

## Lateral Profiles in Preschoolers with Pseudobulbar Dysarthria

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**Keywords:** preschoolers, pseudobulbar dysarthria, functional asymmetry of the brain, lateral profile

**Abstract:** The physiological process of the formation of the distribution of functions between the hemispheres in ontogenesis is important from the point of view of the correct development of speech. Also, this process affects the whole spectrum of the characteristics of the psyche, perception and cognitive processes, adaptive capabilities of the body, and control functions over involuntary behavior. The article is devoted to the study of interhemispheric interaction and lateral profiles in preschoolers aged 6-7 years with normal speech development and pseudobulbar dysarthria. The neuropsychological approach to the problem of the formation of mental functions in ontogenesis is used. The novelty of the study is that in children with pseudobulbar dysarthria, a greater variety of lateral phenotypes is registered. And in such children, there is a shift in interhemispheric asymmetry towards the right hemisphere, which is due to sensory asymmetry (leading ear, eye) to a greater extent. The practical significance of the study is as follows: studying the dominance of the hemispheres in preschoolers with speech impairments will help to understand their individual characteristics, identify left-handedness, select neuropsychological techniques, and exercises for teaching, educating, and maintaining children's health.

### 1. Introduction

Functional interhemispheric asymmetry (FIA) is one of the conditions for the optimal neuropsychic activity of a person. The right and left hemispheres provide a different strategy in the cognition of the surrounding world but should work in concert. The pronounced activity of each of the hemispheres leaves a certain imprint on the characteristics of the human mental organization. For the vast majority of people, the left hemisphere is dominant with respect to speech function. The formation of speech in children occurs with the obligatory activity of both hemispheres. In the early stages of ontogenesis, the development of higher mental functions proceeds with greater reliance on the right hemisphere, while the left takes on more complex functions as the corresponding departments and interhemispheric commissures mature.

In this process, the corpus callosum plays an essential role, and the development of the brain organization of mental functions goes ontogenesis from the right hemisphere to the left. Lateralization of speech processes is normal in children under five years of age; its delay leads to the development of various kinds of dysfunctions, including speech. In recent decades, the negative dynamics of the growth in the number of children (according to various studies, from 7.5% to 20%) with speech impairment, including pseudobulbar dysarthria, have been recorded. It is caused by organic lesions of the pathways going from the cerebral cortex to the nuclei of the glossopharyngeal, sublingual, and vagus nerves. These lesions lead to the dysfunction of brain structures, circulatory disorders, and changes that can occur both in the brain stem and in both hemispheres. At the level of scientific discussion, the question of the features of the distribution of functions between the hemispheres in children with impaired speech development has been discussed in the literature [1; 2; 3; 4; 5].

The purpose of the study is to analyze the features of functional asymmetry in preschool children with normal speech development and with pseudobulbar dysarthria.

## 2. Materials and Methods

Fifty-three children aged 6-7 years were examined using speech therapy and neuropsychological techniques. This group includes twenty children with normal speech development and thirty-three preschoolers with the following speech conclusion: "the child has general underdevelopment of speech of the III level, with a slight degree of pseudobulbar dysarthria." They registered a weak formation of all structural components of speech, such as disturbances in the sound pronunciation of two or more groups of sounds, the insufficient formation of phonemic hearing and phonemic perception, mild agrammatism, and the lack of coherent speech in terms of planning and structuring independent speech.

In all children, an individual profile of functional interhemispheric asymmetry is determined using tests to determine the leading arm, leg, ear, and eye in children. General, motor, and sensory asymmetry coefficients are calculated according to the formula proposed by T. A. Dobrokhotova and N. N. Bragina [2].

## 3. Research Results

Based on the individual profile of functional interhemispheric asymmetry, the correlation of hemisphere dominance in preschool children with the norm of speech development and in children with a speech impairment is determined (Table 1).

TABLE 1. HEMISPHERAL HUMANITY IN CHILDREN WITH RATE AND DISTURBANCE OF SPEECH DEVELOPMENT

Leading hemisphere	Children with normal speech development (%)	Children with speech disorders (%)
Left	80±0.5	39.4 ± 0.1
Right	7±0.5	36.3 ± 0.1
Equanimity	13±0.5	24.3 ± 0.1

As the data in Table 1 show, in 80% of children with normal speech development, the left hemisphere dominates. Moreover, for every third child, the coefficient of right-sided lateralization ranged from 76 to 82%, which indicates a clear dominance. In the motor and sensory spheres of the subjects, a variety of individual lateral phenotypes, with a predominance of cross and mixed, was noted.

In the group of children with pseudobulbar dysarthria, the overall lateralization profile with an implicitly dominated left hemisphere was two times lower (39.4%). A third of the children showed a general dominance of the right hemisphere; moreover, half of these children are left-handed, and a quarter of the examined preschool children are equally hemispherical (Table 1).

The calculation of the following FIA coefficients is made: general, motor, and sensory. The results are presented in Figures 1, 2.

When assessing the contribution of the asymmetry type to the overall lateral profile, it was found that the coefficient of motor asymmetry in children in the group with pseudobulbar dysarthria is close to zero or has a negative value. This means that in children with pseudobulbar dysarthria, the motor profile is shifted to the right hemisphere compared with children with the norm of speech development. Still, an even more pronounced shift of the right hemisphere is noted towards the sensory profile.

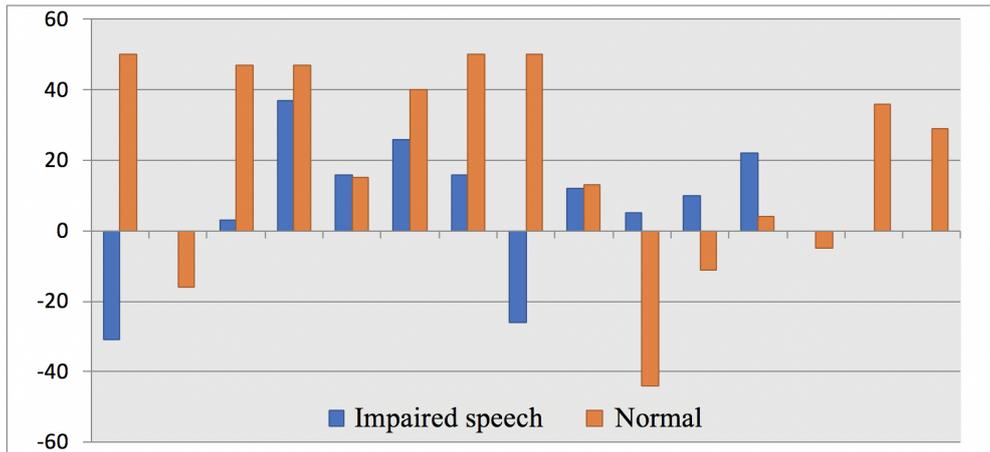


Fig. 1. The profile of motor asymmetry of the brain in children with normal and impaired speech development.

In the group of children with normal speech development, the following most common lateral profiles were identified: (1) crossed, with the leading left hemisphere (up to 60%); (2) mixed, with a leading right hand, left foot, right ear, left eye (15%); (3) right hand, right foot, right eye, left ear (15%).

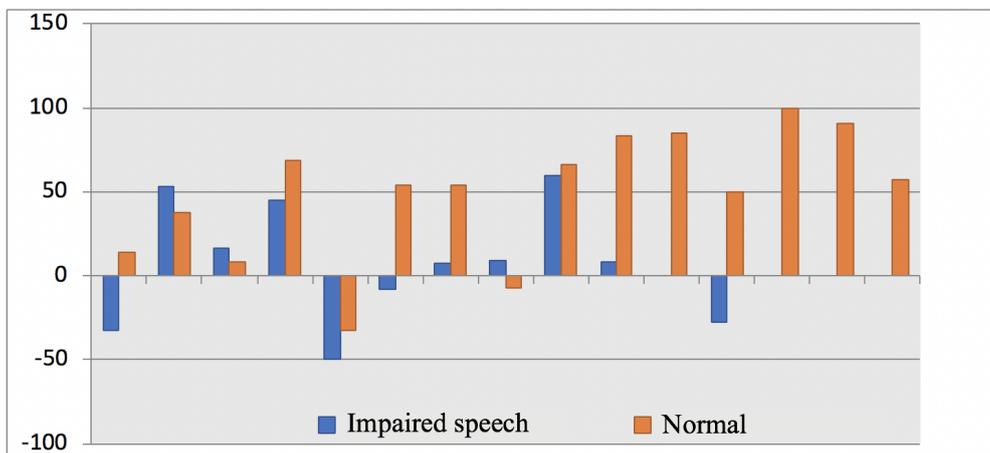


Fig. 2. Profile of sensory brain asymmetry in children with normal and impaired speech development.

In the group of children with pseudobulbar dysarthria, a much greater variety of lateral profiles was noted than in children with normal speech development. However, we can reliably distinguish the following two lateral profiles: (1) mixed with the leading left hand, right foot, left ear, right eye (16.5%); (2) crossed with dominant right hemisphere (16.5%). Among this group of children, there are more unilateral lateral profiles in total that do not provide any optimal adaptation and stress resistance. Children with such patterns are more prone to neurosis formation.

#### 4. Discussion

Under the influence of external and internal factors, in children with pseudobulbar dysarthria, the ordinary course of individual development is disturbed in the early period. Dyontogenesis is manifested in the impaired formation of kinesthetic and kinetic praxis, in the impossibility of performing complex motor programs, in the impaired phonemic hearing, auditory-motor coordination, as well as the specularity in writing and reading, and in-memory features.

Regarding the speech function, the idea of the dominance of the left hemisphere is formed, along with the concepts of “right-handedness,” “left-handedness,” and learning features of left-handed children. When trying to describe the relationship of the presence of speech problems in a child with functional sensorimotor asymmetry, some researchers rely on an assessment of left-handedness only. At the same time, the other relies on a profile of functional sensorimotor asymmetry (an indicator describing the leading arm, leg, eye,

and ear). Moreover, they use a non-standard set of samples to describe both the dominance of one hand and the general profile, which makes it difficult to compare the results [1; 2; 5; 7; 8].

The results of our study indicate that the left hemisphere dominates in most children aged 6-7 years with a norm of speech development. This allows a typically developing child to successfully go through the process of adaptation to the conditions of study at school. The research shows that in this group of children, the majority are the people with a cross lateralization profile. That is, each hemisphere organizes the work of the arm, leg, ear, and eye on the opposite side of the body. Such children have higher stress resistance and adaptive abilities of the body, better academic performance. They learn the learning material well, they are psychologically comfortable in the new conditions, and they rarely get sick.

The study of FIA in children with pseudobulbar dysarthria indicates that they have prevailing indicators of right-hemisphere dominance. The analysis of lateralization profiles and the calculation of the coefficients of motor and sensory asymmetry show that the shift of interhemispheric asymmetry towards the right hemisphere also occurs due to motor asymmetry. But to a greater extent, this is due to the sensory asymmetry (leading ear, eye). Depending on the severity of a speech defect, children experience stress when communicating, especially in a learning situation. In such conditions, constant activity is noted in the brain stem and in the right hemisphere, where impulses of the sympathetic part of the autonomic nervous system arrive. The remaining areas of the brain, including the frontal parts of the left hemisphere, may be partially blocked due to impaired conduction of impulses through the corpus callosum. In a stressful situation, the child's ability to adequately assess auditory and visual information decreases. Compared with children with the norm of speech development, a greater variety of lateral profiles in preschool children with pseudobulbar dysarthria, among which there are mixed and one-sided profiles, indicates the dysontogenetic development of children, the lack of formation of interhemispheric interaction, and the increased activity of the right hemisphere.

## 5. Conclusion

Specialization of the cerebral hemispheres is one of the leading mechanisms of human development in ontogenesis. In the group of children with pseudobulbar dysarthria, activation of the left hemisphere slows down, the dominance of the right hemisphere in motor, and especially in sensory tests, prevails in comparison with children of this age without speech disorders. Lateral profiles of preschoolers with pseudobulbar dysarthria are more diverse (mixed, one-sided prevail). However, from a psychophysiological point of view, they are ineffective. They are less likely to succeed in social environments and learning. In a stressful environment, such children lose the ability to perceive information effectively and adequately respond to what is happening.

In practical work with children with speech impairments, speech therapists and defectologists need to pay special attention to neuropsychological techniques and kinesiology exercises (aimed at developing interhemispheric interaction). School teachers need to more often turn to the possibilities of the right hemisphere, using its inherent features: integrity, generalization, the involvement of involuntary memory, emotionality [6; 9; 10].

## 6. Acknowledgments

The authors are deeply grateful to the G. M. Krinitsyna Center for Speech Development and the Association of Speech Therapists of the Tyumen Region for their assistance in conducting the study.

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