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Modern Methods of Aphasia Correction: New Directions and Promising Technologies

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Аннотация: Aphasia is one of the most severe and socially significant consequences of stroke, leading to persistent impairment of speech communication and a reduction in patients' quality of life. The article examines modern methods of aphasia correction with an emphasis on new directions and promising technologies used in the system of restorative neurorehabilitation. Based on an analysis of domestic and foreign scientific publications from 2022–2025, data on the clinical effectiveness of neuromodulation methods (repetitive transcranial magnetic stimulation and transcranial direct current stimulation), brain–computer interfaces, and digital speech therapy technologies are presented. Special attention is paid to the classification of aphasia according to A. R. Luria and the role of a comprehensive, interdisciplinary approach in the restoration of speech functions. It is shown that the combination of traditional speech therapy and neuropsychological correction with modern technological tools contributes to enhanced neuroplasticity, the formation of alternative communication channels, and increased rehabilitation effectiveness, including in severe and chronic forms of aphasia.

Keywords: aphasia; stroke; speech recovery; speech therapy rehabilitation; neuromodulation; rTMS; tDCS; brain–computer interfaces; digital speech therapy; neuroplasticity.

Introduction

Aphasia is one of the most common and severe consequences of stroke. It is a disorder of speech functions that arises as a result of damage to cortical or subcortical structures of the brain involved in the processing, formation, and perception of speech. Impairment of communication significantly reduces the patient's quality of life, complicates social adaptation, and limits independence. Speech recovery in aphasia is a complex and long-term process requiring the participation of a multidisciplinary team: a neurologist, speech therapist, neuropsychologist, rehabilitation specialist, and the patient's relatives.

Methods

The study used an analytical review of domestic and foreign scientific publications from 2022–2025 devoted to speech recovery in post-stroke aphasia. Studies describing the clinical outcomes of the use of neuromodulation (rTMS, tDCS), brain–computer interfaces, and digital speech therapy technologies were analyzed. Additionally, data from the neuropsychological classification of aphasia by A. R. Luria and the stages of speech therapy rehabilitation were taken into account.

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Results

The analysis showed that the main causes of aphasia development are ischemic and hemorrhagic strokes leading to damage to speech zones supplied by the middle cerebral artery, including Broca's and Wernicke's areas. Depending on the localization of the lesion focus, various types of aphasia are formed, described in detail in the classification of A. R. Luria: efferent and afferent motor, dynamic, acoustic-gnostic, acoustic-mnestic, semantic, and optic-mnestic.

Modern rehabilitation of patients with aphasia is actively developing due to the introduction of technological and neurophysiological methods that complement traditional speech therapy and neuropsychological approaches. In recent years, significant interest has been drawn to neuromodulation methods, brain–computer interfaces, and digital rehabilitation platforms capable of enhancing neuroplasticity and accelerating speech recovery.

One of the most studied methods is repetitive transcranial magnetic stimulation (rTMS), which affects the speech centers of the brain. Clinical studies conducted in 2023–2024 demonstrate that combining rTMS with speech therapy improves patients' ability to name objects and form spontaneous speech in post-stroke aphasia. A meta-analysis of 24 studies (Wu et al., *Neuroscience Letters*, 2022) shows that the effect of stimulation persists for several months, especially in chronic aphasia. Similar conclusions are presented in the work of Wang et al. (*Medical Science Case Reports*, 2024), which notes increased speech activity and improved word repetition.

Along with magnetic stimulation, transcranial direct current stimulation (tDCS) is actively used, based on weak electrical currents modulating cortical activity. According to a review by Liu et al. (*Rehabilitation Research*, 2023), the combination of tDCS with speech therapy contributes to a more pronounced recovery of speech comprehension and an increase in verbal activity compared to traditional methods without neuromodulation. These technologies do not replace speech therapy work but significantly enhance its effectiveness.

One of the most innovative directions has been the application of brain–computer interfaces (BCI). New studies show the possibility of "reading" the patient's intention to pronounce a word using EEG signals. The work of Zhang et al. (*Brain Communications*, 2024) demonstrates that BCI makes it possible to identify patterns of "imagined speech," which is especially important for people with severe expressive aphasia when speaking is physically impossible. In 2025, an improved speech decoding model based on neural network diffusion algorithms appeared (Li et al., *arXiv preprint*, 2025), allowing much more accurate conversion of brain signals into text or sound.

The field of digital speech therapy is developing significantly, including multimedia programs, VR environments, and adaptive training tools. In the study by Ivanova et al. (*Modern Problems of Neurorehabilitation*, 2023), it is shown that multimodal neurorehabilitation platforms increase patient motivation, promote independent work, and accelerate the recovery of lexico-grammatical skills. Game-based cognitive-speech programs ("serious games") also demonstrate effectiveness in working with sensory and amnestic aphasia.

Discussion

The obtained data confirm that aphasia correction should be comprehensive and long-term in nature. Modern technological methods do not replace classical speech therapy and neuropsychological work but significantly enhance its effectiveness. Neuromodulation activates compensatory mechanisms of the brain, brain–computer interfaces form alternative channels of communication, and digital tools expand the possibilities of independent rehabilitation. Integration of these approaches into the system of restorative learning makes it possible to achieve more stable and functionally significant results even in severe and long-lasting forms of aphasia.

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