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COGNITIVE-MOTOR INTERACTION AS A RESOURCE FOR EFFECTIVENESS IN ADAPTIVE PHYSICAL EDUCATION

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ABSTRACT
This article explores the theoretical foundations of cognitive-motor interaction and its role within the system of adaptive physical education. It substantiates the necessity of an integrated approach that combines motor and cognitive components when organizing physical activities for individuals with health limitations. The paper highlights the importance of neuroplasticity, motivation, movement awareness, and sensorimotor coordination as key factors for enhancing the effectiveness of both corrective and developmental interventions in adaptive physical education.

Keywords: adaptive physical education; cognitive-motor interaction; neuroplasticity; motor skills; cognitive functions; interdisciplinary approach; sensorimotor coordination; physical rehabilitation; development of metaskills; integration of movement and cognition.

Modern adaptive physical education transcends the traditional approach focused solely on the restoration of motor functions. Today, it is considered an essential part of comprehensive rehabilitation and social integration for individuals with disabilities. In this context, growing attention is paid to the cognitive dimensions of physical activity and their role in a person's adaptation to altered life conditions. This highlights the significance of the concept of cognitive-motor interaction, seen as a bidirectional relationship between physical actions and mental processes.

Historically, physical education has been viewed primarily as a somatic practice aimed at improving physical qualities and preventing disease. However, with the advancement of neuroscience and psychophysiology, it has become evident that physical activity has a multifaceted impact on cognitive and emotional processes. This is particularly relevant for individuals with disabilities, where cognitive impairments often accompany motor dysfunctions. As a result, there is a demand for new models of adaptive physical education that consider the body and mind as a single functional entity.

Cognitive-motor interaction encompasses a wide range of processes: spatial perception, action planning, attention control, motor regulation, and performance evaluation. Neuroscientific research confirms that physical activity directly influences higher mental functions by activating various brain regions, including the prefrontal cortex, cerebellum, hippocampus, and basal ganglia.

One of the key biological mechanisms ensuring the effectiveness of cognitive-motor interaction in adaptive physical education is neuroplasticity—the brain's ability to reorganize neural connections in response to external stimuli, learning, and physical activity. Critical neurophysiological processes involved include the secretion of neurotrophic factors (e.g., BDNF—brain-derived neurotrophic factor), the formation of new synaptic connections, axonal myelination, and the activation of mirror neurons.

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Regular physical activity can not only restore lost functions but also stimulate cognitive processes such as attention, memory, planning, and spatial reasoning. This is because movements—especially complex, coordination-rich exercises—activate extensive areas of the brain, including the motor cortex, cerebellum, and frontal lobes, which are responsible for executive functions.

It is also important to consider the theory of embodied cognition, which suggests that cognitive processes are directly connected to bodily experience. Within this framework, physical activity serves not only as a tool for improving health but also as a medium for learning, stimulating imagination, developing spatial reasoning, and supporting emotional regulation.

Thus, adaptive physical education fulfills not only a compensatory function but also a developmental one, stimulating neuroplastic processes that promote the individual's integration into educational, professional, and social activities. Programs that include cognitively rich motor tasks can strengthen neural pathways between motor and cognitive centers in the brain, resulting in more stable and long-lasting functional improvements.

Exploring cognitive-motor interaction requires moving beyond narrowly specialized approaches. At the intersection of physiology, neuropsychology, pedagogy, and physical education, a new field is emerging: neuro-pedagogy of adaptive movement. This area incorporates scientific knowledge about brain functioning to enhance the effectiveness of learning and rehabilitation through physical activity.

Current research in neuro-pedagogy demonstrates that instruction based on learners' neuropsychological characteristics improves not only academic performance but also motor skills. Models of sensorimotor integration accelerate the processes of compensation and the formation of new motor patterns. Special attention is given to methods such as biofeedback, sensory stimulation, and digital technologies—for example, the use of virtual and augmented reality to create cognitively engaging physical scenarios.

Educational and rehabilitation practices are already implementing programs that combine motor activity with cognitive stimulation. These may include:

«Interactive routes» that combine movement with tasks involving memory, counting, or logic;

Ball and target exercises requiring counting, strategy selection, and spatial analysis;

Team-based physical games with changing rules that foster cognitive flexibility and self-regulation;

Balance exercises paired with attention, memory, and executive control tasks;

Video training, where learners observe, analyze, and compare their performance with model techniques.

These methodologies not only improve motor coordination and endurance but also foster cognitive flexibility, emotional resilience, self-reflection, and teamwork. Their implementation requires a multidisciplinary team: physical education instructor, neuropsychologist, speech therapist, occupational therapist, and tutor educator.

Cognitive-motor interaction represents a unique resource for improving the effectiveness of adaptive physical education. Its implementation requires a systemic approach, taking into account brain mechanisms, individual learner needs, and the capabilities of modern pedagogical technologies. Neuroplasticity provides the neurophysiological foundation for such transformations, making motor tasks a powerful tool for recovery, development, and personal adaptation.

Adaptive physical education based on the principles of cognitive-motor integration has the potential to provide more comprehensive rehabilitation, improve quality of life, and support social inclusion. Future directions involve the development of individualized programs tailored to neuropsychological profiles, the use of digital tools, and the creation of scientifically grounded methodologies for training and correction.

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