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Differential Diagnosis of Subcortical Aphasia and Dysarthria in the Course of Complex Speech Disorders: A Case Study of a Patient with Parkinson's Disease Following Neurosurgical Complications of Deep Brain Stimulation Application in the Subacute Stroke Phase

Abstract: A case study of a male patient with Parkinson's disease who experienced complications and a hemorrhagic stroke involving subcortical structures following a second neurosurgical operation for Deep Brain Stimulation (DBS) application is presented. The dynamics of the resolution of individual linguistic and motor symptoms were assessed. Five periodic diagnoses were performed in the subacute stroke phase. Gradual resolution of linguistic disorders resulting from the neurological incident was identified. Despite confounding variables such as therapeutic care, the dynamics of changes were significant enough to characterize them in the context of thalamic subcortical aphasia and co-occurring hypokinetic dysarthria. In cases of complex neurogenic speech disorders resulting from subcortical structure damage in the subacute stroke phase, it is reasonable to assess the dynamics of symptom progression correlated with neurostructural and physiological analysis.

Key words: aphasia, subcortical aphasia, Parkinsonian dysarthria, speech therapy diagnosis

Problemy diagnozy różnicowej afazji podkorowych i dyzartrii w przebiegu złożonych zaburzeń mowy: studium przypadku pacjenta z chorobą Parkinsona po neurochirurgicznych komplikacjach aplikacji Głębokiej Stymulacji Mózgu w fazie podostrej udaru

Streszczenie: Przedstawiono studium przypadku mężczyzny z chorobą Parkinsona, u którego po drugiej operacji neurochirurgicznej związanej z zastosowaniem głębokiej stymulacji mózgu (DBS) wystąpiły powikłania w postaci udaru krwotocznego obejmującego struktury podkorowe. Oceniono dynamikę ustępowania objawów językowych i motorycznych na podstawie pięciu okresowych diagnoz w fazie podostrej udaru. Stwierdzono stopniowe ustępowanie zaburzeń językowych, które – mimo czynników zakłócających, takich jak opieka terapeutyczna – wykazały wystarczającą dynamikę, by scharakteryzować je jako podkorową afazję wzgórzową współwystępującą z dyzartrią hipokinetyczną. W przypadkach złożonych zaburzeń mowy o etiologii neurogennej, wynikających z uszkodzenia struktur podkorowych, wskazane jest monitorowanie dynamiki zmian w powiązaniu z analizą neurostrukturalną i fizjologiczną.

Słowa kluczowe: afazja, afazja podkorowa, dyzartria parkinsonowska, diagnoza logopedyczna

The issues of differential neurologopedic diagnosis, in cases of both dysfunctions resulting from the lack of development and loss of linguistic competence, have often been the subject of scientific research and a cause of complications in the clinical diagnostic process. Speech, recognized in speech therapy research as "a set of activities that a person performs with the participation of language to understand reality and convey its interpretation to other participants in social life" (Grabias 2014, 15), is an extremely functionally complex entity, represented at the competency (cognitive-mental), performance (realization), and social levels (Grabias, 2014, p. 16).

Differentiating aphasia (particularly cortical aphasias, which are the most common types) and dysarthria, despite their neurogenic origin, usually does not pose significant diagnostic problems when they result from a single cause. Aphasia is a speech disorder caused by organic damage to the central nervous system, resulting in partial or complete loss of the ability to program or perceive speech (Maruszewski, 1966, p. 98). This condition particularly refers to the loss of linguistic competence in a person who previously fully developed it. Dysarthria, on the other hand, is a speech deficit at the level of the motor execution mechanism, leading to the inability to manage and coordinate the muscles necessary for respiratory-phonatory-articulatory functions. It is usually associated with other neurogenic symptoms within the orofacial system, such as difficulties in ingesting liquids and food in the initial phases of swallowing, or dysphagia, which is a fundamental swallowing disorder (Mirecka, 2008, p. 236). The different nature of these two speech disorder units makes the identification of specific subtypes of these deficits more diagnostically challenging.

The complexity of co-occurring diseases and/or neurological incidents significantly and directly translates into the level of complexity of neurologopedic diagnostics (Bigos et al., 2021). In such cases, separating linguistic-realization symptoms from different sources and identifying symptoms not originating from any initially analyzed causes is a task requiring advanced clinical experience. Particularly, identifying subtle symptoms of subcortical aphasias leading to aphonia and mutism against the backdrop of severe dysarthric disorders resulting from continuously or episodically progressing degenerative changes within the central nervous system is a complex and difficult process.

Subcortical aphasias are less typical speech and language disorders compared to cortical or even transcortical aphasias. Usually associated with the consequences of damage to the basal ganglia, thalamus, and/or cerebellum, these aphasias exhibit features of both linguistic and motor deficits (Murdoch, Whelan, 2009). The key diagnostic challenge here is to distinguish symptoms resulting from central integration disorders of linguistic functions from those caused by motor deficits, typical for dysarthria. In neurological patients with various central nervous system damages, differentiating between aphasic and dysarthric disorders can

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pose additional difficulties, especially in the case of coexisting neurodegenerative changes and complications following neurosurgical treatment, such as Deep Brain Stimulation (DBS). A characteristic feature of thalamic aphasia, as indicated by Crosson, is its spontaneous resolution within a few weeks after the neurological incident or a change in its symptoms (2013, p. 74). The variable nature of linguistic disorders resulting from thalamic damage in the context of other aphasias was also highlighted by Danuta Kądzielawa (1997, pp. 121–130).

Dysarthria in the course of Parkinson's disease is one of the most characteristic speech disorders associated with this condition. It results from progressive degenerative changes within subcortical structures, including the basal ganglia, which are responsible for the proper functioning of the motor system. Key symptoms of Parkinsonian dysarthria include monotony of speech, reduced voice intensity (hypophonia), slowed and unclear articulation, and a tendency to accelerate speech (so-called festination of speech). In advanced stages of the disease, these disorders can intensify, leading to almost complete inability for vocal verbalization (Rusz et al., 2015). Importantly, Parkinsonian dysarthria often coexists with other motor disorders, such as hypomimia, tremor, or bradykinesia, further complicating the diagnostic and therapeutic process (Sinclair et al., 2013, pp. 295–298). In such cases, proper differentiation between deficits resulting from basal ganglia damage and possible aphasic linguistic deficits requires thorough clinical analysis and the use of advanced diagnostic methods.

Deep Brain Stimulation surgery is one of the most advanced neurosurgical methods for treating motor symptoms of Parkinson's disease that are resistant to pharmacological treatment. This procedure involves implanting electrodes into specific brain structures, most commonly the subthalamic nucleus (STN) or the internal globus pallidus (GPi), and connecting them to a pulse generator placed under the skin in the subclavian area (Neumann et al., 2023, p. 4457). Electrical stimulation of these areas aims to modulate abnormal neuronal activity, improving motor control, reducing tremor, rigidity, and bradykinesia. However, despite its significant effectiveness in alleviating motor symptoms, DBS can be associated with neuropsychological complications, including speech disorders (Groppa et al., 2024, pp. 42–48). Some patients experience worsening dysarthria, deteriorated articulation, or difficulty controlling breathing during speech after the procedure (Deuschl et al., 2006, pp. 222–230). Additionally, there is a risk of symptoms resembling subcortical aphasias, especially if the electrodes are placed near structures crucial for language processing, such as the thalamus or basal ganglia (Krack et al., 2010).

In patients with complications following DBS surgery, differentiating between dysarthria and subcortical aphasia becomes even more challenging, as these symptoms can overlap, and speech deficits can be dynamic and change depending on stimulation parameters. Studies show that lesions in subcortical areas affect

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language production disorders and motor speech control, although their exact role in regulating the latter function is not yet clearly defined (Murdoch, Whelan, 2009, p. 237). Differential diagnosis thus requires close cooperation between the neurologopedic and neurosurgical teams to precisely monitor the effects of the procedure and adjust stimulation parameters to the patient's needs.

Method

A case study is presented, reporting the diagnostic process of a 47-year-old patient with Parkinson's disease who underwent neurosurgical operations twice, with complications occurring during the second procedure. During the implantation of DBS electrodes to modulate the activity of deep brain structures, blood vessels in the area of the subthalamic nucleus and internal globus pallidus in the dominant part of the thalamus were damaged. This resulted in intracerebral hemorrhage and a sudden increase in intracranial pressure. Edema also occurred in the thalamus area. During the surgery, the stroke was promptly recognized using neurophysiological monitoring, the bleeding source was located, and hemodynamic stabilization was ensured. A decision was made to postpone further intervention and observe the patient in intensive care until the brain edema subsided spontaneously. A plan was made to resume the operation after this period.

As a result of the above-described complications and the resulting brain injury, the patient experienced a range of neurological symptoms, including movement, speech, respiratory-phonatory-articulatory functions, and swallowing disorders. The patient was also emotionally unstable. He stopped speaking, could not produce any sound, and could not ingest food or medications orally. The patient's family arranged for private neurologopedic, psychological, and physiotherapeutic care, which took place in the neurosurgery ward, depending on the specialist, 2-3 times a week.

Despite full awareness of his health condition and the consequences of the sudden loss of previous functionality, the patient showed remarkable motivation to actively participate in the diagnostic and therapeutic process. His engagement significantly influenced the accuracy of the clinical assessment and allowed for regular progress in rehabilitation. It should also be noted that the patient was an involved father, and returning to this role was one of his main goals. Before the DBS surgeries, he was professionally and socially active, and after the first procedure, he experienced a significant improvement in quality of life. Thanks to the partial recovery of functionality, he was able to return to his personal interests and daily activities, which was associated with the restoration of independence and self-realization.

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Unfortunately, complications from the second DBS surgery, which resulted in a stroke, led to significant mood disorders. The patient experienced episodes of deep sadness, sudden bouts of crying, and feelings of regret and frustration related to the loss of his previous lifestyle. Despite these difficulties, he maintained a high level of motivation for further rehabilitation efforts and continuously attempted to regain his abilities. His determination to improve his health and desire to continue actively participating in family and social life were key factors in adapting to new conditions. His attitude demonstrated remarkable psychological resilience, although clear mood disorders, such as reactive depression, required additional therapeutic support in psychological and pharmacological terms.

Due to the dynamic nature of the progression of speech disorders and changes in neural tissue during the acute stroke phase, it was proposed to postpone the neurologopedic diagnosis by a few days. Ultimately, speech therapy cooperation began on the eighth day after the neurological incident.

The neurologopedic diagnostic process included reviewing medical documentation, interviews with the patient's wife and brother-in-law, interviews with hospital staff, and telephone consultations with the physiotherapist and psychologist who also visited the patient. The core of the diagnosis consisted of a series of experimental-clinical trials based on the standards of speech therapy diagnosis in cases of aphasia and dysarthria (see: Panasiuk, 2015; Mirecka, 2015).

After a screening assessment of the problem, including observation and interviews, the neurologopedic diagnostic process was designed to differentiate between aphasia and dysarthria and identify their subtypes. For this purpose, the key diagnostic aspect was the characterization of the dynamics of variability in speech disorders.

As part of the experimental-clinical speech therapy trials, the following functions were assessed using the following tools:

- *Speech perception assessment:* Perceptual tests evaluating the ability to perceive speech sounds (such as recognizing sounds, differentiating words) were performed.
- *Language comprehension assessment:* The patient was asked to follow simple verbal instructions and select appropriate illustrations, according to the standard proposed in the Speech Comprehension Test.
- *Acoustic analysis of the speech signal:* The Praat tool was used for acoustic analysis of frequency, intensity, and duration parameters of speech, with particular emphasis on the presence of the fundamental formant on the spectrogram and oscillogram. In the acoustic analysis of the patient's phonation, the recorded dB SPL values were averaged during measurement sessions, meaning they could vary depending on specific conditions such as the distance of the microphone from the patient and the acoustic background.
- *Oral gnosis assessment:* Tests for identifying tactile stimuli were used, in

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which the patient was asked to recognize objects placed in the oral cavity, such as different textures or shapes.

- *Oral praxis assessment:* Tests of oral movements were used, in which the patient was asked to perform movements such as repeating motor patterns of the tongue, abducting and adducting the jaw, or performing labial explosive activities.
- *Naming ability assessment:* The Boston Naming Test (BNT) was used in a modified variant. The modification resulted from the patient's limited attention span and involved limiting the examples to 20 per diagnostic session (equivalent to completing the BNT in three sessions instead of one). Due to the increasing difficulty level in the test, examples for each session were selected every third.
- *Automated word sequences assessment:* The patient was asked to reproduce automated word sequences in two variants: 1) performing a fixed sequence from beginning to end; 2) co-performing a fixed sequence in the form of completion. The patient was asked to count from 1 to 10 and to name the days of the week (attempts to perform other sequences were not undertaken by the patient). Automated word sequences were assessed for correctness, fluency, and potential errors and pauses. The intention to perform the word was considered, followed by an attempt to reconstruct the syllabic pattern of the word (correctly accentuating the number of syllables) and the initial syllable or phoneme.
- *Repetition assessment*
- *Narration assessment*

Data on the disease state were collected for 4 weeks starting from the 8th day after the neurological incident. To identify the dynamics of the progression of speech disorders, 5 measurements were taken during this time (8th day, 16th day, 22nd day, 29th day, 34th day).

Results

Analysis of medical documentation, interview data, and the patient's initial speech therapy assessment, compared with recordings provided before the traumatic incident, allowed for the identification of symptoms such as mutism, complete aphonia, impaired speech comprehension, and abolished expressive abilities, including naming and spontaneous speech, as well as agraphia.

Speech comprehension assessment

At the beginning of the diagnostic process, the patient showed significant difficulties in understanding verbal patterns, indicating dysfunction in the area of linguistic information processing. In the verbal tests conducted, such as the Speech Comprehension Test (SCT), the patient had difficulties understanding complex syntactic structures and extracting meaning from situational context. Moreover, at the initial stage of diagnosis, the patient had problems understanding simple commands and single words naming objects and actions. It was observed that the patient could recognize communicative intentions based on prosody and visual analysis, which was verified through tasks involving identifying emotions and the speaker's intentions in situations using different tones of voice and facial expressions (also involving a close person - the wife, whose intentions the patient recognized relatively correctly from the beginning). In contrast to verbal tests, in non-verbal tests engaging other cognitive mechanisms, the patient achieved better results, although certain limitations related to selective attention also emerged.

Distinguishing between verbal and non-verbal comprehension proved crucial for understanding the patient's functional mechanisms. Problems with verbal comprehension may result from damage to centers responsible for integrating phonological and syntactic information, which is essential for adequate language processing. The pattern of disorders suggests that the patient has limited capabilities for acoustic analysis and interpretation of grammatical structures, consistent with theoretical models of speech comprehension in aphasia, which postulate differences in linguistic processing depending on the brain areas involved.

During the first post-traumatic month, significant improvement in the patient's speech comprehension abilities was noted, objectively measured in a series of neuropsychological tests and correlated with speech therapy tests. During the second measurement period, the patient could only understand simple, repetitive commands in everyday situations, such as "sit down" or "come here," indicating limited linguistic processing ability in a practical context. Comprehension abilities began to develop, manifesting in the ability to correctly recognize single words in clinical trials (third measurement session).

During the third measurement, the patient showed noticeable improvement in interpreting longer utterances and understanding spatial pronouns such as "here" and "there," although he had not yet achieved full competence in more complex linguistic structures. Statistical analysis of SCT measurement results indicates significant dynamics in the development of comprehension abilities between the first and third measurements, with improvement at a statistically significant level ($p < 0.05$). Despite persistent difficulties in processing longer forms of utterances and more abstract concepts, the improvement dynamics were most evident between the second and third diagnoses of the measurement cycle, suggesting the possibility of returning linguistic functions to more adaptive levels. On the day of the last measurement, the patient demonstrated efficient speech comprehension, enabling free communication on current topics. Despite still impaired recognition of meanings resulting from the use of complex syntactic structures, comprehension was assessed as good.

Respiratory-phonatory function assessment

Acoustic analysis using the Praat software in the initial recovery phase allowed for the recording of respiratory noises, which constituted a characteristic signal when the patient was unable to phonate. In this case, the recorded noises were of low frequency, with amplitude values reaching 70 dB SPL, reflecting airflow through the respiratory tract. This type of acoustics indicates an inability to generate tonal sound and may also suggest functional limitations in the larynx area, such as muscle spasticity, inability to coordinate them, or nerve damage responsible for phonation.

During the second measurement, the patient began to produce the first sounds, which, from an auditory and clinical perspective, suggested some progress, although this development was not the fastest. During this period, despite the first attempts at phonation, it was still impossible to record the F0 parameter (fundamental frequency of sound), indicating a lack of stable production of tonal sounds. The sounds the patient could generate had a frequency below 100 Hz, insufficient for proper acoustic processing. During this stage, the patient was included in a therapeutic program, and concurrently implemented elements of manual laryngeal therapy aimed at increasing the flexibility and mobility of laryngeal structures.

In the third measurement, the F0 parameter was recorded for the first time, which was 123 Hz, a significant step towards rebuilding the patient's phonation abilities. Given that respiratory and swallowing rehabilitation had a higher priority at this time, it is difficult to unequivocally assess to what extent these changes were the result of rehabilitation and to what extent the natural adaptation process. However, the progress dynamics, especially in subsequent measurements, were clear: in the fourth and fifth measurements, improvement in phonation abilities was observed, manifested by an increase in F0 values to 157 Hz and improvement in the duration and intensity of the phonation signal, which reached 75 dB SPL.

Improvement in respiratory functions proved crucial for the development of the patient's phonation abilities. Better control over airflow not only enabled sound generation but also contributed to the reconstruction of the syllabic structure of words. Ultimately, improvement in acoustic parameters, such as duration and intensity of the signal, significantly impacted the quality of the produced sound,

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which, in turn, facilitated better understanding of the patient and interaction with the environment. These changes highlight the complexity of phonation and respiratory processes, which are crucial in the rehabilitation of patients with aphonia.

Oral praxis and gnosis assessment

During the initial recovery phase, parallel to the process of edema resolution, a significant increase in oral praxis abilities was also noted. From the beginning, the patient recognized tactile stimuli in the orofacial area at a relatively good level, and as communication functions improved, he was able to communicate this better. These are clinical observations. However, I do not have numerical data that would unequivocally illustrate these progressions.

Repetition assessment

Referring to the quantitative results collected using the tests described in the methodology does not fully reflect the patient's progress in repetition. A qualitative assessment of this skill is more appropriate. During the first session, the patient exhibited completely abolished repetition abilities, directly correlated with comprehension disorders. During the second diagnostic session, with simultaneous discrete improvement in speech perception, gross motor skills, and oral praxis, the patient was able to repeat bilabial plosive phonemes. Over time, he correctly repeated selected open syllables starting with bilabial phonemes, correctly realizing vowels. During this diagnostic session, he also reproduced the syllabic structure of words, often starting them with syllables recognizable by the environment. In the auditory assessment, repetition abilities improved very quickly, and these skills could form the basis for reconstructing the expressive function of speech.

Building spontaneous speech assessment

The development of the patient's narrative abilities can be considered in the context of the gradual reconstruction of linguistic and pragmatic competencies. The initial complete aphonia and inability to repeat sounds indicated deep deficits in speech production, preventing the realization of any narrative forms. From the perspective of the structural-functional model of narration theory, the patient could not realize even the simplest linguistic forms because he lacked basic phonological and syntactic units. His narrative abilities were thus absent at the

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microstructure level (lack of correct phoneme production) and macrostructure level (lack of ability to build event sequences). However, when the patient began to correctly repeat the first phonemes, a gradual development of the ability to build simple speech forms could be observed. The patient began to produce short, incomplete utterances based on repetitive phonetic patterns, which often serve as thematic units in everyday narratives. This was a breakthrough moment for the patient's functioning and his environment, not only for biological reasons but primarily due to the impression of regaining relative independence and the ability to realize basic intentions and pragmatic language functions.

As perceptual-realization abilities improved, the patient gradually developed dialogic abilities. From a clinical point of view, at this stage, some progress in communication competencies could be observed, particularly in the area of prosody and intonation, which allowed the patient to convey appropriate communicative intentions, even with limited linguistic proficiency. The increase in correctness in repeating syllables and words influenced the development of dialogic structures based on monosyllabic responses and short, schematic phrases (e.g., "Yes," "I don't know"), which the patient began to use in everyday interactions. The man gradually regained the ability to realize prototypical speech acts, particularly the functions of initiating and maintaining dialogue. Analysis of his progress indicates a dynamic development of pragmatic language functions, considering adaptation to new limitations in lexical and phonological resources, allowing him to partially restore verbal interactions in the form of dialogue with the environment. Just before the repeated surgery, the patient could participate in a conversation using simple sentences and fulfilling his communication needs.

Conclusion

The sudden onset of speech disorders, represented in the areas of language programming, speech perception, and peripheral motor abilities, resulting from a stroke in subcortical structures in a patient with Parkinson's disease, suggests the need for diagnostic consideration between thalamic subcortical aphasia and hypokinetic dysarthria. Identifying competency dysfunctions resulting from central nervous system damage, with abolished communication abilities and psychological dysfunctions shortly after the acute stroke phase, enabled diagnostics based on analyzing the dynamics of speech disorder development. The patient was diagnosed with the breakdown of the motor pattern of words and sentences, fluency and automation disorders, and the abolition of verbal utterances with almost complete loss of comprehension, characteristic of the clinical picture in the

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course of thalamic and surrounding area damage (Weisman et al., 2003, p. 1865; Panasiuk, 2013, p. 128). As the study results indicate, the state of competencies gradually improved - also in the area of programming movements within the articulatory organs, the ability to swallow liquids and solid foods. The dynamics of the resolution of movement pattern design disorders allow differentiating these dysfunctions from dysarthric limitations. These, according to current knowledge, are mainly progressive (Bigos, 2021, pp. 217–218, 220–221). It is difficult to assess the impact of confounding variables on the process of reorganizing motor and linguistic abilities, such as receiving multidisciplinary care or the influence of other higher cognitive function disturbances on language functions. However, implementing therapy was of paramount value due to the patient's well-being, who needed support in ensuring basic life functions (such as eating, as the patient showed potential not to be fed via a tube) and ethical considerations. The level of dynamics in the resolution of speech disorders was high enough to indicate thalamic subcortical aphasia with suspected secondary metabolic and perfusion decline in cortical structures (after comparing speech therapy and other medical results, including functional neuroimaging).

The symptoms characterizing the course of thalamic subcortical aphasia in the described patient include: non-fluent spontaneous speech (mutism), with variable comprehension (transition from deep speech perception deficits to relatively well-functioning comprehension with deficits in processing complex syntactic, narrative structures, and spatial pronouns); efficiently resolving repetition disorders; naming disorders with a variable, resolving nature.

Speech therapy studies indicate that the clinical picture represented is a combination of aphasic and dysarthric symptoms. It is suspected that after the subacute stroke phase, speech disorder symptoms will not resolve spontaneously but will persist to some extent (difficult to estimate) in the form of hypokinetic dysarthria and aphasia taking on a kinetic, efferent, centrifugal-motor character (in A. R. Luria's terms). The estimate of the future course of speech disorders was made based on the previously presented results. Therefore, it was recommended that the patient and his family undergo a repeated neurologopedic assessment after transitioning to the chronic stroke phase and regular speech rehabilitation.

It is concluded that assessing the dynamics of speech disorders in the case of a complex clinical picture, consisting of suddenly developed neurogenic speech dysfunctions, allows for effective and complete diagnosis and differentiation of the scope of these disorders. Motor symptoms, resulting from impaired programming of speech motor and sensory activities due to subcortical structure damage, could thus be effectively classified as thalamic aphasia rather than dysarthria. This highlights the source of potential aphasic disorder progression and allows for programming effective, individually designed speech therapy.

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Limitations of the study

The assessment of the dynamics of linguistic and realization symptoms was influenced by confounding variables such as the implementation of multidisciplinary care during this time and diagnosis in the subacute stroke phase. Some speech therapy symptoms were assessed according to qualitative criteria, and although this was clinically justified, their quantification into quantitative data to precisely indicate the degree of dynamics of changes was not performed. The study included a description of speech therapy results. Conducting a covariance analysis considering the results of psychological and psychiatric tests as dependent variables on a larger research group could be developmental.

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