

## Significance of typological features of the nervous system for the effective implementation of motor coordination processes in 16-18-year-old female volleyball players

ROMAN BOICHUK<sup>1</sup>, SERGII IERMAKOV<sup>2</sup>, VASYL KOVTSUN<sup>3</sup>, VOLODYMYR LEVKIV<sup>3</sup>,  
IVAN KARATNYK<sup>3</sup>, VITALII KOVTSUN<sup>4</sup>

<sup>1</sup>Department of Physical Education and Sports, Ivano-Frankivsk National Technical University of Oil and Gas, UKRAINE

<sup>2</sup>Department of Tourism and Recreation, Gdansk University of Physical Education and Sport, POLAND

<sup>3</sup> Department of sport and recreational games, Lviv State University of Physical Culture, UKRAINE

<sup>4</sup>Department of winter sports, Lviv State University of Physical Culture, UKRAINE

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### Abstract:

Purpose: to determine the influence of typological features of the nervous system on the level of the manifestation of motor coordination in female volleyball players at the stage of preparation for higher achievements. Material: The study involved 22 female volleyball players aged 16-18. Results: The importance of typological features of the nervous system of female volleyball players for the successful solution of complex coordination tasks in the process of competitive and training activities has been established. The interconnections of strength, balance, mobility, dynamism, lability of the nervous system with indicators of the coordination abilities of female volleyball players aged 16-18 were established. The average level of the interconnection between the indicator of the nervous system strength of the players and the ability to reorganize motor actions quickly, the reaction of choice, a sense of rhythm was revealed. A reliable positive relationship was found between the indicator of balance of the nervous processes of female athletes and their ability to coordinate movement actions. The indicator of the mobility of the nervous processes of the studied has reliable interconnections with the ability to a sense of rhythm, rapid restructuring of motor actions, spatial orientation. Correlations of low and medium levels are registered between the dynamic indicator of the nervous system and the ability of kinesthetic differentiations, coordination of movements and reaction. An inverse interconnection of the average level is found between this characteristic of the nervous system of female volleyball players and the ability to static balance. Reliable positive interconnections of medium and high levels were found between the volatility indicator of the neural processes of the volleyball players and the ability to quickly reorganize motor actions, a sense of rhythm, and dynamic balance. Conclusions: typological features of the nervous system have a greater impact on the level of the manifestation of coordination abilities of female volleyball players compared with the makings of lower levels of human biological organization. The relative weakness of the nervous system leads to a higher level of the development of specialized perceptions of the players. The strength and the nervous system balance play a leading role in solving complex coordination tasks that require high level of courage, determination and reliability of motor actions. Indicators of dynamism, mobility, lability of nervous processes are particularly favorable for the manifestation of coordination abilities in sports games and volleyball in particular. Skillful psychological regulation and purposefully formed compensatory mechanisms will eliminate the deficiencies of the nervous system of the players. This will contribute to the effectiveness of competitive and training activities of players.

**Keywords:** volleyball players, training, coordination, nervous system, correlation.

### Introduction

Every year modern sports of the highest achievements imposes more and more strict requirements to athletes with each Olympic cycle. Since the main goal of the athlete's training is to achieve a victorious, and in fact, a record result in the sport of the highest achievements (Malikova, Doroshenko, Symonik, Tsarenko, & Veritov, 2018; Mytckan et al., 2018). Therefore, extreme modes of training and competitive loads are an inevitable feature of the modern process of sports training.

Ways of overcoming the crisis situation caused by the reached volume and intensity of training loads of young and qualified volleyball players (Boichuk, Iermakov, Nosko, Kovtsun, & Nosko, 2017; Kozina et al., 2018) are seen in the improvement of the systems of coordination and technical competence.

As noted by (Lyakh, Sadowski, & Witkowski, 2011; Boichuk et al., 2018) the need to study the coordination abilities of volleyball players is determined by some existing problems. On the one hand, a variety of methodological approaches to the assessment of abilities created a favorable information background, which stimulated a qualitative leap in this area of knowledge. On the other hand, the need to search for new patterns and principles in the study of coordination abilities from the standpoint of a systematic approach and combining the basic principles of psychophysiology and biomechanics is defined. Bernstein N.A. (1967) considers coordination abilities as a system of coordinated motor actions, ensuring the solution of the tasks set in accordance with a specific situation and functional state of the organism. Therefore, the author recommends applying an integrated approach to study coordination abilities. This approach involves a comprehensive biomechanical analysis of the sporting activity in which they are manifested, the definition of the hierarchy of sports-significant qualities and psychophysiological reliability of the organism systems. As a consequence, the study of the internal structure of coordination abilities is currently relevant. It is also necessary to study the relationship between the main components of the structure of coordination preparedness and psychophysiological and functional systems of the organism of volleyball players (Boichuk et al., 2018; Kozina et al., 2018).

Ljach W.I. i Witkowski Z. (2010) indicate that currently there is no clear answer regarding the basic makings that determine the level of human coordination abilities. (Ilyin, 2001; Kozina et al., 2018) refer the neurodynamics features, such as the strength, mobility, and balance of the human nervous system to the makings of these abilities. Drosdovski A.K. (2015) notes a significantly greater influence of typological features of the nervous system on the manifestation of human coordination abilities as compared with morphological, biochemical and physiological makings. Each of the features of the nervous system can act as a positive or negative role depending on what kind of activity and in what conditions a person performs. According to Nebylitsyn V.D. (1972) strength (and, accordingly, weakness as the opposite of this quality) of nervous processes is expressed in the degree of endurance of the nervous system to a long-acting stimulus. Also, this peculiarity is manifested in the correct way the nervous system responds to stimuli of different strengths, which indicates its sensitivity and excitability. The mobility of the nervous processes (the opposite is inertness) is determined by how quickly the nervous system restructures to changing stimuli.

Apparently, this property of the nervous system is one of the main determinants of the speed of central processing of information, including the speed of the decision-making process. Balance (or imbalance) of the nervous processes reveals the ratio and balance of excitation and inhibition.

Rycarev V.V. (2015) understands the concept of "dynamism of the nervous system" as the speed of the formation of motor skills. The researcher notes that volleyball players with a dynamic nervous system quickly learn new motor actions. But, unfortunately, there are cases when these skills are quickly lost. On the contrary, players who find it difficult to learn new movements have strong skills that persist for a long time. The lability of the nervous system is the speed of the flow of nerve processes. This quality is expressed in the speed of simple response and the speed of habitual learned movements. Nebylitsyn V.D. (1972) and Ilyin, E.P. (2001) are convinced that athletes with a weak type of nervous system are incapable of strong volitional demonstrations, high workability, which is expressed in the instability of performance in competitions. The stronger the process of excitation of the nervous system, the greater the improvement in their results achieved by players in competitive activity compared to training. And, accordingly, the weaker the process of excitation of the nervous system, the worse the result of athletes in competitions. The authors explain this phenomenon by the fact that the emotional impact of competitive conditions for the weak nervous system serves as a strong stimulus. This causes significant inhibition of the nervous processes and deterioration of the manifestation of motor abilities.

The works of (Drosdovski 2015; Kozina, Chebanu, Repko, Kozin, & Osiptsov, 2018) showed that people with a strong, mobile type of nervous system show better workability when performing fast dynamic exercises. The quality of doing their exercises is not reducing to the end of workout. Representatives of the weak mobile type of the nervous system do not have sufficient endurance. Such an athlete can perform one exercise no more than 3-5 times. Representatives of the weak inert type also have a low level of workability. They are not able to endure large training loads. The training loads the next day are extremely ineffective for them. Persons with a strong inert type of nervous system show better workability when performing slow and static exercises. They get tired relatively quickly in activities where speed of movement and frequent changes in motor situations are required. According to the total volume of the load performed at the training session, they are characterized as workable.

(Ilyin, 2001; Çetin, Beyleroğlu, Bağış, Suna, 2018) indicate that the mastering of the technique of movement and the manifestation of coordination abilities in young volleyball players are also due to the individual characteristics of the nervous system. Representatives of the normally exciting, moving type of the nervous system usually master the technique of exercises easily, they precisely perform various motor tasks, and succeed in situational activities. Young athletes with a strong, uncontrolled type of nervous system often differ in inequality of success in physical exercises. However, they are able to easily master new motor skills. Persons who are characterized by normal excitability (quiet type of the nervous system), successfully seize difficult coordination movements. However, they are relatively slow to form conditioned-reflex connections and, along

with fast movements, slow movements are also observed. Young volleyball players who are characterized by a reduced excitability of the nervous system in performing movements, as a rule, are inactive. The formation of their conditioned reflexes is extremely difficult. Therefore, researchers recommend that a differentiated approach be applied to young athletes, taking into account the individual characteristics of the nervous system, during the training of motor actions. It is proposed to pay more attention to the verbal method when teaching motor actions of students with a strong type of nervous system, and to use the method of showing for the students with a weak type.

(Lyakh, Sadowski, & Witkowski 2011; Rycarev, 2015) note that in some cases, motor abilities can depend quite strongly on one particular nervous system. However, the ability to a particular sport is always determined by several of its typological features. A quantitative assessment of the physiological basis of the players' temperament allows the coach to explain a lot in the behavior of their students and plan the targeted formation of compensatory mechanisms and character traits of volleyball players. The researchers consider the strength, mobility and balance of the nervous processes to be the main characteristics of the nervous system. Their various combinations form one or another type of temperament. It is believed that the features of the nervous system have a physiological nature, and temperament - its psychological manifestation.

On the one hand, there has been formed a controversial situation between the need to study the relationship between the indicators of coordination abilities and the typological features of the volleyball players at the preparatory stage for higher achievements, and on the other hand, there has been a need to study the insufficient scientific development of the methodological support for solving this pedagogical problem. This determines the practical and scientific relevance of the research problem.

*Hypothesis.* It is assumed that the determination of the influence of the features of the nervous system on the level of manifestation of motor coordination in female volleyball players aged 16-18 will increase the efficiency of the training process. It will contribute to the formation of compensatory mechanisms and increase the competitiveness of players.

*The purpose of the study* is to determine the influence of typological features of the nervous system on the level of manifestation of motor coordination in female volleyball players at the stage of preparation for higher achievements.

#### **Material and methods**

Participants. In an experiment volleyball players who are at the stage of preparation for the highest achievements (n=22, age – 16–18 years) participated. Organization of the research. For evaluation of the general coordination abilities were used indicators of abilities to balance, a rhythm, reaction, kinesthetic differentiation, spatial orientation, coherence of motor actions and reorganization of different by origin motor actions. The corresponding tests were used for evaluation of the general coordination abilities of volleyball players (Boichuk et al., 2017).

Diagnostics of typological features of the nervous system of female volleyball players was carried out using the observation method (Serhiienko 2013). Evaluation was carried out on a five-point scale (5 points - a high degree of manifestation of characteristics, 1 - low). The evaluation criteria were as follows.

##### **Indicators of the strength of the nervous system on the part of excitation**

1. Keeps vigor and confidence in difficult and responsible circumstances (for example, during exams, test starts) regardless of the degree of preparedness for them.
2. Is not distracted by the action of extraneous irritants.
3. Is able to repeat difficult and dangerous exercise.
4. Shows perseverance in mastering the exercises.
5. In the competition achieves higher results than in training.
6. Do not refuse to study complex exercises.
7. Before start is in a state of full alertness.
8. At the end of the class, the quality of the exercises does not reduce.
9. Perceives failures as a stimulus for further actions.
10. Actively aims to participate in competitions with a strong competitor.

##### **Indicators of the strength of the nervous system on the part of inhibition.**

1. Equable dynamics of activity and mood.
2. Collected and calm while awaiting.
3. Patient and persistent during heavy exercises.
4. Outwardly shows no signs of worrying before the competition.
5. Is able to quickly focus on the exercise performance.
6. Calm and restrained in various situations.
7. Does not allow irritability (outbreaks) in communication.
8. Does not break the usual regime on competition days.
9. Thoroughly and leisurely warms up.
10. Clearly expresses their thoughts; speech is smooth and fluent.

**Indicators of mobility of nervous processes.**

1. Is able to quickly move from one activity to another.
2. Is not inclined to linger on the development of individual components of the exercise.
3. At the warm-up prefers speed and speed-strength exercises.
4. Performs static exercises and exercises on the technique without a particular interest.
5. Is prone to a notable external demonstration of emotional worries (positive and negative).
6. Quickly get close to people.
7. Speech is fast, sometimes hasty.
8. Quickly gets used to new conditions of activity.
9. Immediately starts to perform the exercises, quickly get involved into a work.
10. Facial expression is rich and diverse.

*Results.* The degree of manifestation of each feature of the nervous system was assessed by a total score of points (the maximum score was 50 points, the minimum score was 10). The sum of 30 points for a certain characteristic was regarded as its sufficient intensity. That is, it meant that the athlete is distinguished by strength, balance and mobility of nervous processes. Weak degree of characteristic was diagnosed with a sum of less than 30 points. Such an athlete was distinguished by weakness, lack of balance (with a predominance of excitation) and inertia of the nervous system.

The dynamism of the nervous system was determined by the speed of the formation of motor skills (Rycarev, 2015). For this purpose, an expert assessment was applied. The experts were team coaches. Evaluation was carried out on a five-point scale. The highest marks were received by those players who quickly assimilated the techniques offered to them. And, conversely, players who were more difficult to perceive the training material received low marks.

The lability of the nervous system was determined by the speed of the simple reaction of the female volleyball players (Rycarev, 2015). For this purpose, we used the computer program "Psychodiagnostics" (Kozina et al., 2011). A detailed testing procedure is described in (Boichuk et al., 2017).

*Statistical analysis*

The obtained data were processed using the statistical computer program SPSS 17.0. A multiple correlation analysis was performed.

**Results**

The closest to the significant level of interconnection (from  $r = 0.42$  to  $r = 0.47$ ,  $p < 0.05$ ) was found between the indicator of the strength of the nervous system of female volleyball players and the choice reaction and the ability to sense of rhythm (Table 1). This indicator has a statistically significant relationship with the ability to quickly reorganize motor actions, which manifested itself in running 3x10 m with the back to the direction of movement ( $r = 0.60$ ,  $p < 0.05$ ) and the ratio of the running time  $3 \times 10$  m with the face and back to the direction of movement ( $r = 0.65$ ,  $p < 0.05$ ). A negative high-level interconnection was found between the strength of the nervous system and the ability for dynamic balance of female volleyball players ( $r = -0.91$ ,  $p < 0.05$ ). A low level of relationship (from  $r = 0.31$  to  $r = 0.36$ ,  $p < 0.05$ ) was found by an indicator of the strength of the nervous system on the part of inhibition and the ability for complex reaction, dynamic balance and spatial orientation. The closest to significant positive interconnection was found between the balance of the nervous system and the ability to harmonize and combine movements into complete motor combinations ( $r = 0.44$ ,  $p < 0.05$ ). The mobility of the nervous processes of the studied has a low level relationship with the ability to select reaction, static balance and coordination of movements (from  $r = 0.32$  to  $r = 0.38$ ,  $p < 0.05$ ). The result of the test "ten eights", which determined the ability of players to co-ordinate motions in a motor action, has a relationship of the average level ( $r = 0.54$ ,  $p < 0.05$ ) with the indicator of mobility of the nervous processes of volleyball players.

Table 1. The relationship of indicators of coordination preparedness and typological features of the nervous system of female volleyball players aged 16-18.

Coordination preparedness indicators	Indicators of typological features of the nervous system				
	Strength of the nervous system	Balance	Mobility	Dynamism	Lability
Ball throw into the goal while standing with your back to it (differentiation of motion parameters), number of hits	-,176	,099	,178	<b>,440</b>	,176
Stepping over a gymnastic stick (coordination of movements), s	,172	,192	<b>-,336</b>	-,217	,199
Test "ten eights" (coordination of movements), s	-,022	<b>,435</b>	<b>-,535</b>	<b>-,306</b>	,209
Ran to the numbered balls, (orientation), s	,195	<b>,364</b>	<b>-,430</b>	-,223	,142
The difference in running time to the numbered balls and shuttle running $5 \times 3$ m	-,090	,009	,219	,065	<b>,301</b>

(orientation), s					
Stand on one leg with eyes closed (static balance), s	,018	,078	-,320	-,520	-,486
Turns on a gymnastic bench (dynamic balance), number of turns	-,907	,301	,126	-,314	,670
Running 3x10 m with the back to the direction of movement (restructuring of movements), s	,602	,020	-,445	-,238	-,696
The ratio of running time 3x10 m with the face and back to the direction of movement (restructuring of movements), s	,649	-,210	-,214	-,137	-,642
Running 30 m over hoops, s	,467	,095	-,414	-,024	-,640
Difference between 30-meters running and 30-meters running over hoops, s	,420	-,244	,079	,098	-,242
RCh 1-3, ms	-,060	-,327	,375	,413	,515
RCh 2-3, ms	,445	-,311	,068	,034	,291

Note: RCh1-3 – choice reaction of one signal from three, RCh2-3 – choice reaction of two signals from three.

The dynamic indicator of the nervous system of female volleyball players turned out to be interconnected at a low level with the ability to co-ordinate movements ( $r = -0.31$ ,  $p < 0.05$ ) and the reaction of choice ( $r = 0.41$ ,  $p < 0.05$ ). A reliable positive correlation was found between the indicator of kinesthetic differentiations of players (test of throwing the ball into the goal while standing with the back to it) and the dynamism of the nervous system ( $r = 0.44$ ,  $p < 0.05$ ). The inverse relationship of the average level ( $r = -0.52$ ,  $p < 0.05$ ) was found between this characteristic of the nervous system of the female volleyball players and the ability for static balance, which was manifested in a stand on one leg with eyes closed.

The lability of the nervous system of the studied has a low level relationship with the ability to spatial orientation ( $r = 0.30$ ,  $p < 0.05$ ). Also, this feature of the nervous system has a reliable relationship of the average level with the ability to static balance ( $r = 0.49$ ,  $p < 0.05$ ) and the reaction of choice ( $r = 0.52$ ,  $p < 0.05$ ). Ability to dynamic balance, rapid adjustment of movements, sense of rhythm have a high level of interconnection (from  $r = 0.64$  to  $r = 0.70$ ,  $p < 0.05$ ) with the lability of the nervous system of the female volleyball players.

## Discussion

Analyzing the primary results of pedagogical observation, it should be noted that the strength of the nervous system, the balance and mobility of the studied female volleyball players is sufficiently strong. In our opinion, this is logical, because the players have passed the preliminary, intermediate and main stages of selection for volleyball lessons. A competitive activity in this sport makes high demands on the personal characteristics of the players, in particular their temperament and character. Of particular importance is the strength and endurance of the nervous system and psychological stress resistance of players. In our view, these features ensure the reliability of game actions and the ability not to be mistaken in psychologically tense situations. Also the volitional manifestations of players are of great importance, since their presence largely ensures victory in matches.

The transiency of game situations during a match makes high demands on the speed of motor reactions, attention, accuracy in assessing circumstances and making adequate and timely decisions. This coincides with the results of research by other authors (Drosdovski 2015; Rycarev, 2015; Heydari, Soltani, & Mohammadi-Nezhad, 2018), which indicate a relatively small number of persons with a weak nervous system among high-level volleyball players. However, according to the authors, this does not mean that such players should not be involved into volleyball practice, since the deficiencies of the nervous system features can be sufficiently mitigated by various compensatory mechanisms under conditions of a high level of development of volitional qualities and skilful psychological regulation. According to researchers, these mechanisms can and should be purposefully shaped. Then the player will have a chance for a successful sports future. According to (Heydari, Soltani, & Mohammadi-Nezhad, 2018; Kozina, Chebanu, Repko, Kozin, & Osiptsov, 2018), the relative weakness of the nervous system and the high anxiety of the players can be compensated for by a high level of development of the will, optimal composure and mobilization before the game. And also with the help of special techniques of psychoregulation.

The interconnection of high negative correlation between the nervous system strength on the part of excitation and the ability for dynamic equilibrium was confirmed by earlier conclusions by other researchers (Lyakh, Sadowski, & Witkowski 2011; Çetin, Beyleroğlu, Bağış, Suna, 2018) that noted that weakness of the nervous system causes a higher musculoskeletal sensitivity. (Ilyin, 2001; Korobeynikov, Myshko, Pastukhova, & Smoliar, 2017) associate this innate peculiarity of the nervous system with a high ability to reproduce and assess the spatial, temporal and dynamic parameters of movements. The ability to control the parameters of movements in the sport of higher achievements is known as specialized perceptions (perceptions of a ball, partners, playgrounds, etc.). However, according to Nebylitsyn V.D. (1972) and Drosdovski A.K. (2015) in situations that require the athlete's high manifestation of coordination abilities, courage, determination, the

weakness of the nervous system plays a negative role. In such cases, the importance of the strength of the nervous system increases. Being under our study the negative reliable relationship between the strength of the nervous system on the side of inhibition and the ability for quick reaction of choice, in our opinion, confirmed the importance of balance of nerve processes for solving motor problems in harsh time deficient conditions. This opinion is shared by (Aoki et al., 2018; Kozina et al., 2018), pointing out that nervous system imbalances negatively affect the player's actions in competitive activities since a player is expected to perform a high reliability of motor actions there. The reliable positive interconnection between kinesthetic differentiation abilities and the dynamic indicator of the nervous system of female volleyball players has been confirmed by other researchers (Bernstein, 1967; Korobeynikov, Myshko, Pastukhova, & Smoliar, 2017). These two features of human individuality provide more successful (easy and fast) learning of motor actions. A significant amount of reliable interconnections between mobility of the nervous system and indicators of coordination preparedness of female volleyball players indicates that this feature of the nervous system determines the speed of switching players from one movement to another (Polevoy, 2017; Boichuk et al., 2018). Our correlation analysis also revealed a sufficient number of reliable interconnections between the lability of nervous processes and the indicators of the players' coordination sphere. This confirms the data by (Rycarev, 2015; Kozina et al., 2018) that lability is one of the main prerequisites for the high ability of players to respond to various signals in a gaming environment. According to the authors, in contrast to lability the inertness of the nervous system prevents a person from quickly switching from one motor situation to another. However, inertness is one of the factors that affects the strength of remembering information (Ilyin, 2001). Inertness and rigidity can be compensated by a well-developed stability of the athlete's attention, observation, and the ability to predict the development of the game situation. This will facilitate the correct and timely selection of player behavioral responses (Heydari, Soltani, & Mohammadi-Nezhad, 2018).

Thus, our data allowed us to investigate the peculiarities of the relationship between the indicators of the typological features of the nervous system of female volleyball players and their coordination preparedness. A greater number of reliable positive interconnections between the indicators of the "speed" features of the nervous system (mobility, dynamism, lability) and the motor coordination of players showed their high significance for sports and volleyball in particular. The possibility of compensating for the deficiencies of the nervous system peculiarities of female volleyball players with the help of targeted compensatory mechanisms has been confirmed. Along with this, further research is needed on the participation in the management and regulation of the folding-coordination movements of female volleyball players of such mental components as emotional-motivational, value-orientational, constitutive and volitional. Their specific influence on the processes of motor coordination of volleyball players is an unresolved issue of the psychophysiology of movements.

### Conclusions

1. The study confirmed the greater influence of the typological features of the nervous system on the level of manifestation of the coordination abilities of female volleyball players in comparison with the morphological, biochemical, physiological characteristics.
2. The relative weakness of the nervous system causes a higher ability of players to reproduce, assess and differentiate the spatial-temporal and dynamic parameters of movements. The strength and balance of the nervous system play a leading role in solving complex coordination tasks that require high courage, determination and reliability of motor actions.
3. A significant amount of reliable positive interconnections between the indicators of mobility, dynamism, lability of nervous processes and coordination abilities of female volleyball players aged 16-18 confirmed the high importance of these characteristics of the nervous system for successful implementation of volleyball techniques.
4. Those typological features of the nervous system of players that impede the effective implementation of motor coordination processes and the achievement of high efficiency in the competitive activities of the female volleyball players can be compensated for by the purposefully formed compensatory mechanisms.

### Conflict of interests

The authors declare that there is no conflict of interests.

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