

Original Article

Special aspects of psycho-physiological reactions of different skillfulness athletes, practicing martial arts

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Abstract

Purpose: to study psycho-physiological reactions of different skillfulness martial arts athletes.

Material and methods: in the research the following martial arts athletes participated: (n=51), karate, thae-quan do, hand-to-hand combat, MMA. The athletes were divided into two groups: 1st group (n=16, average age 15.53±0.2 years); skillfulness level – 1st category; 2nd group (n=35, average age 23.00±0.21 years) – experienced athletes. We used the tests, which were intended for assessment of simple motor abilities, chrono-reflex metering, tapping test, reactions of choice and recognition and reproduction of geometric figures.

Results: we proved better functional state of 2nd group athletes. They demonstrated greater quantity of touching in test for simple motor abilities and less quantity of mistakes. They quicker responded to simple and differentiated irritators; they were able to keep up the pre-set pace for longer time. Experienced athletes reproduced line quicker and with less deviation from pattern. The 1st group athletes had more correlations with age.

Conclusions: we determined distinctions of psycho-physiological reactions of different skillfulness martial arts athletes. We also confirmed better functional state of experienced athletes. Greater quantity of touching, results of simple visual motor reaction mean better fitness and higher workability. Better results in tests for differentiated irritators show higher readiness for actions in extreme conditions. Experienced athletes demonstrated better ability to keep up the pre-set frequency of blows and kicks. They have better condition of motor analyzer and fine coordination of hand muscles. 1st group athletes have higher imbalance of adaptation. It permits to prognosticate the tension of adaptation. Analysis of dependences on age, value and hierarchy of contribution in system's formation permitted to mark out the most important indicators for prognostication of successfulness. They are: condition of mobilization readiness and adaptation level; ability to maximal quantity of movements; simple and complex reactions to irritators. Control over these qualities will permit to noticeably increase effectiveness of athletes' training.

Key words: martial arts, athletes, skillfulness level, psycho-physiological tests, correlations.

Introduction

Researches of athletes' functional state are widely used for assessment of sportsmanship and successfulness. This criterion permits to judge about fitness by tests, corresponding to specificities of kind of sports. Lidor, Côté, and Hackfort (2009) stress on importance of measuring, analysis and assessment of physical and motor skills in promising athletes' selection, for individual and team kinds of sports.

Complex, integrative approach is an important principle of testing organization. Balagué, Torrents, Hristovski, and Kelso (2017) note demand in integration of sport science, physiology, bio-mechanics, sociology and other fundamental and applied disciplines. Application of these sciences' methodology in sports permits to raise effectiveness of researches.

MacDonald and Minahan (2016) underline significance of complex usage of tests' batteries for functional state assessment. In rugby assessment of players' attention and motor functions were marked out as important qualities. Results were interpreted, considering reliability of the received data.

Franks, Morrow, and Plowman (1988) note demand in tests' for physical fitness correct selection. Selection of valid tests is the compulsory condition. They shall correspond to principles of theory of measurements; reflect the flow of physiological processes. The same conclusion was made in the work of Plowman (2014). The author studied the problems of organization of children's and adolescents' physical fitness. Objectiveness, informative level and validity of tests were marked out as the main principles of selection. In other researches demand in consideration of the mentioned criteria, when assessing the following, is also stressed on:

- Students' workability (Drogomeretsky, Kopeikina, Kondakov, & Iermakov, 2017; Kozina, Iermakov, Crefu, Kadutskaya, & Sobyenin, 2017);

- Determination of students' health (Arziutov, Iermakov, Bartik, Nosko, & Cynarski, 2016; Korobeynikov, Korobeynikova, Iermakov, & Nosko, 2016; Pryimakov, Eider, Nosko, & Iermakov, 2017);
- Schoolchildren's physical fitness (Bodnar & Kindzer, 2016);
- Children's physical rehabilitation (Nosko, Razumeyko, Iermakov, & Yermakova, 2016; Zastavna, 2016);
- Schoolchildren's somatic health (Ivashchenko et al., 2017; Kamaev, Proskurov, Potop, Nosko, & Yermakova, 2017);
- Junior athletes' readiness for competitions (Boichuk, Iermakov, & Nosko, 2017; Potop, Manole, & Andreyeva, 2014; Potop, Timnea, Mihaiu, & Manole, 2014);
- Healthy life style indicators and behavior of students (Osipov et al., 2016; Radziminska, Weber-Rajek, Lulinska-Kuklik, Kazmierczak, & Moska, 2016).

Study of correlations between the researched indicators is also rather important. Hopkins (1979) analyzed significance of tests' complex for successfulness in basketball. Application of discriminant analysis permitted to mark out the main skills for prognostication in this kind of sports.

Woods, Raynor, Bruce, and McDonald (2015) used tests as predictors of successfulness of different sportsmanship football players. Application of dispersion and regression analysis proved the importance of results for prognostication of successful sport functioning.

Cureton and Warren (1990) offered to work out the standards of fitness on the base of testing results. These standards shall become the base of sportsmanship assessment.

Increase of sportsmanship level reflects in psycho-physiological state. Brétigny, Leroy, Button, Chollet, and Seifert (2011) studied grass hockey players' coordination. They found that grass hockey players of better sportsmanship had higher coordination level.

Seifert et al. (2011) proved that coordination level can be used for prognostication of swimmers' successfulness. Krasich et al. (2016) note, that sensor-motor abilities are of decisive importance in sport, military and other professional activities. It conditions interest to training and testing of such skills. Usage of computer tests' battery proved effectiveness of application of visual-motor functional tests.

The purpose of the present work is to study psycho-physiological reactions of different skillfulness martial arts athletes.

Material and methods

Participants: in the research the following martial arts athletes participated: (n=51), karate, thae-quan do, hand-to-hand combat, MMA - Mixed Martial Arts). The athletes were divided into two groups: 1st group (n=16, average age 15.53±0.2 years); skillfulness level – 1st category; 2nd group (n=35, average age 23.00±0.21 years) – experienced athletes. Distinctions, conditioned by age, are confident (p<0.001), due to different experience of training practice.

The design of the research: we carried out a complex of psycho-physiological tests, for assessment of organism's sensor systems. The tests' battery consisted of 10 functional tests. The results were assessed by 13 indicators.

Simple motor abilities were tested by maximally quick pressing on circles, which arbitrary appeared on screen during 10 seconds. As differentiated irritator, circles of other color appeared and pressing on them was assessed as mistake. The results were estimated by average quantity of touching and reliability – by percentage of correct answers.

Chrono reflex metering implied determination of simple visual motor reaction (SVMR) and simple audio motor reaction (SAMR). In contrast to common methodic we registered the time of button release, instead of button pressing.

Tapping test was carried out as per commonly accepted methodic. We registered total quantity of touching in 6 squares (5 seconds for each square).

Time of choice reaction (TCR) was assessed by the time, spent for choosing of object of pre-set color from five possible.

Reaction to moving object (RMO): the task implied stoppage of object (moving at pre-set speed) in pre-set place. As a result we used the time of discrepancy with correct fulfillment.

Reaction of recognition: it was necessary to fix the moment, when the values of stationary and expanding circles coincide. Result was assessed as in the previous test.

Reaction of choosing the half of screen implied choosing of the half of screen, on which signal appears. The time after signal's appearing was registered.

The test for temp reproduction: it was necessary to repeat the pre-set frequency of more than 80 beats per minute. The time of non coincidence was registered.

The test for line reproduction: it was necessary to draw a line as per pattern; linear deviation and speed of drawing were registered.

The test of shape coincidence: it was necessary to fix the moment, when the size of square started to change. The time of reaction was registered.

Statistical analysis: the received data were processed with the help of licensed electronic tables Excel (2010). We found indicators of descriptive statistic (mean arithmetic, standard deviation and error of mean value) (Costa, 2016). Confidence of differences was determined by Student's t-test and differences were considered confident at $p < 0.05$. For finding of correlations we calculated correlation coefficients by Pearson and built correlation structures (Costa, 2016). Their comparative analysis was conducted with the help of such indicators as specific weight of significant and confident correlations, coefficient of synchronizing labilization (SL) and mean correlation coefficient (MCC). The two latter indicators were calculated by the formulas:

$$SL = [n/N(N-1)] \times 100\% \quad (1),$$

Where n was the sum of all significant correlations, created by every parameter of correlation structure; N – total quantity of the structure's parameters.

$$MCC = \sum r_j / n \quad (2),$$

Where $\sum r_j$ was the sum of all confident correlation coefficients in the structure; n was the quantity of significant correlations.

For determination of correlation structure's component, which makes the highest contribution in creation of correlations we found indicator of system formation (IS) by the following formula:

$$IS = \sum r_j \times n \quad (3),$$

Where $\sum r_j$ – was the sum of all significant correlation coefficients in the structure, created by this indicator;

n – the quantity of significant correlations of this indicator of the structure.

Results

The received results are given in table 1.

Table 1. Results of psycho-physiological testing of different skillfulness martial arts athletes

Indicator	1 group (n=16)	2 nd group (n=35)
Average quantity of touching (abs)	26.46±0.13 ²	26.94±0.05
Reliability (%)	79.95±0.35 ³	82.27±0.14
SVMR (msec)	240.54±1.61 ³	230.23±0.49
SAMR (msec)	200.83±2.78 ³	216.40±0.63
Quantity of touching in tapping test (abs)	207.53±2.20	211.83±1.04
Time of choice reaction (msec)	650.39±4.56 ³	611.94±1.95
Reaction to moving object (msec)	23.25±0.59 ³	19.48±0.19
Reaction of recognition (msec)	273.58±1.45 ³	282.66±0.74
Reaction of choice of half of screen (msec)	377.69±2.49 ³	356.12±1.16
Temp reproduction (msec)	41.98±1.02 ¹	39.22±0.52
Reproduction of line (mm)	0.42±0.01 ³	0.383±0.003
Speed of line drawing (mm/sec)	47.85±8.63 ¹	72.18±1.00
Coincidence of shape (msec)	432.27±79.14	546.21±11.62

Notes: 1 – differences are confident at ($p < 0.05$), 2 – differences are confident at ($p < 0.01$), 3 – differences are confident at ($p < 0.001$), msec –milliseconds.

The data of table 1 prove better functional state of 2nd group athletes. It is witnessed by 10 from 13 indicators. By 2 results there was no significant difference between the groups. By 1st criterion 1st group athletes were better.

Experienced martial arts athletes demonstrated more touching in test for simple motor abilities and less quantity of mistakes. They responded to visual irritator much quicker.

Reaction to audio signal was better in young athletes.

In tests for differentiated reaction experienced athletes also showed better results. They demonstrated higher speed and less deviation from pattern in line reproduction.

In tapping test and test for shape coincidence we did not register noticeable differences between groups.

For determination of correlations between the data we built correlation matrixes and calculated indicators for comparison. Results of correlation analysis are given in table 2.

Table 2. Indicators of correlation matrixes of martial arts athletes

Group	Specific weight of significant correlations (%)	Specific weight of confident correlations (%)	Indicators of synchronization labilization (abs)	Mean correlation coefficient (abs)
1	51.65±12.49	29.67±11.42	18.19	0.44
2	34.07±8.01	24.18±7.24	8.72	0.34

These data permit to assess athletes' functional state by the character of the system's correlations. Specific weight of significant and confident correlations was higher in 1st group. But increase of error did not permit to find confidence of the differences ($p>0.05$).

Coefficient of labilization/synchronization was two times higher in 1st group than in 2nd.

Mean correlation coefficient in both groups related to average values.

Considering dependence of sportsmanship on age, it was interesting to analyze correlations of this criterion. Age IS in 1st group was 25.28 and in 2nd – 0.35. In 1st group we found confident correlations with speed of line reproduction ($r=0.95$) and shape coincidence ($r=0.76$). Significant dependences were found with simple motor test results ($r=0.38$), SVMR ($r=-0.37$), time of choice reaction ($r=-0.38$), reaction of recognition ($r=-0.36$), reaction of choosing the half of screen ($r=-0.42$). In 2nd group we found only one confident correlation with speed of line reproduction ($r=-0.35$).

For assessment of the analyzed criteria's contribution in functional state we calculated system formation indicators. Results are given in fig. 1.

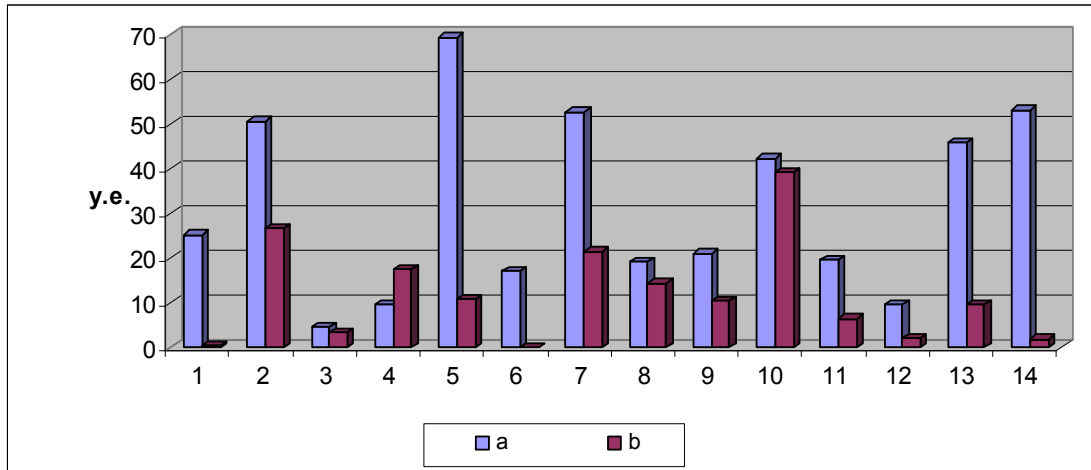


Fig. 1. Indicators of system formation of martial arts athletes' psycho-physiological tests.

Legend: 1 – age; 2 – mean quantity of touching; 3 – reliability; 4 – SVMR; 5 – SAMR; 6 – quantity of touching in tapping test; 7 – time of choice reaction; 8 – reaction to moving object; 9 – reaction of recognition; 10 – reaction of choosing the half of screen; 11 – temp reproduction; 12 – line reproduction; 13 – speed of line reproduction; 14 – shape coincidence; a – 1st group; b – 2nd group; y.e. - conventional units.

Our results show higher contribution of psycho-physiological qualities in successfulness of young athletes. IS value in 1st group varied within 69.38 (SAMR) – 4.44 (reliability of simple motor abilities). In 2nd group the values were much lower. IS changed within from 39.26 (reaction of choosing the half of screen) to 0 (tapping test).

The data analysis permits to mark out definite hierarchy of criteria. In 1st group the highest contribution belonged to SAMR (69.38), shape coincidence формы (53.12), time of choice reaction (52.78), mean quantity of touching (50.58), speed of line drawing (45.94) and reaction of choosing the half of screen (42.23).

In 2nd group the highest contribution belonged to reaction of choosing the half of screen (39.26), mean quantity off touching (simple motor abilities) (26.61), time of choice reaction (21.46) and SVMR (17.42).

Discussion

Effectiveness of functional state analysis depends on informative potential of the used indicators. The main criterion for their choice is consideration of specific aspects of kind of sports. Validity of such approach was proved by analysis of different sportsmanship synchronous swimmers' physical condition (Rovnaya et al., 2016).

For complex assessment of football players fitness anthropometric indicators, functional tests and control over technical skills were used (Fatemeh, Ramin, & Marzieh, 2016; Zerf, 2017). The results of tests were the most informative. It permits to recommend them for control over athletes' state.

Specific of sport activity determines distinctions between wrestlers and impact martial arts' athletes. Iermakov, Podrigalo, and Jagielło (2016) confirmed distinctions in physical conditions of these athletes. As predictors of successfulness strength of grip in dynamic and static modes, arm and forearm's circumferences were determined for wrestlers.

Results of our research permitted to find dependences between functional state and sportsmanship. 2nd group athletes have higher successfulness and sportsmanship. At the same time, 1st group athletes shall be assessed as already having certain sportsmanship and special technical level.

Application of tests' complex permits to increase the quality of analysis of the athletes' state, to standardize the received results. Rayson, Holliman, and Belyavin (2000) worked out the standards for selection of military officers. They were based on tests' combination, which permitted to predict optimal fulfillment of required tasks.

The applied by us tests' complex permitted to find distinctions in functional state of martial arts athletes. Impact martial arts athletes have increased abilities for mobilization, more optimal readiness for actions and developed functions of differentiation (Iermakov et al., 2016).

The used tests reflect specific features of martial arts. Maximal quantity of touching means readiness to realize maximal quantity of movements in certain period of time. For impact martial arts it is rather important indicator. It can be interpreted as ability to make maximal quantity of kicks and punches during minimal time. Higher quantity of touching and reliability of experienced athletes means better fitness as well as better workability: increase of volume of fulfilled work with less quantity of mistakes.

Similar results are provided by Neto, Marzullo, Bolander, and Bir (2013). These authors assessed correlations between speed and accuracy of the made punches/kicks in special test. They proved that more experienced participants had better speed and accuracy.

Speed of reaction in an important factor of success in martial arts. High speed means effectiveness of attacks and defenses. Experienced athletes demonstrated better visual reaction and 1st group athletes – hearing reaction. For success in duels visual sensor system is more important. That is why SVMR results shall be estimated as indicator of better fitness. This result can be interpreted also as indicator of experienced athletes' specialization. Young athletes respond to any irritators. Experienced athletes respond only to irritators, which are important in duel.

Similar results were received by Ridini (1968). The author studied tests' application for athletes' selection. High informative value of reaction speed, visual analyzer's state and technical level was proved. These tests can be used for prognostication of sportsmanship.

Quantity of tapping test touching did not have noticeable differences. It shall be interpreted as stability of nervous system, sufficient mobilization and readiness for actions.

Test TCR (time of choice reaction) illustrates reaction for differentiated irritator. This test implies the participant's being in regime of expectation of taking decision. So, not only quickness of reaction, but correctness of fulfillment shall be registered. This test is important for prediction and selection in martial arts, because it permits to detect not only quick reaction but stable nervous system as well. Better results of experienced martial arts athletes reflect their higher fitness to extreme conditions, i.e. to duel.

Test RMO (reaction to moving object) also is an important for prediction in martial arts. The fulfilled task – stoppage of moving object in pre-set place simulates typical for duel situation. Opponent attacks – it is necessary to respond. The test permits to assess athlete's quickness and ability to control own actions. Significantly better results of experienced athletes illustrate their higher sportsmanship and tactic fitness.

Gierczuk and Ljach (2012) present similar results. These authors used computer tests for assessment of wrestlers' motor skills. On example of Greco-Roman wrestlers they proved informative value of tests for quickness, frequency of movements, space orientation and adaptation for movements.

Reaction of recognition reflects ability for space perception. The received results can be assessed in two ways. May be better results of junior athletes depend of physical growth. At the same time this ability is not very important in martial arts and it conditioned worse result of experienced athletes.

Reaction of choosing the half of screen is one more reflection of activity in extreme conditions. Results unequivocally prove that experienced athletes have better adaptation abilities and mobilization readiness.

Formation of dynamic stereotype is very important for achievement high workability. Just this is the aim of test for temp reproduction. Experienced athletes have better ability to reproduce the pre-set temp. Non coincidences are much less in this group.

The test for line reproduction is intended for fine coordination of hand's muscles. It shows quickness and accuracy of the fulfilled work. Both these criteria were better in experienced athletes. It means that they have better motor analyzer as well as fine coordination of hand muscles than young athletes.

Modern wrestling puts forward very high requirements to motor coordination (Starosta & Fostiak, 2013). This ability is the most important for wrestlers.

The test for shape coincidence also shows ability for space perception. The absence of differences between two groups by results of this test can be interpreted as insignificance of this ability for martial arts.

Potop (2015), Litvinenko et al. (2015) carried out monitoring of junior girl gymnasts' state. The authors found the most important qualities for prediction of girl gymnasts' successfulness. They used anthropometric and physical indicators, tests for coordination and motor analyzer. The tests for coordination were estimated as the most significant for prognostication in gymnastic.

Application of correlation method for assessment of functional state permits to substantially increase the effectiveness of analysis. The presence of correlations between tests' results and successfulness of training reflects its high physiological value (Podrigalo, Iermakov, Rovnaya, Zukow, & Nosko, 2016).

Results of correlation matrixes' analysis permit to assess athletes' functional state as rather similar. The absence of specific weight distinctions in confident and significant correlations permits to consider the level of tension to be practically equal. Jarraya, Jarraya, Chtourou, and Souissi (2014) analyzed correlations between speed, speed-power, coordination abilities and main technical-tactic techniques in handball. The found specific weight of significant and confident correlations was used as criterion of training effectiveness.

CL shows that less experienced martial arts athletes had higher imbalance level. It permits to predict adaptation tension. Comparison of SCC one more proves the assumption about similarity of athletes' functional state. In our opinion the closeness of their state is conditioned by similar sportsmanship level.

Lawton, Cronin, and McGuigan (2014) studied correlations between results of rowers' testing. Importance of mistakes' consideration in tests was proved, especially with little samples of participants.

Analysis of available correlations in respect to age proves less sportsmanship and successfulness of 1st group athletes. More quantity of correlations reflects the process of martial arts athletes' successfulness formation. It permits to mark out the most important qualities. They are: fine coordination, reaction to simple and differentiated irritators. At the same time in 2nd group athletes such system was already formed. It was proved by sportsmanship level of these athletes. That is why the quantity of correlations is much less. The found dependence on speed of line drawing reflects the importance of fine coordination and quickness for victory in martial arts. The presence of reverse dependences between speed values of simple and differentiated reaction and age reflects improvement of these indicators with progressing of sportsmanship.

Dependence of athletes' functional state on age was studied by Baker and Tang (2010). They found distinctions in athletes' functional state. Increase of training experience facilitated reduction of mistakes in tests.

Maximal contribution of SAMR illustrates dependence of young athletes' on coach's instructions. In this case quick responding ensures success. Minimal contribution of reliability reflects not formed completely functional system, dependence of workability on made mistakes.

Experienced athletes significantly differ. The highest contribution of reaction of choosing the half of screen shows high mobilization readiness and sufficient adaptation potential. The absence of significant correlations with tapping test results proves already formed functional system of successfulness. Stability of nervous system at this stage is not very important. It is conditioned by the fact that this parameter already played its role at previous stages of athletes' selection. Analysis of contribution hierarchy confirms the assumptions about importance of separate qualities for different sportsmanship athletes' successfulness. For young athletes it is quickness of reaction to audio signals, reaction to differentiated irritators, ability for maximally quick movements, ability for mobilization and fine coordination of hand muscles. For experienced athletes it is the state of mobilization readiness and adaptation level; ability for maximal quantity of movements, simple and complex reactions to irritators. In case of experienced athletes the system is even simpler. It shall be interpreted as high reliability of the system and proof of its already formed structure. Thus, analysis of the received results permits to mark out the distinctions in athletes' psycho-physiological reactions. Besides prediction of successfulness, the results can be used for health optimization and traumatism prevention. The similar data were presented by Aak (2015). The author underlines motor tests' effectiveness in reduction of wrestlers-beginners' traumatism. He offers screening tests, on the base of which he determined the probability of traumas.

Conclusions

The fulfilled analysis showed distinctions in psycho-physiological reactions of different sportsmanship martial arts athletes. The results prove better functional state of experienced athletes. Increase of touching quantity and reliability, SVMR results mean their better fitness and workability. Better results of tests for differentiated irritators reflect athletes' higher fitness for actions in extreme conditions, i.e. in duel. Results of temp reproduction test show that experienced athletes better keep the pre-set frequency of blows/kicks. Experienced athletes have better motor analyzer and coordination of hand muscles than athletes-beginners.

Results of correlation matrixes' analysis show that functional state of athletes is rather similar. At the same time less experienced athletes have bigger imbalance of adaptation potentials. It permits to predict the state of adaptation tension. Analysis of dependences on age, value and hierarchy of contribution to system's formation permitted to mark out the most important for success prediction indicators. They are: mobilization readiness and adaptation level, ability to maximal quantity of movements, simple and complex reaction to irritators.

Periodical control of these qualities will permit to substantially increase effectiveness of athletes' training.

Conflict of interests

The authors declare that there is no conflict of interests.

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