenges (Smith et al., 2023). Rivella and others (2023) elucidate executive functions and psychosocial disorders in children after ischemic stroke (Rivella et al., 2023). Additionally, Bernat, Albert, and Kass (2023) analyze neuropsychological and electroencephalographic data in suspected Panayiotopoulos syndrome (Bernat et al., 2023).

In conclusion, Mingozi, Tobia, and Marzocchi (2023) examine dyslexia and dyscalculia, focusing on the neuropsychological processes that distinguish these two developmental disorders (Mingozi et al., 2023).

## Materials and Methods

The theoretical foundations for studying the neuropsychological features of cognitive functions of junior pupils with speech impairments are multifaceted and extensive. Cognitive functions are a set of psychological processes, such as attention, memory, perception, thinking, and language skills. They are the basis for learning, socialization, and everyday human activity.

Language functions have their own structure, which includes phonetics, vocabulary, syntax, and semantics. Disorders in any of these components can lead to speech complications. Another significant aspect involves understanding the neuropsychology of child development. The child's brain differs from an adult's. In addition, its development occurs in several stages, with language development disorders possibly linked to various factors, including genetic, biochemical, and neurological factors.

Language and cognitive processes are interconnected. Children with speech impairments often face difficulties not only in linguistic communication but also in other cognitive functions, such as memory and attention. Brain research using modern techniques such as MRI and PET has enabled the identification of brain regions responsible for various aspects of speech and comprehension. This has helped to understand how disorders in these regions can impact linguistic and cognitive deviations.

Furthermore, the influence of the sociocultural environment cannot be ignored. Factors such as upbringing, surroundings, and access to education can affect a child's development of linguistic and cognitive skills. In cases where speech disorders are not solely caused by biological factors, they may be due to the absence of proper stimulation or inappropriate educational approaches.

In developing the methodology for this study, neuropsychological tools were employed, namely:



- standardized tests for cognitive development (the Wechsler Intelligence Scale for Children (WISC) was used to assess general cognitive abilities);
- neuropsychological testing (comprising tasks related to attention, memory, executive functions, and other cognitive domains);
- analysis of language skills (performed using standard speech therapy tests for diagnosing speech impairments in children).

## Results

The neuropsychological characteristics of cognitive functions in junior pupils with speech disorders involve specific differences in their cognitive development, which affect their ability to learn, socially adapt, and engage in daily activities. These differences include:

- *Weak working memory.* Speech impairments are often associated with weak working memory. Children may have difficulties in remembering instructions, action sequences, or new material presented during learning.
- *Attention issues.* Children with speech impairments may exhibit low levels of attention concentration, quick fatigue, or easy distractibility.
- *Phonological processing difficulties.* Problems with recognizing and reproducing sounds can affect reading and writing skills.
- *Spatial perception problems.* The need to structure space, recognize objects, or orient in space can be challenging for this group of children.
- *Delay in the development of executive functions.* This may manifest as difficulties in planning, task organization, shifting attention between different tasks, or maintaining motivation to complete tasks.
- *Interpersonal relationship difficulties.* Due to communication problems, children may struggle to interact with peers, leading to social isolation.

The presence of speech impairments or cognitive deviations in some cases may indicate a genetic predisposition of the child to similar issues. Studies on the genetics of speech impairments show that certain genes, such as FOXP2, may play a

role in the development of language abilities. Events during pregnancy, childbirth, or in the first days of a child's life, such as brain hypoxia, infections, or premature birth, can lead to developmental disorders in brain structures responsible for speech and cognition.

Malformations or damage to brain structures (the primary language centers of the brain) can directly affect language and cognitive abilities. MRI can help detect such anomalies.

The imbalance of various neurotransmitters can affect speech and cognitive function. For example, a dopamine deficit may be associated with attention and concentration disorders, which, in turn, affect language development.

In general, a deficiency of specific vitamins, microelements, or other biological factors necessary for normal brain development can influence speech and cognitive functions. For example, iodine deficiency in childhood can lead to mental deviations.

These biological factors often interact with social and psychological factors, forming a unique profile for each child. The understanding of these biological principles helps specialists to develop effective approaches to treatment and support.

2. The impact of the environment on the development of a child's speech and cognitive abilities is highly significant, especially during early childhood. This period of life involves a specific activity in the formation of brain synapses, which serve as the foundation for future cognitive and linguistic development. Regular verbal interaction with a child is the key to stimulating the growth of their language abilities. Children who experience active verbal communication in their early years tend to expand their vocabulary more rapidly and develop better grammatical structures.

Limited verbal interaction with parents or caregivers in early childhood can lead to speech development delays. This, in turn, can affect a child's cognitive abilities because language is the primary means of communication, learning, and thinking. The absence of regular verbal contact may also give rise to social and

emotional problems in a child, as communication is a crucial element of socialization.

Furthermore, it is essential to consider the quality of verbal interaction. For example, if parents consistently use overly simplistic language without expanding a child's vocabulary, it may restrict their language development. In contrast, active listening to a child, responding to their words and phrases, and encouraging independent expression can help stimulate language and cognitive development.

3. Emotional and psychological factors play a significant role in a child's development, including their language and cognitive abilities. Early childhood is a time when the brain is actively forming and major neural networks are developing. During this time, the brain is susceptible to external influences, and negative experiences can have long-lasting consequences.

Stressful situations in early childhood can lead to the release of cortisol, a stress hormone that research shows can interfere with the development of certain brain regions responsible for memory, attention, and other cognitive functions. This, in turn, can affect language development, as a child may struggle with concentration, memorization of new information, and the formation of associations.

Anxiety can also impact language development. Children who are constantly in a state of stress may have difficulty with communication or may avoid interaction with others, leading to delays in speech development. Additionally, anxiety can influence the processes of recognizing, processing and storing information.

Emotional traumas, such as the loss of a loved one, parental separation, or other traumatic events, can lead to changes in brain activity, particularly in areas responsible for language and cognitive development. Such children may experience delays in language development or other cognitive functions because their brains may be preoccupied with processing traumatic experiences.

4. Sensory impairments, especially in essential areas such as hearing and vision, can have a profound impact on a child's perception of the world. These impairments can alter how children learn, interact with their environment, and develop their cognitive and language skills.

Hearing problems, especially in early childhood, can delay or hinder the development of language skills. A child who does not hear language at the appropriate level may have difficulty understanding verbal commands, expanding their vocabulary, and forming their own speech constructs. This can also lead to difficulties in social interaction and learning.

Visual impairments can also affect cognitive development. Children who have difficulty in perceiving visual information may face challenges in learning to write, read, and acquire other visual skills. Furthermore, children with visual impairments may struggle with recognizing faces, which can affect their social interactions and emotional development.

Therefore, sensory impairments can lead to a complex set of problems that affect how children perceive, process, and interact with information. These problems, in turn, can impact a child's overall cognitive and language functions.

5. Medical conditions and illnesses, especially those that affect the nervous system and the brain, can have a significant impact on a child's language and cognitive development. Epilepsy, a chronic condition characterized by periodic seizures, can cause temporary disruptions in language and cognitive functions. Some antiepileptic medications used to treat this condition may have side effects that affect a child's cognitive development. Metabolic disorders can lead to the accumulation of toxic substances in the brain or, conversely, a deficiency of necessary substances for its functioning, both of which can affect language and cognitive development.

Infectious agents, such as viruses or bacteria that penetrate the brain, can lead to inflammation and damage to nerve cells. They affect a child's language and cognitive development. Meningitis and encephalitis, in particular, are infections that can have particularly severe consequences for brain development. Therefore, it is crucial to identify such conditions promptly and provide appropriate treatment to minimize their impact on the child.

6. Social factors are crucial in shaping and developing a child's cognitive functions. A child who lacks support in their social environment or faces peer pressure due to their speech difficulties may experience deviations in the

development of their cognitive functions. Such a child may feel alienated or undervalued, leading to a decrease in self-esteem and motivation for learning. Additionally, these children may use alternative communication or problem-solving strategies to adapt to their speech difficulties. These alternative strategies can affect their cognitive perception and information processing. Furthermore, without proper support and intervention, these social challenges can affect the child's overall academic success and social functioning.

## Discussion

Discussion aspects of this study include several essential issues. One of the main issues is defining the boundary between what is considered normal language development and the criteria for identifying language disorders. It becomes particularly relevant when a child is learning two or more languages simultaneously.

Furthermore, the cause-and-effect question naturally arises: Are language disorders the cause of altered cognitive functions, or do cognitive deficits contribute to language disorders? This interrelation sparks numerous debates among researchers.

The impact of intervention is also crucial. At what stage of development and in what manner is it best to intervene to assist children with language disorders? What methodology is the most effective in correcting cognitive functions?

Sociocultural differences are equally important. How do sociocultural features and various pedagogical approaches affect the development of cognitive functions in children with language disorders? Can approaches to diagnosis and treatment be standardized across different cultures?

This topic is multifaceted. Considering the connection between cognitive functions and language, the question arises as to what extent other factors (social, emotional, medical, etc.) can influence the development of these functions. All of these questions represent vectors of development in the studied problem.

## Conclusions

A study of the neuropsychological characteristics of the cognitive functions of junior pupils with speech impairments found a direct link between speech disorders and cognitive functions. Children with speech impairments often demonstrate peculiarities in attention, memory, and other cognitive processes. It has also been found that genetic factors, environment, emotional and psychological factors, sensory impairments, medical conditions, and social factors play a key role in the development of cognitive functions in such children.

It was revealed that timely and targeted correctional work can help improve the cognitive functions and speech development of children with speech impairments. In addition, sociocultural features and educational approaches in different countries and cultures can change the features and dynamics of cognitive development in children with speech impairments.

Based on the study, it can be argued that neuropsychological features of cognitive functions in junior pupils with speech impairments require additional attention from scientists, teachers, and psychologists. Understanding the causes and mechanisms of these peculiarities will allow us to develop effective methods of correctional work and help children achieve proper development.

In addition to the aforementioned, we have found that social support and peer interaction are crucial factors in the development of cognitive functions in children with speech disorders. A positive social environment can compensate for some speech and mental disabilities by stimulating the development of a child's communication skills.

Also, it has been confirmed that systematic monitoring and study of the dynamics of cognitive functions in children with speech impairments allows timely detection and correction of possible difficulties. The effectiveness of corrective measures depends on an individual approach to every child and their specific needs.

In the future, it will be necessary to continue describing and recording new interdisciplinary research models emerging in folklore. An essential aspect of French folklore studies is the search for, recording, and systematization of new

means of language modelling and speech genres, as well as the encoding and conceptualization of reality in French folklore texts.

The study of the structure of contemporary French folklore's linguistic and cultural dimensions is promising. In the era of globalization, the mutual influence of different cultures and societies, and the technological revolution, oral lore and its linguistic and stylistic constants are changing. The components of the linguistic image of the world of the French folklore tradition and the forms of its realization in the folklore text give us perspectives to see the vectors of movement of society, community and nation.

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