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NEUROLINGUISTIC FEATURES OF OPTICAL DYSGRAPHIA

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ABSTRACT

*This article provides a comprehensive analysis of **optical dysgraphia**, a rare but scientifically and pedagogically significant form of written language disorder. The causes, neuropsychological mechanisms, diagnostic criteria, and practical approaches to optical dysgraphia are discussed based on current scientific literature. The author examines the complex features of this disorder by exploring neuroimaging research, visual-spatial perception deficits, visual memory, and graphemic analysis mechanisms. Furthermore, the paper emphasizes the importance of distinguishing optical dysgraphia from other writing impairments and outlines modern diagnostic and corrective strategies based on an individualized approach. This article is of theoretical and practical value for researchers, speech therapists, psychologists, and educators working on the identification and remediation of optical dysgraphia.*

Introduction. Written speech, as an external expression of human thinking, is one of the most complex forms of speech activity. It requires the coordinated activity of visual, motor, phonological, semantic, grammatical, and cognitive systems. The process of children's mastery of writing is based on complex neuropsychological development, and disorders that occur in this process can lead to various types of writing disorders. One of these is optical dysgraphia, that is, a severe form of written speech disorder that occurs as a result of disorders in visual-spatial analysis and synthesis, visual memory, and letter recognition. The Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R; American Psychiatric Association, 1987) uses the term "developmental expressive writing disorder" to describe the concept of dysgraphia. This is because dysgraphia usually appears in early childhood or early elementary school age. This condition may be hereditary or may have arisen in the early stages of development due to biological-neurological, socio-psychological, pedagogical (educational) reasons. Dysgraphia is not associated with mental retardation, visual or hearing impairment, or neurological diseases. A relatively rare form of dysgraphia - optical dysgraphia - is explained by a violation of the visual analysis-synthesis process, visual memory, and visuomotor coordination.

Optical dysgraphia is a poorly studied, but extremely important neuropsychological, neurolinguistic, cognitive, and didactic condition. This disorder causes serious obstacles in the formation of children's reading and writing competence, significantly negatively affects

educational achievement. At the same time, it is pedagogically and scientifically relevant to distinguish this condition from phonological or agrammatic writing disorders, to understand its complex neuropsychological mechanisms, and to develop modern diagnostic and correctional approaches.

This article reviews research on optical dysgraphia, its underlying causes, neuropsychological mechanisms, types, and modern diagnostic approaches. This will provide a foundation for a deeper understanding of this unique written language disorder and help develop educational and corrective strategies based on an individualized approach.

Methods. This article is written using a descriptive-analytical method, and the main sources are the scientific works, diagnostic approaches, neuropsychological, neurolinguistic studies of A.R. Luria, T.V. Akhutina, Filippos Vlachos, Goulandris, Snowling, Maeland, Jiri Mekyska and other scientists. The following were taken into account in the analysis:

- classical and modern scientific views on the optical form of dysgraphia;
- neuroimaging studies reflecting the relationship between the visual, motor and cognitive systems of the brain;
- diagnostic capabilities based on modern technologies, in particular digital tools, artificial intelligence;
- errors characteristic of optical dysgraphia and their types.

This type of dysgraphia occurs as a result of underdevelopment of visual gnosis (a general concept for the processes of dividing stimuli of different modalities into perceptual categories - recognition and differentiation), visual mnesis (the ability to memorize the visual image of a letter), insufficient formation of representations of similar shapes, underdevelopment of optical-spatial perception and spatial representations, visual and visual-spatial analysis and synthesis. (Leshchenko S.G. 2023: 290)

A.R. Luria associate's optical dysgraphia with dysfunction of the posterior lower areas of the central nervous system (hypothalamic-temporal areas). The scientist noted that writing activity is a complex system of visual-motor and cognitive integrations, requiring the memorization of the geometric shape of a letter, its orientation in space, and its distinction from other letters using visual images (Luria, 1973). The theory put forward by Luria is the main model for analyzing problems in written speech, but modern neuroimaging methods allow us to further expand this idea. Modern studies using FMRI, PET, DTI technologies show that there are several parallel systems of the brain involved in writing. That is, the visual, motor, phonological, working memory systems are active in separate regions, but simultaneously. This means that some disorders (for example, dysgraphia) may be associated not with dysfunction in individual areas of the brain, but with disruptions in a complex network. In general, modern neuroimaging tools do not refute Luria's model, but rather expand it. That is, they help to analyze problems in writing more complexly and systematically. They also open the way to studying brain activity not only in narrow localization, but also on the scale of entire neural networks.

T.V. Akhutina (2002) associates optical dysgraphia with children's difficulties with spatial perception and orientation in space. According to the scientist, incorrect orientation in space leads to incorrect writing of letters, especially when writing letters of similar geometric shapes. In general, T.V. Akhutina analyzes optical dysgraphia as a problem of spatial learning,

which is extremely important from the point of view of cognitive development diagnostics. T.V. Akhutina considers this disorder not as a simple inability to recognize letters, but as a cognitive limitation in the perception of space through the eyes. This may be due to low visual spatial attention, poor development of the right hemisphere of the brain, and insufficient activation of working memory. This approach allows us to understand dysgraphia as a combined uncoordinated functioning of the visual perception, spatial movement, memory, and attention systems, and paves the way for its assessment not only as a problem related to language or sound, but also as a cognitive-spatial disorder. A study by Goulandris and Snowling (1991) on the writing of a child named J.A.S. proved that visual memory problems caused the inability to form clear graphic images in the lexical system. Along with developmental dysgraphia, the child had reading and spelling difficulties, significant visual memory impairment, but his phonological processing ability was relatively good. (Filippos Vlachos, 2004:1282) It follows that dysgraphia is a multicomponent disorder, which may be associated not only with phonological, but also with factors such as visual memory, visuomotor coordination, and working memory. This indicates the need for an individual approach for each child diagnosed with dysgraphia.

Another important study was conducted by Maeland (1992). The scientist studied handwriting and sensory-memory skills in dysgraphia and “normal” children, and the results of the study showed that handwriting has a significant relationship with visuomotor integration. (Filippos Vlachos, 2004:1282)

Filippos Vlachos and colleagues (2013) conducted research on the detection of optical dysgraphia based on visual stimulation. According to them, the main disorders in this type of dysgraphia depend on visual-perceptual analysis, which affects the recognition and writing of letters. That is, the shape, direction, size, details of letters are perceived incorrectly, or similar letters are not distinguished. As a result, the child writes the grapheme “d” instead of “b” or “n” instead of “m”. Researchers used special tests based on visual stimulation to identify optical dysgraphia, which provide greater accuracy than conventional tests.

In general, this type of dysgraphia is associated with defects in the functioning of the occipital and occipital-parietal regions of the cerebral cortex. The occipital and occipital-parietal areas of the cerebral cortex are the central apparatus that allows for integrated visual perception, storage and differentiation of visual images, and the implementation of the most complex and generalized forms of visual and spatial cognition. Damage to the occipital systems of the cerebral cortex can prevent the integration of individual visual signs into a holistic image or lead to impaired navigation skills.

In most cases, damage to the occipital-parietal region of the left hemisphere leads to specific defects: the inability to move in the right direction, the inability to distinguish the right from the left, the inability to correctly repeat gestures, among others. All these signs indicate a violation of spatial orientation, the loss of the ability to accurately reflect spatial coordinates. This undoubtedly has a negative impact on the writing process. Most of the letters in any alphabet have a clear spatial orientation. A relatively small minority (for example, the letter o) do not have such a feature: their right and left sides, top and bottom are not clearly defined, that is, they are “not oriented in space”. The majority of letters have a symmetrical structure, but are clearly oriented from bottom to top in space, and the letters u –

n, h – y, p-b, q-q, in cursive form are mirror images of each other – the upper part of one corresponds to the lower part of the other. In addition, most of the letters in the alphabet have the same spatial orientation from right to left (mirror image). Naturally, to write such letters, it is necessary to maintain a clear spatial orientation; if it is violated, it will be impossible to write the letters correctly.

The parieto-occipital region of the cerebral hemisphere is responsible for maintaining the correct graphic outline of the letter, and it is often observed that damage to these areas leads to an unclear image of clearly oriented letters.

In this case, patients usually know what elements a particular letter consists of. However, as soon as they start writing, they cannot clearly say how to write this letter, or rather, how its individual elements should be connected.

Studies have shown that damage to the higher areas of visual synthesis located in the occipital cortex does not lead to a breakdown of spatial orientation, but rather to more serious disorders that cause an optical “alienation” of graphemes.

According to the results of scientific research by O.P. Kaufman, damage to the occipital (or occipital-temporal) sections of the cerebral cortex clearly leads to a violation of optical images, in particular, optical images of letters. The nature of these disorders is not yet fully understood, but their symptoms are clearly described. Patients belonging to this group demonstrate a sufficient degree of preservation of the sound analysis of the word, but when they try to write the correct word, it turns out that they have forgotten the letters denoting this sound, and they begin to search for the necessary word, often replacing one letter with another. Moreover, sometimes the necessary letters are replaced by others that show a certain graphic similarity with them (Воронина Т.П. 2015: 2).

If this sign is absent, the “forgotten” letters are replaced by random graphemes.

In such writing disorders, there is a weak connection between the visual images of words and their sound images: when writing a given sound, the dysgraphia patient's brain creates an inappropriate image of the letter and writes it. These connections are weak, and the same sound can be designated by a different letter each time.

Thus, optical dysgraphia is a written speech problem that is not associated with problems with articulation, poor vision, or poor mastery of spelling rules, and is less common than other types of dysgraphia. This pathology often causes visual difficulties in reading - optical dyslexia. Studies on optical dysgraphia have shown that its mechanism is associated with the inability of the brain to process visual information quickly and accurately. Based on specific neurological studies, it can be said that damage to the occipital-parietal area of the left hemisphere causes difficulties in recognizing a letter, but the sound correctly selected for the image (sound analysis of the word) is preserved. “Such a nature of the disorders,” emphasizes A.R. Luria, “is associated with the central apparatus of the occipital-parietal region of the cerebral hemispheres, which provides for holistic visual perception, the transformation of visual information into complex optical images, the storage and differentiation of visual images, and at the same time the implementation of the most complex and generalized forms of visual and spatial cognition.” As a rule, as a result of this anomaly, it becomes impossible to carry out reading and written speech activities, since such patients lose the graphic representation of letters and, as a result, cannot reproduce them. In some cases, such

phenomena are noted in children at the initial stage of mastering writing. The student cannot reproduce the learned letter on the board or paper or represents it by placing the elements incorrectly. He can read and write letters that are not similar in shape, but confuses letters that are optically close to each other. Such difficulties in learning to read and write in children are most often associated with poor development or damage to the optical systems in the cerebral cortex, starting from the postnatal period.

In optical dysgraphia, the student does not recognize individual letters, cannot associate them with certain sounds, and cannot perceive them as graphemes. The same letter is perceived differently at different times. Incorrect, unclear perception of letters causes them to be confused more often. Since visual stereotypes of words are poorly formed in children, it is also difficult for them to recognize them in written text and causes dyslexia.

As noted, in severe cases of optical dysgraphia, writing activity cannot be carried out. The reason is that in this case the student cannot write words, but can only write individual letters.

Optical dysgraphia is relatively rare as an isolated disease in childhood; most often this form is observed in children with brain diseases (encephalitis, trauma).

Due to the weak connection between the images of words and their sound and visual images, the child has difficulty writing the desired letter. He forgets what image this or that letter has or has an incorrect image of the letter.

In the case of optical dysgraphia, the leading pathogenetic link is the low functioning of the speech analyzer, as a result of which visual differentiation is observed. In this case, more formally similar letters are replaced. These include: letters consisting of the same elements, but having a different appearance (b-d, b-f, e-l);

letters containing the same elements, but differing from each other by additional elements (m-n, o-a, o-o‘,); “mirror letters” (b-d, g-q, p-q); ; writing with an extra element (o, o‘, u,), etc. Optical dysgraphia is divided into three groups depending on the mechanism and type of errors:

a) literal dysgraphia - writing letter elements incorrectly;

b) verbal dysgraphia – writing optically similar letters in a word by alternating them (b,d; a,o,o‘; g,g‘; p,q; n,m; e,l,t; u,v)

c) mirror writing – writing letters in reverse, mirror image. This condition may be associated with the incorrect orientation of visual conductors. Most often, mirror writing is observed in some children with left-handedness and brain damage (Галкина С.С. 2015:30).

The above can occur both independently of each other and in combination with other types of dysgraphia. A number of researchers in the field also consider motor (kinetic) dysgraphia to be a type of optical dysgraphia. In our opinion, it is appropriate to define a written speech disorder associated with motor skills as dyslexic dysgraphia, since this type of dysgraphia is not caused by defects in visual analysis, but by insufficiently developed fine motor skills, as a result of damage to the part of the brain responsible for motor skills.

In the presence of literal dysgraphia, even pronunciation may be impaired. During verbal dysgraphia, isolated letters are pronounced correctly, but in writing they are distorted, letters in the optical description change their places. Optical dysgraphia also includes reverse

writing, which often occurs in left-handed people, as well as as a result of organic inflammation of the brain.

The characteristic features of writing in optical (visual-spatial) dysgraphia are:

– writing by replacing letters that are similar in shape;

– writing with the omission of letter elements;

– writing with additional elements added to the letters;

– difficulties in orientation on paper and finding the beginning of the line (generally, the lack of a border);

– instability in writing letters and numbers (writing in a different way each time);

– writing the same word or sentence repeatedly;

– completely omitting words or sentences, etc.

Discussion. Optical dysgraphia is not only a linguistic disorder, but also a condition associated with a mismatch of complex neurocognitive processes. This disorder has a serious negative impact on students' reading and writing competencies. Studies show that this condition is explained not only by the dysfunction of individual brain regions, but also by a disruption of the integration between several parallel systems - visual, motor, working memory, spatial attention systems. In recent years, special attention has been paid to the study of writing disorders using digital technology. In particular, Jiri Mekyska (2018) developed a methodology for diagnosing optical dysgraphia by analyzing writing movements (graphomotor trajectories) using digital devices. Mugdim Bublin and colleagues (2022) attempted to assess optical dysgraphia by automatically detecting and analyzing writing errors using machine learning algorithms. This model identifies structural problems in the text written by the child. In general, the use of digital technologies in diagnostics is becoming increasingly important for the correct analysis of the writing process and the creation of individual educational plans.

Modern diagnostic approaches, in particular, visual stimulation-based tests (Vlachos et al., 2013), digital trajectory analysis of writing (Mekyska, 2018), artificial intelligence tools (Bublin et al., 2022) are becoming important tools in the identification and analysis of optical dysgraphia.

In addition, an individual correctional approach is extremely necessary in this case, since optical dysgraphia can manifest itself in different ways for each child.

Conclusion. In conclusion, it can be said that optical dysgraphia is a complex disorder in the writing process, which depends on the integration of visual analysis and synthesis, spatial perception, memorization and motor actions. An analysis of the scientific literature shows that for a thorough study of this condition it is necessary to combine neuropsychological, cognitive and technological approaches. Modern diagnostic methods - artificial intelligence, digital handwriting analyzers - undoubtedly open up great prospects in this regard.

References:

1. Filippos Vlachos, Argiris Karapetsas. Visual memory deficit in children with dysgraphia. Perceptual and Motor Skills, 2004. P. 1281-1288.

2. Ахутина Т.В. Трудности письма и их нейропсихологическая диагностика // Письмо и чтение: трудности обучения и коррекция : учебное пособие / под общ. ред.

О.Б. Иншаковой. М. : Московский психолого-социальный институт ; Воронеж : Издательство НПО «МОДЕК», 2001. С. 7–20.

3. Воронина Т.П. Дисграфия, или Почему ребёнок плохо пишет? Ростов-на-Дону: Феникс, 2015.

4. Галкина С.С. Профилактика и коррекция оптической дисграфии у младших школьников с ограниченными возможностями здоровья. Теоретические и прикладные аспекты современной науки. Сборник научных трудов по материалам VII Международной научно-практической конференции. Часть IX. Б.: 2015.

5. Е.Ю. Хомутская, А.О. Святошенко. Проявления оптической дисграфии при изучении русского и иностранного языков. Поволжский педагогический вестник. 2017. Т. 5, №1(14). С. 35–43.

6. Корнев А.Н. Нарушение чтения и письма у детей : учебно-дидактическое пособие. СПб.: ИД «МиМ», 1997. 286 с.

7. Лалаева Р.И., Венедиктова Л.В. Дифференциальная диагностика и коррекция нарушений чтения и письма у младших школьников. СПб. : Образование, 1997. 172 с.

8. Лурия А.Р. Письмо и речь: нейролингвистические исследования. М. : Академия, 2002. 248 с.

9. Понятийно-терминологический словарь логопеда / Под ред. В.И. Селиверстова. М.: ВЛАДОС, 1997. 400 с.

10. Садовникова И.Н. Нарушение письменной речи и их преодоление у младших школьников : учебное пособие. М. : ВЛАДОС, 1995. 256 с.