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Means of Physical Education of School-Aged Children in the Context of Neuroscience

Oleksandr Dorohin
PhD student, State University "Uzhhorod National Universiti", Uzhhorod, Ukraine.
oleksandr.dorohin@uzhnu.edu.ua

Tetiana Bolotnykova
Candidate of Science in Pedagogy, Assistant Professor, Head of Department Pylyp Orlyk International Classical University, Mykolaiv, Ukraine.
btania92@ukr.net
https://orcid.org/0009-0003-2826-2491

Volodimir Yakovliv
PhD, Doktor of Philosophy, Associate Professor, Department of Theory and Methodology of Physical Education, Vinnitsia Mykhailo Kotsiubinkyi State Pedagogical University, Kafedra TMFV, Vinnitsia, Ukraine.
dekykovliv576@gmail.com

Iryna Mashtaler
Candidate of Sciences in Physical Education and Sports, Associate Professor of the Department of Theoretical Foundations and Methods Physical Education of Volodymyr Hnatyuk Ternopil National Pedagogical University, Ternopil, Ukraine.
pqtnitsa13@gmail.com
https://orcid.org/0000-0001-5033-2562

Oleksandr Lohvynenko
Candidate of Pedagogical Sciences, (PhD in Pedagogy), Associate Professor, Associate Professor of the Department of Theory and Methods of Physical Education and Sport, Drohobych Ivan Franko State Pedagogical University, Drohobych, Ukraine.
vinograd2010@ukr.net
https://orcid.org/0000-0001-6417-7006

Abstract: *The article analyses health technologies in the physical education of children at the current stage. During the analysis of scientific sources, it was established that the main priorities are the development of new, most adequate programs, the search for the most effective methods of healthy physical education of children. The most priority directions of research work have been determined, in particular, the neuroscientific aspects of the work have been formed. The relevance of scientific work is determined by the need to popularise physical education. In the conditions of the restructuring of the national system of general secondary education, the innovative activity of general educational institutions, which is characterised by systematic experimentation, testing and application of innovations in the educational process, is of great importance. The study analysed theoretical and methodological approaches to the formation of physical health. In particular, the article analyses the neuroscientific context of studying the problem. Concepts and terms on the specified issue have been formed. In order to determine the most pressing problems of education in the implementation of educational standards, a number of scientific opinions were studied, which formed the key questions of the research. So, work results achieved with the help of appropriate methods and technologies were designed. Scientific research is the basis for the formation of key trends in the study of physical education and the foundations of health formation. Research, scientific, descriptive and explanatory methods were used to achieve the results. The method of synthesis and analysis was also used. The results of the study do not exhaust all possible goals, but they testify to the importance of the formation of physical health.*

Keywords: *neuropedagogical approach; self-esteem; physical education; healthy lifestyle; central nervous system.*

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Iryna Liashuha
Candidate of Historical Science, Assistant Professor of Physical Education and Sports, National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine.
ira.lyashuga@gmail.com
https://orcid.org/0000-0001-5867-3580

1. Introduction

Contemporary researchers regard innovation in education as the process of developing, sharing, and implementing new strategies to tackle teaching challenges that have traditionally been approached differently. What matters most is the outcome of an inventive quest for unique and unconventional solutions to various educational problems. These innovations are pertinent, meaningful, and systematic, arising from a range of initiatives, and they show potential for advancing education while positively influencing its growth.

The process of innovative activity is multifaceted and requires the development of a responsive and well-founded framework for scientific support of innovations. This approach considers the reasoning and unique characteristics of innovative activities, as well as how different system components perceive, assess, and adapt to one another (Kornosenko et al., 2021).

This leads to a more effective implementation process. The foundation of the technology for delivering innovations should involve a method of analysis that allows for the simultaneous consideration of multiple interaction aspects, which significantly affect the efficiency of innovation processes. The modern development of physical culture and health work takes place in the presence of the following signs of real changes:

- new educational activity and new content of education;
- the novelty of the way of life, the organisation of the educational process;
- new tasks and means of pedagogical activity;
- tendency to preserve health and develop the individuality of the uniqueness of the growing personality;
- a tolerant attitude towards carriers of potentially critical information capable of generating new ideas, breaking stereotypes, etc.
- neurophysiological features of personality development (Dykan et al., 2021).

Therefore, the purpose of the research is to clarify the essence of modern technologies and neurophysiological features of the implementation of integration complexes in the physical education of children in school conditions.

2. Peculiarities of Physical Education of School-Aged Children

It is known that the body's adaptation to physical exertion is based on morphological, metabolic, and functional changes in various organs and tissues of the child, which arose as a result of systematic training, during which the functions of nervous, hormonal, and autonomous cellular regulation are improved. All these changes determine the training effects. They contribute to the improvement of various functions of the body, which ensure the implementation of muscle activity, and as a result - an increase in physical fitness.

When developing fundamental and applied aspects of children's adaptation and health problems, considerable attention should be paid to their motor activity’s optimisation, which is considered a natural need at all stages of ontogenesis, as the formation of a valuable attitude towards oneself. It was established that in the modern population of schoolchildren, the share of children with a body weight deficit has increased to 20%, and functional immaturity is found in 30-50%. Thus, the age of 7 years turns out to be critical in both socio-psychological and psychophysiological terms. Therefore, the main goal of the research is to study the impact of continuous educational culture in the conditions of an educational institution with the use of physical innovative technologies on the health of children, which is a factor in the formation of a child's physical culture.

The formation of physical health is a socially significant process of personality formation due to external influences and internal determinants of individual development, aimed at achieving an individually optimal level of indicators of morphophysiological development, physical fitness, and adaptation capabilities of the individual organism (Vatseba & Kuts, 2001).

The result of the formation of physical health of schoolchildren is the level of formation of physical health. In modern psychological and pedagogical studies, it is emphasised that the basis of

the development of each individual is a person's desire for positive changes. Therefore, scientists consider a child's personality process formation as a step-by-step development of individual-personal features, which are caused by qualitative changes in emotional actions and volitional experiences (Vilchkovsky, 1979). At the current stage of the development of science, it has been proven that a person's health primarily depends on the degree of his own efforts in the direction of preserving and strengthening health. Thus, the quantitative criterion of the formation of physical health includes the following indicators:

1) an individually optimal level of morphophysiological development, which is necessary and sufficient for the high-quality functioning of the organism;

2) individually optimal level of physical fitness, which is necessary and sufficient for high-quality work capacity;

3) an individually optimal level of adaptation capabilities of the organism, which is necessary and sufficient to compensate for the pathological processes of the external environment.

The qualitative criterion includes motivational-value (system of life values, life position; needs, and motives), cognitive-intellectual (knowledge and skills to preserve and strengthen health), behavioural (meaningfulness, independence, and ability of the student to self-control), emotional-psychological (responsibility for one's health and the health of others) indicators.

The current situation in the education system leads to an increase in the load on the body of students. Under the influence of training in schoolchildren, there is a marked tension in the body’s functional state, a decrease in work capacity, and fatigue caused by a violation of the coordination mechanisms of the central nervous system (Vorobey, 1993).

Insufficient regulation of the loads placed on the growing organism, and their increase due to the intensification of studies, affects the health of schoolchildren. Revealing the mechanisms of a stable functional state of the body will allow us to coordinate the physiological and psychophysiological functions involved in the regulation of human behaviour and activities as efficiently as possible. At the same time, the level of optimisation of psychophysiological resources of the individual increases. With the full flow of physiological and psychophysiological processes, a person perceives and processes information in the best way, programs activities, carries out control, and corrects errors (Kuts, 1997).

In a stable state, intellectual activity increases, which consists of three components: mental speed, and mental and psychomotor plasticity, which act as regulators of a person's general abilities and increase the effectiveness of educational activities. In the conditions of high requirements of a comprehensive school, it is necessary to find new methods of their use in psychological-pedagogical and medical-biological practice to preserve and strengthen the health of schoolchildren during classes in a comprehensive educational institution. It is very important to create such conditions in the school, under which teachers, taking into account the abilities of students, would contribute to increasing the effectiveness of the educational process (Tsvek, 1990). It is necessary not only to optimise training loads but also to develop criteria for their compliance with functional reserves, and to search for ways of correcting the physiological and psychophysiological state of the body of schoolchildren. Recent medical evaluations indicate a rising trend in students exhibiting low levels of physical development, including conditions such as hypertension, obesity, underweight issues, and shorter stature. To enhance the health benefits of physical activities within the educational framework, it is crucial to conduct a quick assessment of the physical well-being of schoolchildren, which can help in addressing their physiological and psychophysiological conditions effectively.

3. Effectiveness of Technologies and Means of Physical Education of School-Aged Children

When planning the work, it's essential to consider the principles of pedagogy, which view the educational process as a cohesive blend of learning, development, and teaching. Each of these elements has its own specific focus, content, and methods for impacting the child's physical, mental, and social aspects (Shyyan, 2001):

1) education is evident in the development of meaningful historical experiences gained through physical culture, which is shown in the attainment of legal knowledge, skills, and competencies;

2) it is viewed as an intentional development of socially important beliefs, ideas, personal values, and ethical orientations, which manifest in the formation of an individual's perspective and consistent personality traits, as well as approaches to international communication, through the engagement in physical activity;

3) education involves children actively acquiring fundamental skills in physical education, which is evident in the creative growth of their personalities and the development of their interests in this area (Lynets, 1997).

According to this approach, the development of physical culture of an individual occurs in stages, and in the conditions of the pedagogical process of mastering physical activity, it is possible to highlight (Giddens, 1991):

- identification – assimilation of knowledge and methods of physical activity, mastery of movements and vital motor actions, physical exercises that allow for engagement in active physical education;
- individualisation – assimilation and creation of knowledge, mental and motor actions in accordance with individual physical, mental, and personal qualities;
- personalisation - possession, upbringing, and purposeful use of means, methods, and forms of physical activity, formation of individual experience, and creation of models and values directly related to the satisfaction of personal interests and needs (Dzhordzhi & Mayer, 2014).

Accordingly, in the system of school education, physical education involves the expansion of the child's individual motor experience and consistent learning of movements and motor actions. This means that the pedagogical process, aimed at assimilating experience, has all the signs of the identification process and should presuppose the use of means and methods of physical education.

Considering that the main goal of the educational area "Physical culture" was and remains the formation of the physical culture of the individual taking into account the age-related anatomical, physiological, and psychological characteristics of children, it is first necessary to form the task of physical education for children of each age period (Zakirova & Purik, 2016).

For school-aged children, personality development in the process of mastering the basics of physical activity with a general developmental focus is common. Such a goal is specified as mastering physical education activities with a general development focus for preparing children for schooling.

As an innovative component of the physical education process, a simulator is used that implements the laws of wave biomechanics in practice. The technology of using the simulator involves the formation of sets of exercises for children of different ages (Zhelezovskaya, Abramova, & Gukova, 2014). During the academic year, the presented complexes change by using modifications of individual exercises or by replacing exercises from other complexes. Complexes are adjusted once a month in children.

Thanks to the application of innovative technology, it is possible to increase the time of children's motor activity by 50-60% when performing the complex with the simulator three times a day and by 90-100% when performing five times a day. The rise in physical activity reinforced the view that employing a simulator for children's classes in educational settings during a "full day" does not lead to overload or disrupt sleep patterns (Tomozii & Topala, 2014).

Biomechanical waves of tension and relaxation engage all systems in a synchronized rhythm of function, ensuring the proper operation of biomechanical structures that influence the efficiency of work and the overall health of the organism (Wagner, 2008).

The research revealed that the objectives of children's physical education are closely linked to the primary methods utilized in the field. These approaches can help lower the incidence of illness among children throughout the year, sustain the expected growth rates in physical development, and enhance key physiological measurements.

4. Neurophysiological Factors of Personality Development as an Aspect of Physical Education

Physical education is an essential part of the educational experience, aimed at promoting health, improving posture, enhancing resilience, and developing physical abilities in children. This discipline not only focuses on cultivating discipline but also on building communication skills. These objectives are integral to the physical education of all children (Robinson & Aronica, 2009).

A form of corrective and educational intervention designed to promote the development of the central nervous system involves utilizing a variety of physical exercises. These exercises help cultivate both gross and fine motor skills while addressing and alleviating neurological symptoms. It is known that a necessary condition for the successful development of children in the future is a properly organised developmental environment, which includes an optimal movement regime, and therapeutic and adaptive physical education. There are anecdotal reports of the successful use of exercise for cognitive development in healthy children and adults. However, there is much less neurophysiological justification and detailed sequential description of physical exercises that such a child should master during childhood to stimulate development and compensate for the pathology of the central nervous system (Schwartz, 2017).

The current level of development of neurophysiology indicates that the use of targeted physical training will contribute to the maturation of various departments of the central nervous system, the formation of compensatory changes in it, and more successful physical and mental development of the child (Tartakovsky, 2015).

The neurophysiological justification of the requirements for physical education, aimed at the maturation of the central nervous system, is the compensation of its defects and the development of the intellectual abilities of young children, taking into account the motor capabilities and characteristics of the psycho-emotional sphere of such children (Katz, 2013). The neurophysiological basis of the construction of such training is: ontological and phylogenetic features of the maturation of the central nervous system, features of the development of the nervous system; the doctrine of the three blocks of the brain, and the doctrine of the functional system as a dynamic self-regulating central-peripheral organisation that provides, on the basis of constant feedback afferentation, an adaptive result important for the organism (Loreman et al., 2016).

At birth, a child has a certain set of vital unconditional reflexes that allow it to satisfy its biological needs and adapt to the surrounding world (breathing, sucking, swallowing, etc.). The maturation of the functional systems responsible for these reactions occurs in the prenatal period and ensures the survival and development of the organism (Gray, 2008). In the postnatal period, maturation of the central nervous system continues. In the first year of life, pathways are myelinated, and spinal cord, supra-cerebral, vertical, and horizontal connections are formed (Batowski, 2001). As the child's central nervous system matures, first simple, then more complex motor stereotypes are formed, each of which is the basis for the formation of subsequent, even more complex motor acts.

The correctness and timeliness of the appearance of new motor skills serve as markers of the normal development of the central nervous system. In a child with a preserved nervous system, motor development occurs with minimal support from adults and in a strictly defined order from top to bottom. First, the baby learns to control the position of the head, then the shoulder girdle, rolling over (control of the lying position), sitting (control of the sitting position), kneeling (control of the

pelvic girdle), crawling (formation of cross-coordination of the movements of the upper and lower limbs), standing (control of the vertical posture), bipedal locomotion (control of vertical posture in dynamics), which will be further divided into walking and running. The order of these processes is determined genetically but can change under the influence of internal pathological processes and external circumstances. Internal pathological processes - a congenital lesion of the central nervous system - can be manifested by a violation of the blood supply to the head and back of the brain, fluid dynamics, the presence of a diffuse lesion, or a focal defect. This, in turn, leads to a violation of the ratio of the processes of excitation and inhibition in the entire central nervous system, the order and speed of the processes of myelination of the conducting systems, and changes in the patterns of formation of interneuronal connections. As a result, a delay in motor development is observed in the baby, or development occurs in a different, unusual order.

In children with perinatal pathology of the central nervous system, parts of the body are often kept in a physiologically unfavorable, forced position and movements are limited in some direction. This may reflect a deficit of descending influences, and the presence of focal symptoms and serve as the basis for the formation of vicious postural and locomotor stereotypes. As a result, the CNS receives an afferent flow different from that which is formed during correct motor stereotypes. Under the influence of uncharacteristic afferent input to the central nervous system, the order and speed of myelination of conducting systems changes, and the formation of interneuron connections, including those that provide sensorimotor interaction, coordinated muscle contractions during complex motor acts is disrupted.

As a result, the morpho-functional development of the central nervous system does not take place most optimally. This is manifested in the features of the child's both motor and mental development. Children with residual phenomena of organic damage to the cerebral cortex are significantly behind their peers in the rate of formation of motor skills. Even with mild disorders, the skill of controlling the position of the head appears 3-6 months later than normal. As motor acts become more complicated, this lag becomes more and more noticeable (Dykan et al., 2021). Another feature of the motor development of children with mental retardation is insufficient differentiation of movements. Such children are characterised by impaired orientation and coordination, the presence of stereotyped movements, and inadequate motor behaviour. All this indicates significant disturbances in the formation of higher cortical centers responsible not only for motility but also for higher nervous functions.

In children with mental retardation, the basis of total mental retardation is often an organic lesion of the associative zones of the cerebral cortex, formed late in ontogenesis (primary defect), which entails a violation in the intellectual sphere (secondary defect). Violation of processes of synthesis and analysis of afferent monomodal information coming from undamaged primary zones of analysers leads to the incorrect formation of sensory stereotypes, and violation of all mental and motor functions (tertiary defects).

In children with a preserved central nervous system, neuroontogenesis is genetically determined, but under the condition of timely and adequate exposure to the external environment, especially at an early age, it is possible to stimulate the formation of intrahemispheric and interhemispheric connections, which expand the functional capabilities of the central nervous system. When mental development is delayed, neuroontogenesis is distorted, which manifests itself in a significant peculiarity of psychomotor development: the formation of the body scheme, cross-laterality, non-differentiation of movements, and, as a result, the lack of formation of a behaviour strategy in difficult conditions is disturbed. These features determine the specificity of the pedagogical approach in the formation of new abilities and skills in such children.

Both in normal conditions and in cases of mental retardation, special training aimed at the formation of vertical and horizontal connections in the central nervous system, polymodal afferent synthesis, can not only increase the set of motor coordination, which is the basis of a variety of human motor behaviour but also expand functional capabilities Central nervous system as a whole. This will stimulate the child's intellectual development and allow him to adapt better to the team.

To stimulate the correct and comprehensive development of the central nervous system, when building complexes of physical exercises in the process of corrective work, it is necessary to take into account the phylogenetic patterns of maturation of brain structures. The oldest part of the brain is the medulla oblongata and the hindbrain (cerebellum and pons), responsible for homolateral movements. Subsequently, the intermediate and midbrain were formed, which took over the functions of ensuring versatile movements. The youngest part of the brain is the cerebral cortex, it controls activities related to the joint work of both hemispheres (language) and is also responsible for multimodal synthesis and probabilistic forecasting.

Therefore, when practicing physical culture, it is necessary to first include homolateral movements, then cross movements of the upper and lower limbs, and after that, movements from the intersection of the body's midline. It is also important to use analysers in the order of their evolutionary appearance. Corticalisation of old sensory systems (tactile, proprioceptive, olfactory, vestibular) occurs earlier in ontogenesis than younger visual and auditory ones. Phylogenetically ancient, previously matured analysers have less individual and situational variability. Therefore, the child's central nervous system most easily and predictably reacts to the afferent flow from the skin and proprioceptors, which are formed during physical exercises.

The higher nervous activity of a person, both in normal and pathological conditions, is provided by a whole complex of brain structures working together, each of which makes its own contribution to this process. There are three blocks of the brain: the block of brain tone, the unit for receiving, processing, and storing information, block of programming, regulation, and control of complex forms of activity. By influencing the body with the help of physical exercises, we first of all load the unit for receiving, processing, and storing information, which is characterised by the hierarchical structure of its incoming structures, the reduction of their specificity as the level of the hierarchy increases, and the progressive lateralisation of functions at higher levels of the hierarchy. Analysis of mentally retarded children is usually preserved, unlike the associative areas of the cortex, which determines the leading value of sensations at the initial stages of learning. With the correct organisation of classes and the gradual inclusion of various analysers, gradual activation of increasingly complex brain structures is possible. This process will lead to the activation of associative zones of the cerebral cortex, responsible for multimodal synthesis, as well as for higher nervous functions, which will favorably affect the development of the central nervous system and the formation of functional systems.

FS is a selective formation that unites various departments of the central nervous system, analysers, links of the ODA, and other body structures, necessary to achieve a result useful for the body. The structures of the central nervous system play an integrating role in the FS, and the working periphery determines and implements the direct achievement of the result, for example, maintaining a posture or performing a movement. The task of the teacher is to create such conditions for the formation of FS, so that in case of complications, the gradual inclusion of more and more complex structures of the central nervous system is preserved, for example, performing movements in easy conditions, then in normal conditions, then in complicated ones.

Taking into account the described regularity, as motor FSs form, their central mechanisms and peripheral links mature, it is necessary to reduce the number of simultaneously engaged afferent inputs. For example, when forming cross movements, they use demonstration, explanation, and correct the child. At the beginning of the training process, the child is given various ensembles of stimulating signals to obtain the necessary movement.

Integrating different sources of information will allow researchers to obtain a new holistic picture of the physiological process of human development, covering the dynamics from molecular changes to cognitive manifestations.

Circadian plasticity of the brain is still not fully understood. Circadian changes in the nervous system are likely influenced by intracellular oscillations of circadian clock proteins, enzymatic activity in clock cells, and fluctuations in small molecules involved in neuroplasticity, regulated by both central and peripheral clock systems. Each of these molecules can be regulated

differently. During the day and night, the brain undergoes significant functional and morphological changes, and some of these rhythms are generated by endogenous mechanisms controlled by the circadian clock. These cyclical changes in the efficiency and number of synapses or the morphology of neurons and glial cells seem to correlate with motor activity in both vertebrates and invertebrates.

Circadian brain plasticity is a model that integrates time- and state-dependent changes in synaptic plasticity. In this model, the output signals of the clock regulate circadian plasticity processes, and the global changes observed in sleep-wake cycles are driven by the clock, not by the state of the brain.

Combined and hybrid clusters in the diagnosis, treatment, prevention, and rehabilitation of cognitive impairments and cognitive disorders. A modern solution to the problem of rehabilitation of the “cognitive brain” of Homo Sapiens using, on the one hand, the means and technologies of AI, and on the other hand, the multidisciplinary interaction of a neurophysiologist with a clinical “universal” specialist in the field of neurology, psychiatry, psychotherapy, psychoanalysis, and geriatrics. The Homo Sapiens brain is the next silver and gold frontier for neurorehabilitation and P4 healthcare in the long-term perspective of “conventional” medical and economic investments. For the short-term “mistakes” of cardiologists and oncologists, clinical geriatricians will have to “pay” in the long term. The combination of combined and hybrid neuroimaging methods with AI technologies has made it possible to understand and diagnose neurological and geriatric disorders, as well as find new rehabilitation methods and economic programs for medical and social support that will improve mental health and allow many of us to live the golden years of our lives with dignity.

The main problem of society is the medical, social, and economic accessibility of a person to a quality life in the period of the “creative man Homo Sapiens”: modern brain-computer interface technologies, hybrid AI, “virtual brain”, “virtual brain”. reality", "virtual paranormal brain phenomena", since homeostatic brain plasticity is involved in neurorehabilitation at all ages of the Homo sapiens brain.

The construct of "cognitive reserve" is a set of variables, including intelligence, education, and mental stimulation, that are believed to allow the brain to adapt to major pathologies, preserving cognitive function despite major neural changes. The Homo sapiens brain also shows resilience to neuropathological damage and can be defined as the ability to optimise or maximise performance through an efficient set of neural networks and/or alternative cognitive strategies. Childhood cognition, educational attainment, and adult occupations all independently influence cognitive reserve.

In the process of forming each motor function, it is desirable to gradually narrow the "starting" afferentation, achieving a motor response to each separately presented stimulus: visual, auditory, kinesthetic, and achieving the performance of the exercise in easy, neutral, and difficult conditions.

Thus, when building any complex of physical exercises aimed not only at the physical but also at the intellectual development of the child, it is necessary to take into account:

- ontogenetic patterns of organism development;
- phylogenetic regularities of the development of the nervous system;
- features of the functioning of brain blocks;
- systemogenesis in the functional system's formation.

To achieve an optimal result in work, in addition to the listed features, it is necessary to rely on the features of their psychomotor development:

- delayed formation of sensory and motor stereotypes;
- violation of lateralisation;
- insufficient coordination of motor acts;
- insufficient differentiation of afferent stimuli;
- lack of motivation when performing any tasks;
- predominance of non-verbal memory and attention over verbal ones.

At the beginning of the training process, the child is given various ensembles of stimulating signals to obtain the necessary movement.

Then, as the function is formed, stimulating signals are given in turn, achieving an appropriate response to each one, regardless of its modality: they are offered to repeat according to the instructor, perform according to sound commands, and perform independently according to the command with sound accompaniment. This moment is also necessary since a change in afferent supply causes a change in the postural program of motor activity, therefore, the formation of adequate motor reactions to various afferent signals serves to form new associative connections in the central nervous system and expand human motor capabilities.

5. Conclusions

Research has been conducted, and the main key factors in the formation of physical health in school-age children have been determined. Summarising the research, it should be noted that when organising movement works with children, it is necessary to start with the simplest exercises, relying on the maximally preserved subcortical structures and all available analyser systems. After mastering the proposed motor stereotypes, you can make the exercises more difficult by introducing additional external afferentation in the form of music, excluding visual influence while preserving voice commands, and later, when performing the exercises, you can change the rhythm, tempo, and sequence of the proposed exercises. The next step in the development of the psychomotor sphere will be the performance of cross-exercises based on previously formed skills. Thus, during the formation of motor stereotypes at this stage, the intermediate and midbrain will be involved, and a greater number of receptors will be activated, especially tactile and proprioceptors, which will result in the activation of polymodal afferent synthesis in higher cortical areas. This aspect testifies to the importance of the neurophysiological development of the personality in the formation of the child's physical health.

Therefore, a correctly designed and implemented complex of physical exercises with a mandatory reliance on preserved functions and the involvement of all systems of the analyser will not only develop existing and form new motor skills but will contribute to the maturation of higher cortical structures, which is the basis of the successful development of children in the educational process.

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Iryna Mashtaler defined the article’s concept and structured the content of the research according to certain thematic blocks.

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Iryna Liashuha formed the research criteria and methodology, and identified the key results.

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