# DOI: 10.24234/se.v5i1.281 BRAIN INTERHEMISPHERIC INTERACTION IN CHILDREN WITH MENTAL DISABILITIES WITH SPATIAL ORIENTATION DISORDERS

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#### ABSTRACT

Children with intellectual disabilities can freely orientate in everyday situations only if their orientation is properly developed. They can orient aided by their peers and the environment. However, the slightest change or complication of the route from one familiar place to another cause's confusion and sometimes helplessness in the actions of children. Unlike their normally developing peers, children with intellectual disabilities cannot mentally imagine the location of the kindergarten and combine all its premises in one space.

Neurophysiological mechanisms for children with mental development disorders defined as functional insufficiency of the left or right hemispheres and the features of intra - and interhemispheric interaction in the developments of mental functions.

Children with intellectual disabilities or mental development disorders can freely circumnavigate in everyday situations only if this task is carried out in a situation which is known and familiar for them. However, the slightest change or complication of the route from one familiar place or space to another cause's confusion and sometimes helplessness in the actions of children.

**Keywords:** interhemispheric interaction, brain functions, spatial orientation disorders, intellectual disabilities.

## **INTRODUCTION**

Changes for both functional specialization of the hemispheres and interhemispheric interaction, based on integration of brain functions, cause complex violations of cognitive activity observed in children with mental disabilities. Differences and deviations from the normal functioning of the left and right hemispheric systems in children with developmental

and mental retardation reflect the features of neurophysiological mechanisms that provide integrative brain activity.

Intellectual and emotional-volitional processes of children development and improvement are closely associated with the development of neurophysiological mechanisms of functional specialization of the left and right hemispheres of the brain, with the formation of interhemispheric interactions, with an increase in the regulatory role of associative systems in the cerebral integration of intra-hemispheric and interhemispheric relations.

There are several points of view regarding to the occurrence of hemispheres functional specialization of human brain in ontogenesis. According to the following view, postnatal development of both hemispheres functionally have equal potential and ability of the right hemisphere to the speech development in the initial stages until approximately 2-4 years equal to the level of abilities of the left hemisphere. Experimental data showed that there is still no strict dominance of the left hemisphere for speech and the functions of the hemispheres are interchangeable for 3-year-old children.

At the same time, there are another data featuring to the early occurrence of hemispheric asymmetry, the early specialization of the hemispheres. According to the researchers compelling data are given based on the observations of preschoolers with a defect in the development of hemispheres.

Experimental data indicate that the hearing impaired with a gross violation, speech smoothed hemispheric motor asymmetry disturbed are the processes of formation of functional asymmetry of the brain. So, why in fact, delayed development of speech functions hinders the development of right-hand preference for more complex forms of arbitrary activity? Obviously, the main reason is that speech disorders disrupt the processes of speech regulation of various forms of active undertaking of the child. It is necessary to track how these processes occur in ontogenesis. For a deeper understanding of this internal connection of the development of the processes of generalization of objects, various actions with objects, their verbalization with the development of functional asymmetry of the brain.

It is shown in numerous psychological observations that the process of child speech development is closely related to the development of the motor sphere. Thus, almost in the first months of life the word causes more intense motor reactions in comparison with non-verbal signals.

As many researchers note there is the greatest increase in lateralization of functions and domination of the left hemisphere in 3-to 7-year-old children. There is a qualitative leap in the peculiarities of the neurophysiology of laterality among children born after 2000.

According to the results of several studies there were children with balanced right-left laterality in brain processes within the ambidextrous groups. In our opinion the more applicable term for this phenomenon is «ambicerebrality». It is crucial to adopt the following working formulation: ambicerebral is the ability of the human right and left hemispheres alternately, or concurrently and simultaneously carry out the processing of information. We consider that this is a more exact recording of a new attitude that differs from the "two-handed" - ambidextrous.

It should be noted that the processing of information switching in the right and left brain occurs spontaneously for such children. Though, during maturation, both hemispheres start processing information parallelly and at the same time, demonstrating qualitatively new possibilities of brain activity.

#### METHOD

Educational activities of first-grade students have significant requirements for orientation in space, including orientation on a sheet of paper. In the well-known test of D. Elkonin (Shif, 1995) "Graphic dictation" interesting data were received. The left-handed and right-handed students performed equally well under dictation task, but the analysis of individual work showed obvious differences. Higher indicators were seen in the performance of lefties during their individual work. They saw the patterns as a whole and wonder where to hold the next line, the next piece of the pattern, completed the task confidently, quickly and without any mistakes. The difference between the data obtained during the individual work of the "Graphic dictation" test between left-handed and right-handed was statistically significant.

From our point of view, the best results in left-handed children in the tests "Graphic dictation" and "Koos cubes" are explained by the synthetic method of information processing. Children with dominance of the right hemisphere perceived features of a pattern, both in two-dimensional and three-dimensional spaces.

Neurophysiological mechanisms under mental development disorders in children are defined as functional insufficiency of the left or right hemispheres and the characteristics of intra - and interhemispheric interaction in the processes of mental functions.

## **DISCUSSION OF THE RESULTS**

Studies on the functional asymmetry of the hemispheres of the brain allow us for better understanding the objective causes and mechanisms underlying disorders and deviations in the cognitive activity of children with various developmental disorders. Each hemisphere contributes and plays its own role in the realization of higher mental functions. The specificity of the integrative activity of the brain in violation of mental development and mental retardation in particular, revealed in psychological, pedagogical and electrophysiological studies, due to differences in the nature of deviations from the norm of the system organization of structures of the left and right hemispheres and features of interhemispheric interaction in the processing of information.

Changes for both functional specializations of the hemispheres and interhemispheric interaction, based on integration of brain functions, cause complex violations of cognitive activity observed in children with mental disabilities. Differences between deviations from the normal functioning of the left and right hemispheric systems in children with developmental and mental retardation, reflect the features of neurophysiological mechanisms that provide integrative brain activity.

The processes of lateralization functions in ontogenesis in a person is nonlinear, with alternating dominance of the right and left hemispheres, a gradual transition from duplication of functions to their specialization. Delayed lateralization of functions disrupts the cognitive and emotional development of the child and creates prerequisites for learning difficulties.

With mental retardation, the violation of interhemispheric interaction is manifested by a marked change in the transmission of sensory information from the left hemisphere to the right. According to the results of the analysis the data obtained by the method of evoked potentials, afferent signals from the structures of the left hemisphere enter the right hemisphere more dispersed, asynchronously due to the slowdown in the processing of information in the left hemisphere or changes in the system organization of sensory processing in the left hemisphere. This manifest itself in a reduced amplitude, a slower development and changed the configuration of indirect EP in the right hemisphere.

As the interhemispheric communications transmitted complex, processed in "itself" hemisphere information, informing the other hemisphere about the case in this hemisphere, preparing it to receive and process addressed directly to its information (Velichkovsky, 2006; Elkonin, 1989) the violation of such transmission, undoubtedly leads to a violation of the right hemisphere and to a change in the integration of the hemispheres of the brain in the process of perceptual activity. Extending the period of development of EAP on complex stimuli, slowing down the time of interhemispheric information transferring reflect the specificity of signal perception in mentally retarded children. Slowing down the visual perception, requiring more than usually for recognition of objects, stresses the psychologists as well.

According to psychologists and teachers, the lack of functions of the right hemisphere in mentally retarded children manifests itself in violation of the holistic nature of perception, in violation of visual and spatial perception. At the same time, the difficulty of establishing verbal connections and verbal mediation is characteristic (Petrov & Belyakova, 2012) which reflects the violation of left hemisphere functions, revealed during electrophysiological study. Violation of hemispheric relationship interaction in mental retardation manifests itself in the limitation of cognitive activity. It states in that knowledge acquired in verbal form does not have a significant impact on the development of a mentally retarded child due to the fact that sensory cognition and practical activities are not sufficiently understood and formalized in the word (Ushakov, Sharaev & Kartashov, 2016). It can be assumed that the change in interhemispheric interaction in the processing of sensory information reflects to some extent the neurophysiological mechanisms of brain integration in the process of activity. Considering the functional specialization of the hemispheres, as well as the role of joint activities of both hemispheres in the exercise of higher mental functions, it can be assumed that the violation of interhemispheric information transmission distorts cognitive integration in intellectual activity.

Changes in both mechanisms of hemispheres functional specialization and interhemispheric interaction, which is the basis for the integration of brain functions, cause complex violations of cognitive activity observed in children with mental disabilities. Differences in deviations from the normal functioning of the left and right hemispheric systems in children with developmental delay and mental retardation reflect the features of neurophysiological mechanisms that provide integrative brain activity.

The ability to orientate in space is one of the necessary conditions for the harmonious development of personality.

The problem of human orientation in space is quite multifaceted. It includes both ideas about the size, shape of objects, and the ability to distinguish the location of objects in space, the understanding of different spatial relationships. The concept of spatial orientation includes the assessment of distances, sizes, shapes, mutual position of objects and their position referring to the orientation.

The simplest forms of orientation in space, linked to the transition to a vertical position, the development of substantive action, are formed in infancy (Luria, 1969). By the age of three, the child develops a systemic mechanism of spatial orientation, in which vision, kinesthesis, static-dynamic sensations appear in certain relationships.

It is quite multifaceted problem of orientation of the child in space. Penetrating all spheres of interaction between the child and reality, orientation in space has an impact on the development of one's self-consciousness, personality and is an integral part of the process of socialization. This problem includes both the idea of the shape and size of objects and the ability to distinguish the location of objects in space, understanding of different spatial relations.

The concept of spatial orientation includes an assessment of the shape, size, distance, relative position of objects and their orientation setting. Yarbus A.L. by saying the orientation in space intended to mean "understanding and definition of person by his/her relation to another one's, identified by material body or, that the same, the own reaction to themselves (Drummers, 2014).

At an early stage of ontogenesis, the process of spatial perception and representation formation is caused by the development of several factors. These include: the formation of the mechanism of the child's gaze fixation, the formation of hand movements and the associated development of substantive actions. Forming the subject actions are of great importance for the development of perception of objects as individuals, the accumulation of ideas about their diverse properties, as well as the definition and establishment of various spatial relationships between them (Velichkovsky, 2006; Kok, 1972).

Important role in the development of this process is the formation of locomotor functions in the child (sit, crawl, walk), which occurs normally in the first two years of the child's life. By the 2nd year of life, the child's reflection of space and orientation in it occur only on a practical level.

A very important role in the development of spatial orientation is given to mastering the child's speech. When mastering the speech, the child can move to the second signal level of space reflection, which is higher. We can say that the process of formation of spatial representations and spatial perception is carried out at the visual and verbal levels. Based on practical activities, spatial representations are formed and as children master speech throughout the preschool age, their verbalization occurs.

Schematized spatial representations are the most important type of spatial representations that students should master. They act as a means of visual spatial modeling and are a universal means of mental activity.

In school-age children, the development and formation of spatial representations takes place in the classroom design, visual activities and in a variety of gaming activities, too. Training more complex types of spatial orientation to form new spatial representations should be conducted by the teacher specifically and systematically.

Studies of psychologists and teachers show the possibility and need for systematic and consistent work on the formation of students of different types of spatial orientation. School age is sensitive to this impact.

Persistent difficulties in the development of the space belong to the characteristic manifestations of intellectual retardation. As a result of the interconnected complex of organic, functional and social reasons for the formation of spatial representations in mentally retarded children is violated in all defining areas, including the mastery of the actions of perception, the acquisition of experience of practical transformation of space, its reflection in the word, productive activities. Disadvantages of orientation, both in the subject and in the social space adversely affect the cognitive and personal development of the child, preventing his social overall adaptation.

Thus, one of the necessary conditions for the child's health is the ability to orientate in space.

The development of spatial orientation in mentally retarded children of school age is subject to general laws. In such children, it is much slower and has a kind of deviation.

The early diffuse damage of the central nervous system provides an unfavorable biological basis for the development of the systematic mechanism of space perception. The maturation of all analyzer systems is delayed, and a delay occurs in establishing a complex set of inter-analyzer links. There is a distortion of the formation of the system mechanism of perception of space. The most prominent form of violation of the spatial orientation arises from the failure or lack of zones formation of the brain cortex that combines the work of visual, auditory and vestibular analyzers.

With the defeat of the visual analyzer occurs evenly concentric narrowing of the visual fields, reducing visual acuity and eye. Insufficiently expressed functional motor asymmetry, which is a consequence of narrowing the perceptual pathways, adversely affects the formation of spatial perception of children (Drummers, 2014; Luria, 1969).

Higher nervous activity in mentally retarded children has several features that complicate the formation of conditioned reflexes: a decrease in the strength of the processes of excitation and inhibition, a violation of their mobility and balance in their course. This leads to difficulties of differentiation, inertia of old connections, especially verbal. The reason for the fragility and slow pace of the formation of conditional connections is the weakness of the closing function of the cerebral cortex. From pathological changes in higher nervous activity in mentally retarded children occurs underdevelopment of complex forms of mental activity, such as arbitrary attention, analyzing perception, memory, etc.

Based on this, the children manifested the primitive of the analysis and synthesis of the perceived objects, instability and blurred recorded images.

The delay in the development of all locomotor functions, the main types of movement is a consequence of early organic damage to the central nervous system. There is a delay in the timing of the expansion of the review of the surrounding space and, as a rule, the movement in it. Children with mental retardation are mastering space from the first years of life which is incomplete and fragmented. One of the most important tasks of training and education of a child with mental retardation is the formation of spatial representations. An important condition for successful learning in a special (auxiliary) school and in a school with inclusive education is the ability to practically navigate in space and perception of spatial relations among surrounding objects. From the level of spatial representations formation largely depends on the mastering success for the children with intellectual disabilities, writing, drawing, manual activity and other academic subjects.

Underdevelopment of spatial representations, as mentioned by and others, is one of the main reasons causing difficulties in mastering these skills (Petrova & Belyakova, 2012).

Children with intellectual disabilities entering the first grade are not being yet ready for the assimilation of mathematical knowledge. Their numeric knowledge is not fully complete. Children have difficulties in comparing objects in size; they do not know the vocabulary that determines the signs of objects in size. They also poorly orient in space and time, do not understand the words-adverbs and prepositions, indicating the position of objects on the plane and in space (Kinsbourne, 1972). Phrasal speech development is also delayed, which is important in the development of spatial perception and spatial representations. Only through speech it is possible to generalize the reflection of space. The delay of this stage in the development of spatial orientation occurs with a delay of 1.5-2 years.

To reduce the perception of speech and poor understanding of it leads to a significant underdevelopment of phonemic hearing.

For mentally retarded students are characterized by the inferiority of all aspects of their speech activity, the delay in the assimilation of phonetic, lexical, grammatical aspects, understanding and adequate use of speech. In this regard, without the necessary practical basis, the child's speech cannot be used as a full-fledged means of orientation in the surrounding space.

Due to the significant delay in the emergence of mental retarded children subject activity and its inferiority, as well as, in connection with a weak interest in the world, there is no basis for the formation of these children's play activities. In particular, we are talking about the story game. The game affects all kinds of children's activities.

By the age of 7, some children with mental retardation may have formed elementary spatial representations, such as spatial characteristics of objects (shape, size), spatial relationships between objects, directions in space.

By the time they go to school, some children (considering the system of correctional work), as a rule, already distinguish their right and left hands, understand the meaning of the

words "up", "down", "on", "closer", "ahead", "behind", etc., can not only practically reproduce, but also to determine the location of objects relative to himself.

Considering the sensitiveness of preschool age, it is assumed that difficulties in educational activities can be prevented with targeted corrective work on the formation and improvement of spatial orientation in mentally retarded children in preschool age. The program of training and education of mentally retarded children in special preschool institutions, integrated groups, considers the work on the development of spatial representations in various classes: drawing, application, design, physical education, etc., which gives positive results. However, the difficulties of spatial perception and the shortcomings of spatial orientation in mentally retarded children are not overcome until the end of preschool age (Kratkova, Lukyanov, Masherov, Kaverin, 2005).

Children with intellectual disabilities are not being able to operate on their ideas with spatial orientation. As a rule, these ideas, learned only in one standard situation, are not transferred to others, which is due not only to the peculiarities of cognitive activity of children with intellectual disabilities, but also with communication deficiencies. Spatial orientation is more successful in conditions close to the experience of children. The conditions of orientation farther from daily experience and from the usual situation, the harder it is to navigate.

Children with mental retardation have a large discrepancy between active and passive vocabulary reflecting spatial categories. The word can exist by itself, specifically without the image, and therefore often used inappropriately.

Along with the poorly formed spatial orientation, the ability to fix and hold the verbal instruction, as well as to act in accordance with it, prevents mentally retarded children from successfully completing the task. The fixation and execution of an instruction are also affected by its connection to a familiar situation. The analysis of observations shows that the scheme of own body is hardly assimilated by children with intellectual insufficiency (mental retardation) in the senior preschool age. Orientation on itself is formed slowly. Due to the peculiarities of the development of cognitive activity, even the knowledge of which hand is right and which is left does not allow confidently distinguish the appropriate directions.

### CONCLUSION

A child with mental retardation is characterized by the inability to act in an imaginary plan, mental turn in determining the sides of a person or object located opposite is not available and is not clear. The child needs a visual display of this transfer, where he or she not only saw, but also acted, moved from his own position to the position of another person (object). Mental transfer remains difficult after multiple corrective-developmental exercises and tasks, but children get experience of understanding the essence of this mechanism and in some cases, it can help to overcome the problem.

Both for normally developing children and for children with intellectual disabilities, it is a better formed ability to navigate in vertical directions- up and down and horizontal directionsforward and backward. However, motoric difficulties for children with intellectual disabilities prevent more complete assimilation of these areas. The ability to define and verbally denote spatial relationships between objects is a difficult task for children of both categories.

By the end of training level of preschool education, preschoolers with intellectual disabilities show the ability to navigate in such undifferentiated relationships as "in the middle" and "about". Determine the position and relationship of objects in space, marked by the prepositions "on" and "under". However, orientation in such spatial relationships, it is required to differentiate precisely, as from right to left, it turned out to be difficult for the mentioned category of children.

Children with intellectual disabilities can freely navigate in everyday situations only if this task is carried out in a situation which is very close to their daily experience. They are oriented in the space of their group. However, the slightest change or complication of the route from one familiar place or space to another causes confusion and sometimes helplessness in the actions of children. Unlike their normally developing peers, children with intellectual disabilities cannot mentally imagine the location of the kindergarten and combine all its premises in one space.

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