

## Formation of the structure of psychophysiological features of elite basketball players

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### Abstract

Among coaches and scientists, one of the main topics is the improvement of the system for training elite athletes. Traditional studies in basketball devoted to the actual connection of study with a long training process. Training and competitive activity in basketball includes neurodynamic, psychomotor, cognitive and psycho-motional characteristics. Modern research devoted to the characteristics of the functional states of athletes in various training and competitive conditions. But among the modern studies of team sports, there are no data on the psychophysiological states of elite athletes for different types of monitoring.

**Purpose:** Development of the system of psychophysiological support of elite basketball players as an actual scientific direction in the theory and methodology of sports training

**Materials and methods:** The 13 elite basketball players, age 19-23 (sport experience more than 8 age) were examined. The sensory-motor response, mobility and balance of nervous process, verbal memory, operative thinking and general intelligence were studied. All of tests include the complex of computer diagnostic "Multipsychometer 05". Also, in battery were include tests: estimates of actual psychical state (by color test Lusher), field independence (by Stroop test), motivation (by Mehrabian test) and aggressive (by Bass-Darke test). With the factors analysis the main components of psychophysiological characteristics of basketball players were obtained.

**Results:** The factor's structure of psychophysiological state of elite basketballs included 4 factors: neurodynamics, cognitive resources, energy-information and emotional-cognitive.

**Conclusion:** The factor structure of psychophysiological state of elite basketball players was revealed. The identified factors can be used to correct the training process of elite athletes.

**Key words:** neurodynamics characteristics, cognitive properties, elite basketball player, factor's structure.

### Анотація

**Формування структури психофізіологічних особливостей елітних баскетболістів.**

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**Вступ.** Серед тренерів та вчених однією з головних тем є вдосконалення системи підготовки елітних спортсменів. Традиційні заняття баскетболом присвячені фактичному зв'язку навчання з тривалим тренувальним процесом. Тренувально-змагальна діяльність у баскетболі включає нейродинамічні, психомоторні, когнітивні та психоемоційні характеристики. Сучасні дослідження присвячені особливостям функціонального стану спортсменів у різних тренувальних та змагальних умовах. Але серед сучасних досліджень ігрових видів спорту відсутні дані про психофізіологічний стан спортсменів високої кваліфікації за різних видів моніторингу.

**Мета** - розробити систему психофізіологічного забезпечення баскетболістів високої кваліфікації як актуальний науковий напрямок теорії та методики спортивного тренування.

**Матеріали та методи:** обстежено 13 елітних баскетболістів віком від 19 до 23 років (спортивний досвід занять понад 8 років). Вивчалися сенсомоторна реакція, рухливість та врівноваженість нервового процесу, мовна пам'ять, оперативне мислення та загальний інтелект. Усі обстеження включають комплекс комп'ютерної діагностики «Мультипсихометр 05». Також до батареї тестів були включені тести: оцінки актуального психічного стану (за кольоровим тестом Люшера), польової незалежності (за тестом Струпа), мотивації (за тестом Мехрабіана) та агресивності (за тестом Басса-Дарки). За допомогою факторного аналізу одержано основні компоненти психофізіологічних характеристик баскетболістів.

**Результати:** факторна структура психофізіологічного стану елітних баскетболістів включала 4 фактори: нейродинаміку, когнітивні ресурси, енергоінформаційний та емоційно-когнітивний.

**Ключові слова:** нейродинамічні характеристики, когнітивні властивості, елітні баскетболісти, структура фактора.

### Introduction

Modern basketball is very popular all over the world. Basketball requires athletes to quickly determine the effective-

ness of actions in different situations [2, 3]. But athletes must not only fast improve their technical skills. A basketball player

needs to take into account the active actions of the opponent and look for an adequate response [18, 19].

One of the main topics in the training of basketball players is to improve the training system to achieve high sports results [5, 6, 11].

The most important factors of the training process is the functional state of athletes. Among many components, the important properties of the functional state are: physical performance, functional fitness, adaptive capabilities, physical development, level of technical and tactical skill and psychophysiological state [12, 15, 16].

Sports results correlate with the effectiveness of individual approach in the training process of players in sports [4, 12, 17].

Training and competitive activity in basketball is supported by neurodynamics, psychomotor, cognitive, motivational and emotional components [7, 8, 14].

Analysis of current research has shown that a greater number of researchers focus on local characteristics of the functional state of athletes training and competitive activity [9, 13].

However, among modern studies of game sports there are no data on psychophysiological states in elite athletes for different types of control.

The topic of psychophysiological support in game sports is a new and undeveloped area in the system of training athletes [1, 5, 6, 20].

Thus, the development of the system of psychophysiological support of elite basketball players is a very relevant direction of the theory and methodology of sports training.

## Materials and Methods

Written consent was obtained from all athletes before

the procedure to use the results of the study for scientific purposes, in accordance with the recommendations of the Ethical Committee for Biomedical Research and the Declaration of Helsinki Ethics.

Thirteen elite basketball players aged 19-23 years (sports experience of more than 8 years) were examined.

The methodological approach included three blocks of test performance. The first block, "neurodynamics", was used to assess sensory-motor reaction, mobility and balance of nervous processes. The second block, "cognitive", offered indicators of verbal memory (for words), verbal intelligence (pattern identification) and non-verbal intelligence (Raven's test). The third block, "cognitive-activity", included the following tests: assessment of current mental state (Lusher color test), field independence (Stroop test), motivation (Mehrabian test) and aggressiveness (Bass-Darkey test).

Statistical analysis was performed using the computer program STATISTICA 10.0, the level of statistical significance was  $p < 0.05$ .

## Results

During the study we used descriptive statistical and correlation analysis and obtained 42 parameters for each person. When the number of correlations between values was limited, we used the factor analysis method (normalized by Varimax).

Factor analysis revealed informative values from a set of research methods in elite basketball players.

From the total number of values, only informative parameters that include the structure of psychophysiological state of elite basketball players were selected (Table 1).

The value of concentricity (Lüscher color test) indicates rest, pleasure, passivity. In basketball players concentricity has a low level of manifestation ( $Me=4.00$  conventional units). Ac-

**Table 1 Informative values from a set of studies of psychophysiological methods in elite basketball players (n=13)**

Test	Values	Median, Lower and Upper Quartile	CV, %	Level of manifestation
Color test Lüscher	Concentricity, conventional units	4 (3; 6)	56,48	Low
Balance of nervous process	Accuracy, %	2,45 (1,92; 3,59)	43,03	Average
Functional mobility of nervous processes	Dynamism, conventional units	66,23 (62,48; 70,69)	10,79	Average
	Capacity of visual analyzer, conventional units	1,58 (1,53; 1,74)	8,48	Below average
	Limited time of decision making, ms	400 (350; 420)	13,83	Average
Visual motor response	Latent time of response, ms	305,6 (295,5; 315,5)	6,41	Low
Memory on words	Effectiveness, %	75,85 (63,65; 79,47)	18,83	High
Pattern identification	Productivity, conventional units	23 (22;23)	7,38	High
	Accuracy, conventional units	0,92 (0,88; 0,95)	7,15	Above average
	Effectiveness, %	82,8 (74,8; 82,8)	15,7	High
Test Reven	Productivity, conventional units	9 (8; 10)	19,12	Average
	Effectiveness, %	57,46 (47,65; 73,27)	40,17	Average
Personal aggression	Auto aggression, conventional units	2 (1; 3)	74,75	Average
	Aggressiveness, conventional units	12 (10; 14)	21,34	Average

ording to this indicator the group is not homogeneous.

The balance of nervous processes between the processes of excitation and inhibition indicates the state of the nervous system and personality behavior. The accuracy of test performance in elite basketball players appears at an average level and indicates the heterogeneity of the group (CV=43.03%).

Functional mobility of neural processes determines the information processing capabilities of basketball players in limited time. Informative parameters for basketball players: dynamism (CV=10.79%), capacity of visual analyzer (CV=8.48%) and limited time of decision making (CV=13.83%). The analysis shows the average manifestation of these parameters and the homogeneity of the groups.

The study of visual-motor reaction showed low reaction speed (Me=305.60 ms). This indicates that elite basketball players have a low level of speed reaction, but it is sufficient for efficiency.

The study of verbal memory effectiveness revealed of high level of quality of test performance. The variability of memory performance has a high level of manifestation and homogeneity of the group (CV = 18.83%).

The results of the pattern identification test in all athletes showed a high level of productivity, accuracy and effectiveness (CV = 82.8%). Also this group is homogeneous in verbal test.

For the nonverbal test (Raven's test) informative values - productivity and effectiveness - have an average level of manifestation. By the value of productivity the group of athletes is homogeneous (CV=19,12%), and by the value of effectiveness - heterogeneous (CV=40,17%).

According to the obtained results, auto aggression and aggressiveness in elite basketball players indicate an average level of manifestation. This is due to the low level of defense mechanisms in the external environment. The analysis shows that by auto aggression the group of athletes is heterogeneous (CV=74,75%), and by aggression - also heterogeneous (CV=21,34 %).

We obtained four factors with a sum of 62.5% in the main variance (Table 2).

The first factor, with a contribution to the total variance

of 15.1%, combined the characteristics of neurodynamics. The significant parameters of this factor were: accuracy on the nerve balance test (-0.81), the Limited time of decision making on the nerve mobility test (-0.79), and the Latent time of the visual-motor reaction (-0.72). The second factor (14.9%) has more informative values are related to cognitive characteristics: productivity (-0.92), accuracy (-0.81) and effectiveness (-0.89) on the test of pattern identification.

The third factor (14.0%) was associated with peculiarities of psychical state and neurodynamics. The main parameters of this factor are: concentricity according to the Lusher color test (0.77), dynamism (-0.76) and the ability of the visual analyzer (-0.73) according to the functional mobility test. Moreover, both of these tests can have opposite directionality of vectors.

The fourth factor (18.6%) indicates the parameters of intelligence and personal aggression. Informative values in this factor are productivity (0,75) and effectiveness (0,83) by Raven's test, autoaggression (-0,72) and general aggressiveness (-0,74). In this factor, there is an inverse relationship between the properties of intelligence and aggressiveness.

## Discussion

It is traditional to use factor analysis to study the competitive activity of basketball players [5, 6, 16]. But we use this analysis to develop the structure of psychophysiological state related to the effectiveness of technical and tactical actions in elite basketball players.

The obtained results indicate the presence of four factors reflecting the psychophysiological state of elite basketball players. The first factor included indicators of neurodynamics: speed and quality of information processing. In this factor the main personality properties of athletes were observed. These results were consistent with the relevance of information processing fast and accuracy to a player's athletic performance [10].

The second factor is related to the cognitive resources, which determines the abilities of brain activity in decision

**Table 2 Factor structure links among psychophysiological values of elite basketball players (n=13)**

Test	Values	Factor 1	Factor 2	Factor 3	Factor 4
Color test Lüscher	Concentricity	-0,30	0,28	<b>0,77</b>	0,30
Balance of nervous process	Accuracy	<b>-0,81</b>	-0,19	0,11	0,03
Functional mobility of nervous processes	Dynamism, conventional units	-0,06	0,02	<b>-0,76</b>	0,06
	Capacity of visual analyzer, conventional units	0,27	-0,28	<b>-0,73</b>	0,04
	Limited time of decision making	<b>-0,79</b>	-0,13	0,12	-0,45
Visual motor response	Latent time of response	<b>-0,72</b>	-0,20	0,10	-0,56
Memory on words	Effectiveness	0,16	0,04	0,06	<b>0,81</b>
Pattern identification	Productivity	0,01	<b>-0,92</b>	-0,15	0,27
	Accuracy	0,043	<b>-0,831</b>	-0,150	0,327
	Effectiveness	0,04	<b>-0,89</b>	-0,16	0,31
Test Reven	Productivity	0,47	-0,26	-0,20	<b>0,75</b>
	Effectiveness	0,25	-0,09	0,10	<b>0,83</b>
Personal aggression	Auto aggression	-0,10	0,38	0,33	<b>-0,72</b>
	Aggressiveness	-0,01	0,20	0,06	<b>-0,74</b>
Summarize		6,35	6,26	5,89	7,80
obtained of factors with summa, %		15,1	14,9	14,0	18,6

making and effectiveness of tactical and technical actions. The main values of this factor indicate the presence of verbal intelligence in athletes. According to the structure, this factor can be called "cognitive resource". Success in competitive activity is supported not only by functional abilities, but also by motor and sensory activity. One of the main properties to support competitive performance is brain activity, memory, attention and speed of mental problem solving [4].

The third factor was named "energy-informational". The main parameter of this factor is concentricity of psychical energy. This parameter characterizes the necessity of energy accumulation and preservation. Accumulation and preservation of energy provide fast and qualitative perception and information processing of complex visual reactions.

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## Conclusions

The factor structure of psychophysiological state of elite basketball players was revealed. The identified factors can be used to correct the training process of elite athletes.

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