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Mini Review

The Effectiveness of Using Neuroenergic Mapping in the Training Process in Artistic Gymnastics

Baskakov IS, Bindusov EE* and Kovalenko VE

Department of Theory and Methods of Gymnastics, Moscow State Academy of Physical Education, Moscow Region, Lyubertsy, Russia

***Corresponding Author:** Bindusov EE, Head of the Department of Theory and Methods of Gymnastics, Moscow State Academy of Physical Education, Moscow Region, Lyubertsy, Russia.

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Abstract

The article discusses the effectiveness of using the registration of ultra-slow brain potentials in the training process of young men in artistic gymnastics. The effect of complex-coordination exercises on the change in the electrical activity of individual brain zones in young male gymnasts is shown.

Keywords: *Artistic Gymnastics; Training Process; Registration of Constant Brain Potentials; Training Load*

The modern theory of organizing the training process in artistic gymnastics, which has been developing since the 1950s, provides an important description of the structure and organization of training [1]. However, its relevance requires rethinking. The available sources lack data on planning the volume and intensity of training loads, as well as on the alternation of micro- and mesocycles within the annual training cycle in artistic gymnastics.

Experts in the field of sports physiology and sports theory agree that achieving optimal fitness for the competitive stage is inevitably associated with changes in physiological processes in athletes. In our opinion, the central nervous system's response to training stimuli plays a crucial role in these changes. The planning of training in artistic gymnastics is traditionally based on the annual cycle, which serves as the foundation for organizing the training process. The theory of sports, including gymnastics, examines in detail the features of the load for athletes of different levels at each stage of the annual cycle.

The central nervous system plays a key role in managing all the processes of the body, including adaptation to training loads, while physical exercises have a significant impact on the entire body, including the "control" brain. One of the most important aspects of brain function is its energy supply.

S.E. Pavlov [2] emphasizes that in recent years, the method of neuroenergic mapping, based on the measurement of ultra-slow processes in the brain, has been increasingly used in sports medicine and medical control. N.A. Aladzhalova [3] formulated the concept of ultra-slow processes related to the preliminary reflection of functional changes in the body in the central nervous system. Research by V.F. Fokin and N.V. Ponomaryova [4] has revealed that the level of constant brain potential (Upp) correlates with the activity of cortical and subcortical structures of the central nervous system. The background activity of the central nervous system reflects the degree of an athlete's functional readiness for training and competitions. The registration of Upp serves as an applied tool for a comprehensive assessment of energy metabolism and the state of readiness of the body for to a specific load. The study of the electrophysiological characteristics of the "slow" processes of the central nervous system is of significant practical value among specialists. Our research is based on the hypothesis that the construction of training microcycles in artistic gymnastics has a direct impact on the functional state of the central nervous system (CNS), which can be objectively measured using the neuroenergy mapping (NEM) method. This method allows for the assessment of brain metabolic activity through the measurement of constant potential levels (CPLs), which are stable millivolt-range electrical signals that reflect energy metabolism in neurons and belong to ultra-slow physiological processes.

It is assumed that different types of microcycles have different effects on the CNS of gymnasts. For example, impact microcycles with high loads cause significant changes in the bioelectric activity of the brain, manifested in a decrease in the PPP in the frontal and central areas. Research data suggests that intensive training leads to a general decrease in the PPP, indicating a decrease and imbalance in energy metabolism in the brain. In contrast, recovery microcycles contribute to the normalization of these processes, resulting in a gradual increase in the PPP, although full recovery may require significant time. The need for this study is based on our previous observations, which showed that the actual workload of 10-12-year-old gymnasts exceeds the workload described in the scientific literature. This requires an assessment of the impact of such a training regime on the CNS of athletes. In this study, the registration and analysis of ERPs were performed using the Neuro-KM hardware and software complex. The potentials were recorded monopolarly using silver-chloride electrodes on five channels: the active electrodes were placed along the sagittal line in the frontal, central, and occipital regions (Fz, Cz, Oz), as well as in the right and left temporal zones (Td, Ts) in accordance with the international 10-20 scheme. The left wrist was used as the reference electrode. The PEP values were recorded 5-6 minutes after the electrodes were placed on the selected points, both before and after the training session. The results of the measurements in the indicated monopolar leads in 10-12-year-old gymnasts before and after the impact microcycle are presented in table 1.

Names of leads	Before training	After training	Asimp. zn. (two-sided)	Level of significance
Fpz (mv)	15,9 ± 5,9	13,6 ± 5,7	0,036	<0,05
Cz (mv)	21,6 ± 15,2	13,8 ± 18,8	0,03	<0,05
Oz (mv)	16,7 ± 8,4	13,2 ± 8,8	0,001	<0,05
Td (mv)	17,1 ± 12,8	11,5 ± 12,1	0,015	<0,05
Ts (mv)	17,1 ± 8,6	13,5 ± 13,5	0,187	>0,05

Table 1: *Indicators (mv) of monopolar leads of gymnasts 10 - 12 years before and after training load in the impact microcycle (n = 42).*

The results of neuroenergic mapping in 10-12-year-old gymnasts indicate a consistent decrease in the level of constant potentials (CP) in all monopolar channels after a shock microcycle.

- Frontal zone (Fpz): From 15.9 ± 5.9 mV to 13.6 ± 5.7 mV, which corresponds to a decrease of 14.5%.
- Central zone (Cz): From 21.6 ± 15.2 mV to 13.8 ± 18.8 mV, a decrease of 36.1%.
- Occipital zone (Oz): From 16.7 ± 8.4 mV to 13.2 ± 8.8 mV, a decrease of 21.0%.
- Right temporal lead (Td): From 17.1 ± 12.8 mV to 11.5 ± 12.1 mV, a decrease of 32.7%.

The average values significantly differ in the frontal, central, occipital, and right temporal channels ($p < 0.05$), while no significant changes were observed in the left temporal channel ($p > 0.05$).

The greatest negative dynamics in the central zone (Cz, −36.1%) is consistent with the high functional load on the sensorimotor areas responsible for coordinating movements. The decrease in the frontal area (Fpz, −14.5%) reflects the involvement of structures responsible for higher cognitive functions in compensatory inhibition processes during stress. Asymmetry of the temporal indicators (a sharp drop on the right side with relative stability on the left side) indicates a disruption in the interhemispheric balance under the influence of fatigue. A decrease in the UPP indicates the depletion of the CNS's energy resources after an intense training session. Changes in the UPP are associated with a decrease in the rate of cerebral energy metabolism, a reduction in oxygen and glucose consumption, and a suppression of the activity of respiratory chain enzymes. Training effects in the shock microcycle of artistic gymnastics lead to a statistically significant decrease in the values of constant brain potentials (CBP) in most of the analyzed leads (Fpz, Cz, Oz, Td), with no significant changes in Ts. The recorded dynamics of CBP reflect specific adaptive changes in the central nervous system in response to the amount of training load. The registration of constant potentials can be considered as an objective physiological marker of the state of the nervous system and a tool for optimizing the training process in athletes [5-7].

Conclusion

Thus, modern recovery of athletes after training and competition loads is a complex and multi-level process that involves the systemic integration of biochemical, physiological, and neuroenergetic mechanisms. The comprehensive use of individualized methods and tools, as well as scientifically based planning and precise monitoring of the state dynamics, not only allows for the prompt compensation of functional resources, but also ensures the long-term preservation of high performance. Moreover, it has been shown that the effectiveness of recovery measures significantly increases when considering the intersystem interactions of the body, which requires the implementation of personalized programs and the use of neurophysiological assessment criteria.

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