Original Article

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The analysis of psychophysiological features of football players and water sports athletes

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Abstract

Introduction: The purpose of the study was to analyze the psychophysiological characteristics of football players and water sports athletes as factors of professional selection. *Materials and methods*: The study involved students of a specialized sports school (n = 31, age: 16-17 years). The participants were divided into two groups: group 1 – 20 football players, group 2 – 11 water sports athletes (swimming). The level of sportsmanship is 1 category, Candidates and Masters of Sports. Tests applied: determination of the duration of an individual minute (IM), measuring of a 10 cm segment (SM), determination of simple hand-eye coordination (SHEyC), and simple hand-ear coordination (SHEaC), the technique of "Figures memorizing", solution of 10 sums. *Results*: The results of the IM test reflect the prevalence of the earlier test completion. All participants indicated a lower value in 9th test of a segment measuring. The results of the SHEyC and SHEaC of the participants were similar. The results of all tests were less than 10 in the test of "Figures memorizing". Football players revealed link between coordination and psychophysiological tests results, while swimmers revealed link between coordination and sensory type of tests. *Conclusions*: The carried out psychophysiological analysis of athletes' condition of team sports and water sports confirmed the possibility of applying these tests for selection. The results obtained reflect the specific influence of the sport on the athletes' bodies. These indicators demonstrate the increased requirements for spatial orientation, the importance of reaction to auditory stimuli and the increased ability of football players to control the surrounding space and control the game situation.

Keywords: soccer, swimming, athletes, psychophysiological tests, functional state.

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INTRODUCTION

One of the central problems of modern sports science is the provision of effective professional selection. The purpose of this selection is a comprehensive assessment of physical and psychophysiological features by a system of special tests [1]. Psychophysiological selection is an integral part of professional, but it differs significantly from other types of selection. Its main task is to determine the condition, degree of development of these psychophysiological, mental and personal qualities of an athlete. These qualities contribute to the successful mastery and effective use of professional skills. Thus, the effective selection provides a high level of athlete success.

Success in sports is determined primarily by a high level of physical skills, as well as cognitive abilities [2,3]. The review by Russo, Ottoboni [4] examined how martial arts could form the perceived cognitive skills of athletes. The studies revealed better general anticipation skills with real and simulated stimuli and better cognitive functions with regards to attention for experts than novices. Yagotin et al. [5] studied the psychophysiological state of athletes by the objective parameters of psychomotor qualities and functional capabilities of the cardiorespiratory system. Criteria for physical and psychophysiological capabilities are recommended for determining physical activity. Results of Hulsdunker et al. [6] confirm the importance of neural visual processes for the speed of the visual-motor reaction in various sports and age groups. The visual system is an important factor in specific visual diagnostics and training. Korobeynikov et al. [7] emphasize the importance of information processing speed and optimization of psycho-emotional status for success in martial arts. Nikookheslat et al. [8] investigated the anthropometric and physiological profile of the Iranian karate elite. The reaction rate is included in the list of indicators important for success. Podrigalo et al. [9] conducted a comparative analysis of the psychophysiological characteristics of athletes involved in various types of martial arts. It is established the specific influence of the type of fight on the studied indicators. Technical athletes (judo, sambo) demonstrated the best results in such tests as a simple hand-eye reaction, tapping test, selection reaction, line reproduction tests, and conformity test. The worst indicators of endurance sports athletes (Greco-Roman wrestling and freestyle wrestling) indicate that their reaction rate to various stimuli is not a leading predictor of success. Korobeynikov et al. [10] studied the correlation between motivation and psychophysiological indicators in qualified judo athletes. The high level of motivation to achieve success in judo is provided by the activation of neurodynamic, cognitive functions. Volodchenko et al. [11] carried out the comprehensive analysis of the sensory systems' condition of martial arts athletes. The authors confirmed the varying information content of the tests used for different types of martial arts. Participation in the study of athletes with a high level of training can significantly increase the effectiveness of the successful prediction. Nagovitsyn et al. [12] studied the psychological health features, personal development features, and mental "burnout" of various qualifications athletes. Athletes represented the following sports: boxing, martial arts, basketball, gymnastics, swimming, volleyball. It is determined a lot of positive correlations between psychological health indicators and mental "burnout". Thus, the data available in the literature indicate the high information content of using psychophysiological methods for professional selection in sports. It is stipulated the choice of research direction.

The purpose of the study was to analyze the psychophysiological characteristics of football players and water sports athletes as factors of professional selection.

MATERIALS AND METHODS

Participants

The study involved students of a specialized sports school (n = 31, age: 16-17 years). The participants divided into two groups depending on the type of sport: group 1 – 20 football players, group 2 – 11 water sports athletes (swimming). The level of sportsmanship is 1 category, Candidates and Masters of sports.

The study design

The design of the study involved the following battery test: determination of the duration of an individual minute - IM [s], measuring of a 10 cm segment – SM [cm], determination of simple hand-eye coordination – SHEyC [s], and simple hand-ear coordination - SHEaC [s], the technique of "Figures Memorizing", solution of 10 sums. Duration of IM. The participant counts seconds silently (from 1 to 60), starting at the researcher's signal. The participant says aloud the number 60. The stopwatch fixes the time duration. The study repeated 10 times. The duration of IM was fixed. The measurement of the segment. On a piece of paper, someone draws a 10 cm segment. After that without visual control, someone draws the same segment. Its length is fixed. The study repeated ten times. The length of the segment was fixed. The determination of simple hand-eye coordination (SHEyC), and simple hand-ear coordination (SHEaC) were performed using the chronoreflexometry technique. The study repeated 10 times. Reaction rate was fixed. The technique of "Figures memorizing". Participants were shown a table within 30 s with 10 double figures which should be remembered. Participants had to write down these figures after the table was put away. The study repeated ten times. The number of correctly stored numbers was fixed. The result was considered high, when memorizing 10 numbers, above average 7-9, average 5-6 numbers, low 3-4 numbers. The solution of 10 sums. Participants were asked to solve 10 sums with double figures mentally. The percentage of correctly solved sums evaluated. The study repeated four times. The percentage of correctly resolved examples was fixed. The result was rated as high at 90% or more, above average 75-89%, average 50-74% and low - less than 50%.

The design used is a comparison of different sports athletes that is widely used in sports science. A similar design was used by Kolosov et al. [13]. The authors investigated the psychological status of martial arts athletes (boxing), complex coordination (gymnastics), speed-power (discus throwing), and cyclic sports (swimming). It was confirmed that combat and integrated coordination sports are very similar in the specifics of self-confidence expressing.

Bostancı et al. [14] also applied a similar design study. The authors studied the psychological characteristics of athletes in skiing, snowboarding, climbing, automobile and motorcycle racing.
A similar design was used by Krenn et al. [15]. The authors compared the athletes' functional condition in static, interceptive, and strategic sports. Strategic sports demonstrated advantages over static sports in average reaction time, cognitive shifts and to a certain degree of working memory.

The methodological method used is the repetition of the same tests is also common in sports research. Finkenzeller et al. [16] emphasize that the repeated performance of one test or functional test is widely used in sports practice to analyze the dynamics of the athletes' functional condition. Similar results are reported by Nguyen et al. [17]. The results confirm that athletes could demonstrate the improved reaction time in testing repetition. Korobeynikov et al. [18] used a battery of sequentially performed tests: simple hand-eye coordination; reaction to a moving object; the speed of perception; assessment of the emotional excitement scale. The authors studied the role of visual perception in information processing and its connection with emotions in elite Greco-Roman wrestlers. Romanenko et al. [19] conducted a repeated study of the choice reaction with a parallel study of heart rate. It is confirmed the specificity of the sport's influence on the functionality. The athletes demonstrated productivity and improved results in the process of performance.

Statistical analysis

Licensed MS Excel carried out statistical analysis of the obtained data. It was determined the indicators of descriptive statistics: arithmetic mean, standard deviation, and mean error. The parametric Student's test (t) and the nonparametric Rosenbaum's test (Q) evaluated the significance of differences in the groups. To verify, whether there are correlation between tested variables, Spearman Correlation Test was used.

RESULTS

The results are shown in figure 1-4 and contain in table 1. The results of the IM test reflect the prevalence of earlier completion of the test (figure 1). Football players in 5 tests out of 10 finished it earlier than necessary, in 3 tests – later and in 2 tests were close to the exact result. This trend more expressed in swimmers. In 6 tests out of 10, they finished the score earlier. The number of later completions of the test was the same in the football players. Swimmers performed the test exactly only in the 1st test.

There are some differences in the comparison of groups' results. The swimmers' results were significantly higher in the 5th IM test (Q = 7, $p < 0.05$). All participants indicated a lower value in 9 tests of the segment measuring (figure 2). A value higher than necessary was indicated in the 1st test.

The analysis of the results reflects the different orientation of segment measuring in different groups. Football players started with an increased segment in comparison with the standard one (10 cm) and subsequently gradually approached the desired result. Starting from the 6th test, deviations in the segment's length are hundredths of a percent, which allows us to consider them close to the standard. The error in the average value of the test was 1.2%.

Swimmers demonstrated much worse results. The error in the first tests was 30–40%, gradually decreasing as the test is performed, to 2–3% in 5–7 tests. On the 8th test, there was an excess of length relative to the standard. The last tests were lower than the standard. The average test result was 10% less than the standard.

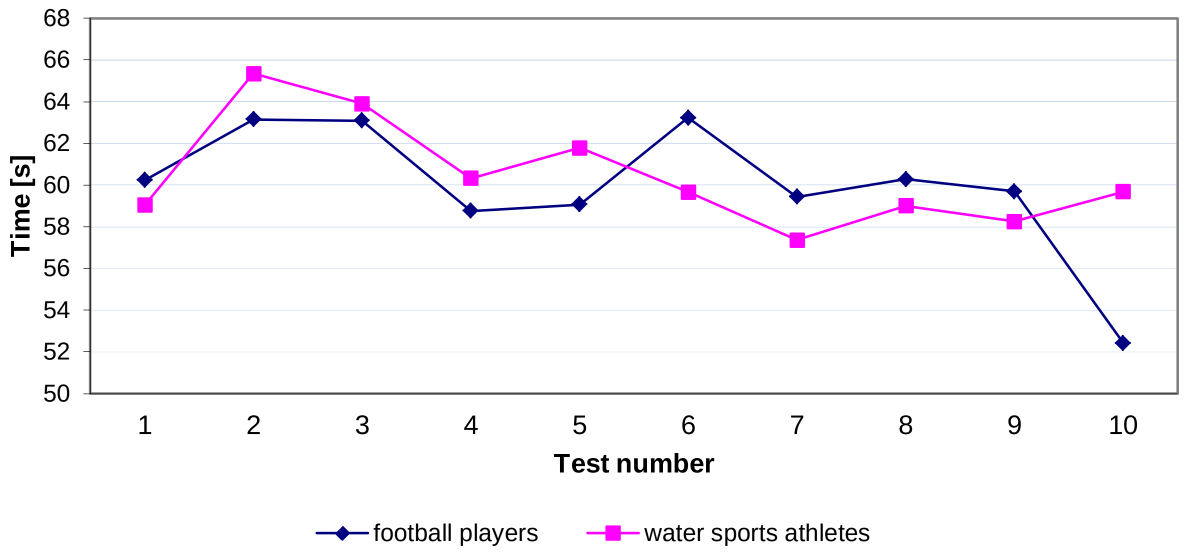

Figure 1. Results duration of IM of football players and water sports athletes.

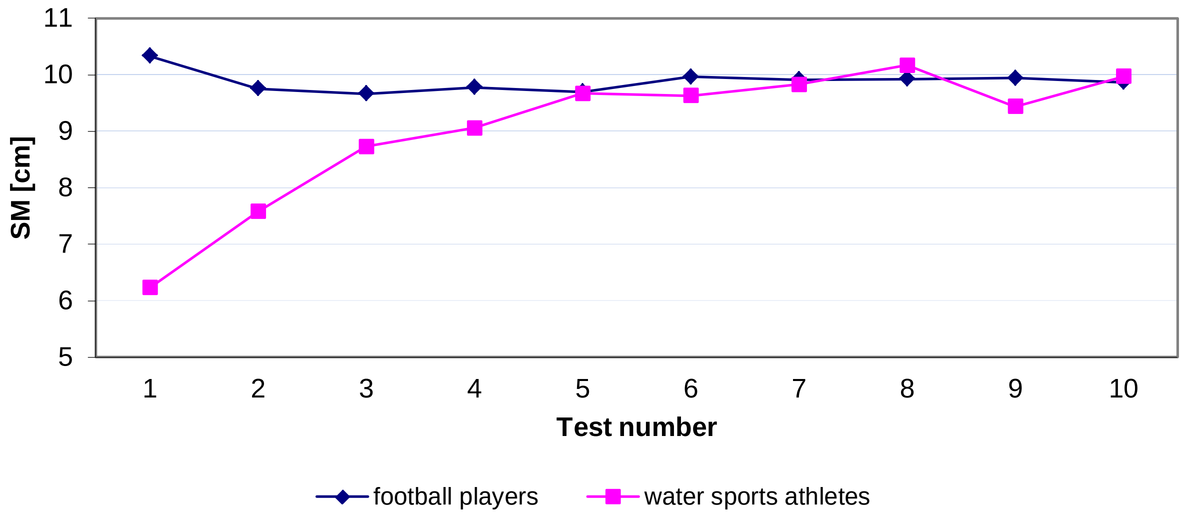

Figure 2. Results measuring of segment of football players and water sports athletes.

Significant differences between the groups established during this test. The values were significantly lower in the football players in the 1st, 2nd tests and the average result. Student's test was, respectively, 6.14, 4.15 and 3.78, ($p <0.05$). The use of Rosenbaum criterion confirmed significant differences in 1st test (Q = 16), 8th test (Q = 7) and average test performance (Q = 14).

The results of SHEyC in participants were similar (figure 3). In group 1 the results were (0.22 ± 0.01) s, in group 2 – (0.23 ± 0.01) s. A similar trend was in SHEaC (figure 4). The results of group 1 were (0.19 ± 0.02) s, group 2 (0.20 ± 0.01) s. The differences in SHEyC found out in 3rd test (Q = 7), 9th test (Q = 8) and 10th test (Q = 7). The reaction rate was better in swimmers in the 1st test, in other tests – in football players.

The results of the football players were better in performing 3rd SHEaC test (Q = 9). They also have the best results on the average performance of this test (Q = 8). In the test of figures memorizing, the results of all tests were less than 10 (table 1). Significantly worse results were demonstrated by swimmers in performing 2nd tests (t = 6.39).

The football players demonstrated quite low results in 1st and 2nd tests of the solution of sum, 3rd and 4th tests approached the maximum possible result. The swimmers had quite high results only in the 3rd test. It was confirmed a significant excess of the results in 3rd tests by football players (Q = 8).

Analysis of correlation between average values of each obtained results for tested variables of football players group reveals that there is strong correlation between results of SHEyC and SHEaC (r = 0.775). Moreover, there are moderate negative correlation between SHEaC and figures memorizing 9 r = -0.524) and moderate positive correlation of solving sums test with both SHEyC and SHEaC (respectively, r = 0.464 and r = 0.523) (Table 2).

Analysis of correlation between average values of each obtained results for tested variables of water sports group reveals moderate correlation between SHEyC and SHEaC tests (r = 0,682). Moreover, on contrary to group of football players, there were no correlation between coordination skills and psychophysiological tests, but with the sensory tests. There was moderate negative correlation between results of IM and SHEaC (r = -0,59) and between SHEyC and 10 cm segment test (r= -0.656) (Table 3).

Table 1. Results of psychophysiological testing of football players and water sports athletes

Indicators	1 group, n=20	2 group, n=11
Figures memorizing, 1st test, abs	6.89±0.39	5.75±0.80
Figures memorizing, 2nd test, abs	8.11±0.34	5.63±0.18*
Figures memorizing, 3rd test, abs	6.56±0.68	5.13±0.40
Figures memorizing, 4th test, abs	6.78±0.40	6.13±1.03
Figures memorizing, 5th test, abs	6.78±0.53	5.88±0.48
Figures memorizing, 6th test, abs	6.44±0.51	6.00±0.78
Figures memorizing, 7th test, abs	6.56±0.50	6.38±0.68
Figures memorizing, 8th test, abs	6.33±0.45	4.88±0.61
Figures memorizing, 9th test, abs	6.00±0.66	4.75±0.56
Figures memorizing, 10th test, abs	7.11±0.38	6.63±0.53
Figures memorizing, average value, abs	6.76±0.42	5.71±0.42
Solving sums, 1st test, %	68.89±10.62	76.67±14.10
Solving sums, 2nd test, %	57.78±11.33	45.56±16.60
Solving sums, 3rd test, %	98.89±2.40	93.33±8.31
Solving sums, 4th test, %	93.33±5.72	77.78±13.86
Solving sums, average value, %	79.72±9.22	73.33±14.74

* – differences between groups are significant according to Student's test ($p <0.05$).

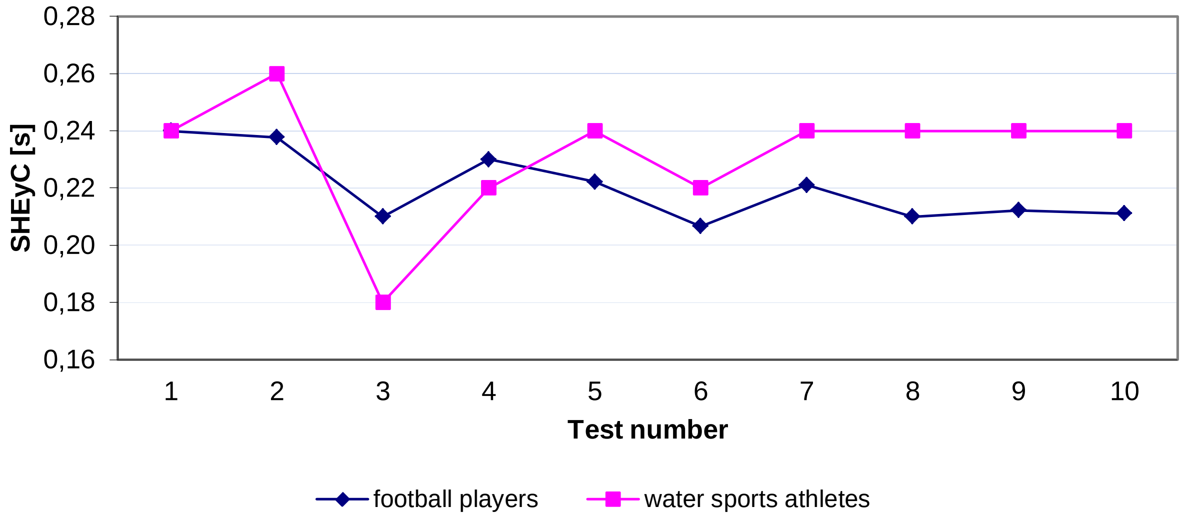

Figure 3. Results SHEyC of football players and water sports athletes.

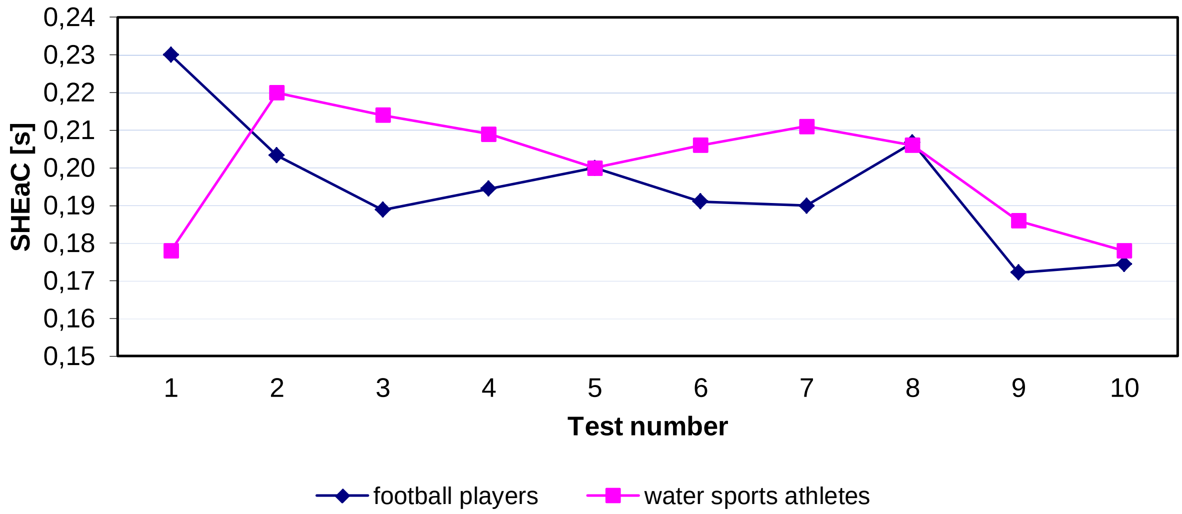

Figure 4. Results SHEaC of football players and water sports athletes.

Table 2. Spearman Correlation Matrix of tested variables for group of football players (n=20).

Variable	Football players					
	IM	10 cm	SHEyC	SHEaC	Figures memorizing	Solving sums
IM	-	-0.023	-0.225	0.057	-0.314	0.057
10 cm	-0.023	-	-0.008	-0.005	0.248	0.140
SHEyC	-0.225	-0.008	-	0.775*	-0.391	0.464*
SHEaC	0.057	-0.005	0.775*	-	-0.524*	0.523*
Figures memorizing	-0.314	0.248	-0.391	-0.524*	-	-0.102
Solving sums	0.057	0.140	0.464*	0.523*	-0.102	-

* – significance level ($p < 0.05$).

Table 3. Spearman Correlation Matrix of tested variables for group of water sport players (n=11).

Variable	Water Sport Players					
	IM	10 cm	SHEyC	SHEaC	Figures memorizing	Solving sums
IM	-	0.049	-0.491	-0.590*	0.171	0.384
10 cm	0.049	-	-0.656*	-0.403	-0.155	0.195
SHEyC	-0.491	-0.656*	-	0.682*	0.006	-0.208
SHEaC	-0.590*	-0.403	0.682*	-	-0.126	-0.318
Figures memorizing	0.171	-0.155	0.006	-0.126	-	0.041
Solving sums	0.384	0.195	-0.208	-0.318	0.041	-

* – significance level ($p < 0.05$).

DISCUSSION

The analysis of the psychophysiological characteristics of athletes allows us to evaluate their functional state. This criterion is important as one of the characteristics of health, as well as an indicator that allows us to predict sports success and skills development.

The repetition by participants of the same test allows us to indirectly evaluate their ability to mobilize and concentrate in extreme conditions. The duration of 10 tests is minimal and does not cause the formation of fatigue. It is possible to evaluate the stability and balance of the nervous system of participants by tests that demonstrate the significant differences. The tests used are simple, accessible and atraumatic. This makes it possible to use them in the monitoring of athletes' conditions.

The proximity of the results obtained is noteworthy. There are no significant differences in many of the tests used. In our opinion, this should be interpreted as a reflection of the proximity of the psychophysiological status of the study participants.

The duration of IM is one of the criteria for the endogenous organization of biological rhythms. The creator of this test, F. Halberg, noted that the IM value is a relatively stable indicator in healthy individuals. It characterizes the endogenous organization of time and the adaptive abilities of the body. IM exceeds a minute of physical time in individuals with high adaptive abilities. IM is on average 47.0 - 46.2 s in individuals with low abilities and IM is 62.90-69.71 s for those individuals who adapt well. According to IM, one can evaluate the formation of fatigue.

Analysis of the results allows us to conclude that participants have high adaptive abilities. This is evidenced by the predominance of increased test results. The last test in group 1 was performed with a sufficiently large value of underestimation. This may be indirect evidence of fatigue formation among football players.

The results obtained are close to the data of Koryagina UV [20]. Her research showed that volleyball players, football players, and weightlifters most accurately determined the duration of IM. The skiers, gymnasts, athletes, and skaters undermeasured and basketball players, hockey players, and boxers overmeasured. The magnitude of IM for the soccer players was 62-63 s, for volleyball players 60-61 s, weightlifters 58-59 s. An underestimated result was found among skiers (45-50 s), gymnasts (53-57 s), athletes (52-59 s) and skaters (45-55 s). The increase in the minute was confirmed among basketball players (67-70 s), hockey players (65-68 s) and boxers (61-66 s). The analysis of the data showed that the tendency to undermeasuring the minute interval quite often observed in athletes of standard sports, and tendency to overmeasuring in situational sports.

The comparison of the segment measuring results allows evaluating that football players' orientation in the space is much better than that in swimmers. In our opinion, this is due to the specifics of the sport and coincides with the data of Koryagina UV [20]. Her studies showed that athletes of almost all specializations performed the test for estimating and measuring spatial linear values quite accurately (error values within 15%), the exception was skiers, wrestlers and non-sportsmen: their error values were 20-60%.

The evaluation of the reaction rate to various stimuli is a traditional indicator of athletes' functional state. These tests are widely used in the athletes' condition monitoring [21,22].

Crowe et al. [23] determined the importance of the fastest reaction in racing sports. Recently, it was suggested that traces of previous temporal durations drive temporal preparation performance rather than the traditional explanation that performance is related to the currently perceived hazard function. Hulsdunker et al. [6] conducted the study of badminton athletes. The authors showed that the time of the hand-eye coordination substantially depends on the speed of perception and processing of the visual signal in the system of visual movements of the brain.

The results of the reaction rate evaluation show that the athletes of both groups have high rates in these tests. This is due to the specifics of these sports, in which a quick reaction largely determines success. The best indicators of SHEaC in football players reflect a predominant focus on the auditory stimulus in a game sport. The analysis of the reaction to a light stimulus shows that swimmers react better at the beginning of the test, and football players react better at the end of the test. It also reflects the specifics of the sport. In swimming, there is no need to maintain a constant tension, the athlete should be ready for a quick starting reaction. In-game forms, the tension is almost constant, so this psychological load is common for athletes.

Zouhal et al. [24] obtained close results. The authors used the determination of the reaction rate to a visual stimulus as a criterion of football players training effectiveness. This test allows you to assess indirectly the skill and coordination of players. Schmidt et al. [25] used the reaction rate as an indicator of the quality of attention of football referees and their assistants. The analysis of the reaction rate against the background of a standard functional test reflects the ability to act in conditions of constant stress.

The results of Koryagina UV studies [20] showed that boxers, then in increasing order by weightlifters, football players, and athletes, demonstrate the shortest time for a simple sensorimotor reaction to light. The highest values of the simple sensorimotor reaction time to light observed in volleyball players and weightlifters. The study of the simple sensorimotor reaction time to sound showed the best values for this indicator in football players, then in increasing order in weightlifters, skaters and boxers, then hockey players, athletes, volleyball players, basketball players, wrestlers, non-sportsmen, skiers, weightlifters, and gymnasts. The author showed that for athletes of all specializations, the time of a simple sensor motor reaction to sound was in the range from 0.24 to 0.33 s, and the time of a simple sensor motor reaction to light was from 0.29 to 0.37 s. The values of the sensor motor reaction time to sound in athletes of all specializations were longer, than the values of the time of a simple sensor motor reaction to light. In absolute terms, our results are close to those given by Koryagin [20]. Our SHEaC results were better than SHEyC, which does not coincide with the data of the indicated author.

In analyzing the figures memorizing test in football players, 8 tests determined the average value of memorization (5-6 figures) and 2 tests determined a low result (3-4 figures). The significantly worse results of the participants of group 2 explained by the lack of the need to memorize objects during swimming. In-game types, this is quite an important indicator. It reflects the ability of football players to control the environment and control the game situation.

Analysis of the test for solving sums allows us to conclude that this task was quite difficult for all participants. The dynamics of the test reflect different responses to mental stress. For football players, 1st and 2nd tests, reflect involvement in the work, and 3rd and 4h tests illustrate a high level of mental performance. Swimmers do not have a clear separation of the phases of mental performance. This distribution of results suggests difficulties with concentration.

Obtained results from correlation analysis clearly indicates link between each coordination tests results for two tested groups. This indicates internal validity of those test application used alongside each other. Moreover, football demands different type of information processing, linked to better solving psychophysiological tests, which was confirmed by significant correlation between results. On the other hand, swimming and water environment stimulates strongly self-perception of a body, and this phenomena was confirmed by correlation between coordination tests results and sensory testing like 10 cm segment.

CONCLUSION

The psychophysiological analysis of the athletes' condition of team and water sports confirmed the possibility of applying the used tests for selection. The methodical techniques used allow us to estimate the adaptation capabilities condition and its dynamics under the influence of loads. The closeness of the results reflects the closeness of the psychophysiological status of the study participants. The analysis of the IM results leads to the conclusion that the participants have rather high adaptive abilities. The results obtained reflect the specificity of the impact of the sport on the athletes' body. So, the players had better results in segment measuring, better performance on the SHEaC, higher results in figures memorizing in comparison with the swimmers. These indicators illustrate the increased requirements for spatial orientation, the importance of reaction to auditory stimuli and the increased ability of football players to control the environment and manage the game situation. The analysis of the reaction to the light stimulus shows that at the beginning of the test swimmers react better, and at the end - the players. This reflects the need for a quick start reaction for swimmers. The tests used are simple, accessible, informative and atraumatic. This makes it possible for them to be used in monitoring the current status of athletes.

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