ORIGINAL ARTICLE

CONTENTS

Dynamic muscular endurance as an indicator of functional readiness of cyber-athletes

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ABSTRACT

Aim: To study the dynamic muscular endurance of hand movement according to the tapping test in connection with the manifestations of cognitive qualities of cyber-athletes and students involved in computer games as a hobby.

Materials and Methods: Dynamic muscular endurance of the right and left hands of the examined subjects was studied (using the tapping test method), as well as the reaction to a moving object using the diagnostic complex "Diagnost-1". Correction tables (Landolt rings) were used to study voluntary attention. 45 students of the National University of Ukraine on Physical Education and Sport of both sexes, aged 17-26, took part in the study, among whom 10 are cyber-athletes (sports experience of 1-10 years), 15 amateurs (involved in computer games as a hobby) and 20 students who do not play computer games (control group).

Results: In cyber-athletes and students involved in computer games, the dynamic muscular endurance of the movement of the hand of the subdominant hand was greater than in students who did not engage in computer games. A higher level of dynamic muscular endurance for the subdominant hand and less functional asymmetry according to the tapping test scores in cyber-athletes were associated with a more successful performance of the attention test.

Conclusions: A higher level of dynamic muscular endurance for the subdominant arm and a smaller functional asymmetry according to the tapping test indicators in e-athletes can be considered as an indicator of functional readiness.

KEY WORDS: e-sports, tapping test, cognitive qualities

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INTRODUCTION

At the current stage of sports development, eSports acts as a social phenomenon in a broad sense, as it contains common features inherent in other types of sports [1, 2]. Cybersports, or competitive computer games, is a form of competitive activity in which participants (gamers) use their physical and mental abilities to compete in various games in a virtual electronic environment [3]. As is known, the psychophysiological state of athletes is a component of the general functional state [4-6]. The state of psychophysiological functions of athletes in any sports affects the effectiveness of sports activities [7]. Other authors believe that the main factor of successful competitive activity should be considered functional readiness, which indicates the athlete's physical ability to perform specific actions that determine the meaning of his sport [8]. Agreeing with the authors and relying on the provisions of the theory of functional systems and adaptation, it can be assumed that the functional readiness of an e-athlete includes psychophysiological and cognitive components [9].

One of the indicators of the functional state of the body, which characterizes the ability of all links of the motor analyzer for speed and endurance, that is, dynamic muscular endurance (DME), is the maximum pace of hand movement according to the tapping test method [10]. The tapping test technique is widely used in the research of domestic scientists in the modern psychophysiology of sports [10]. At the current stage, considerable attention is paid to the study and development of methodical approaches, which at a high level make it possible to assess the psychological state and functional state of the central nervous system (CNS) of athletes [11]. For now, the study of the dynamic muscular endurance of the movement of the hand using the tapping test method can become the factor that will significantly increase the effectiveness of the training process in eSports.

AIM

The aim of the research is to study the dynamic muscular endurance of hand movement according to the

tapping test in connection with the manifestations of cognitive qualities of cyber-athletes and students involved in computer games as a hobby.

MATERIALS AND METHODS

The work was performed at the Research Institute of the National University of Ukraine on Physical Education and Sport. 45 students of NUUPES of both sexes, aged 17-26, took part in the study, including 10 cyber-athletes (1-10 years of sports experience), 15 amateur students (involved in computer games as a hobby) and 20 students who do not play computer games (control group). In most of the examined, the right hand was dominant. Students were tested during intersessional training. In accordance with the purpose of the work, the dynamic muscular endurance of the right and left hands of the athletes was studied (using the tapping test method). The indicator of functional asymmetry was determined as the ratio of the tapping test indicators for the dominant and subdominant hand (DME1 and DME2, respectively). To determine the maximum pace of movement of the hand, the diagnostic complex «Diagnost-1» (M. V. Makarenko, V. S. Lyzogub) was used.

Correction tables (Landolt rings) were used to study voluntary attention and to assess the pace of psychomotor work, work capacity and resistance to monotonous work that requires constant attention. The results of the test were evaluated by the number of viewed and missed signs with a completion time of 5 minutes. The method allows to determine the level of concentration of attention [12]. The «Three Words» technique was used to investigate the peculiarities of the creative imagination of the examinees [13].

Statistical data processing was carried out using non-parametric statistics methods. Medians and interquartile range (Me [25%; 75%]) were used to describe the sampling distribution. The Mann-Whitney test was used to compare independent samples. Correlation analysis was performed according to Spearman's test.

When conducting research with the participation of students, the legislation of Ukraine on health care and the Declaration of Helsinki of 2000, the directive of the European Society 86/609 on the participation of people in medical and biological research [14].

RESULTS

The examinees were divided into two groups: Group I – cyber sportsmen (n=10) and Group II – amateur students (n=15). The peculiarities of dynamic muscular endurance were studied according to the maximum rate of movement of the hand during 60 s separately for the dominant and subdominant hand in e-athletes and amateur students involved in computer games as a hobby (Table 1).

According to the results of the correlation analysis of the obtained data, DME and functional asymmetry between the dominant and subdominant hand were not related to the age and sports experience of the subjects. In both groups, the DME for the dominant hand was greater than for the subdominant hand ($p<0.01$). However, no differences were found between the selected groups in terms of DME and functional asymmetry (Table 1).

Therefore, the next step was to compare the united group of students involved in computer games (e-sport athletes and amateur students) with the control group (students who do not play computer games) – i.e., III and IV groups (Table 2).

According to the results of the correlation analysis of the obtained data, DME and functional asymmetry between the dominant and subdominant hand were not related to the age and sports experience of the examined groups III and IV. In both of these groups, the DME for the dominant hand was greater than for the subdominant hand ($p<0.01$). A significant difference was found between the III and IV groups of students according to the DME indicator for the subdominant hand and the functional asymmetry indicator (Table 2). In e-athletes and students involved in computer games, the DME of movement of the subdominant hand was greater than in students who did not play computer games. Accordingly, the functional asymmetry between the dominant and subdominant hand in e-athletes and amateur students was smaller than in the control group. No differences were found between the III and IV groups according to the DME index for the dominant hand (Table 2). The obtained data are consistent with the results of previous studies when testing qualified female athletes of game sports: for the subdominant hand, the DME of hand movement was significantly greater in female athletes of the older age group. The asymmetry of the tapping test indicators between the right and left hands in athletes of the older age group was smaller than in athletes of the younger age group [15]. It should be noted that, according to the literature, a decrease in functional asymmetry in experienced athletes indicates optimal training tactics [16], and in cyber-athletes it may indicate a state of functional readiness.

Correlation analysis of the obtained data in the group of e-athletes showed the existence of relationships between the measured indicators of the tapping test and the cognitive indicators of the «Rings of Landolt» and «Creative imagination» tests (Table 3).

Table 1. Tapping test indicators, age and experience of sports training of e-athletes (n=10) and amateur students (n=15), Me [25%, 75%]

Indexes	I group, eSportsmen, n=10	II group, amateur students, n=15
Indicator of dynamic muscular endurance of the movement of the dominant hand, the number of clicks	394,50 [381,00; 404,00]#	399,00 [378,00; 438,00]#
Indicator of dynamic muscular endurance of movement of the subdominant hand, number of clicks	361,00 [341,00; 375,00]	371,00 [349,00; 390,00]
Indicator of functional asymmetry	1,12 [1,03; 1,15]	1,08 [1,04; 1,12]
Age, years	19,00 [18,00; 22,00]	19,00 [18,00; 19,00]
Sports experience (eSports), years	7,00 [2,00; 8,00]	7,00 [6,00; 10,00]
Total sports experience, years	12,00 [8,00; 13,00]	12,00 [8,00; 14,00]

Note: # $p<0.01$ – significant difference between the indicators for the dominant and subdominant hand according to the Mann-Whitney test.

Table 2. Tapping test indicators, age and experience of sports training of e-athletes and amateur students (n=25) compared to the control group (n=20), Me [25%, 75%]

Indexes	III group, cyber sportsmen and amateur students, n=25	IV group, students who do not play computer games, n=20
Indicator of dynamic muscular endurance of the movement of the dominant hand, the number of clicks	399,00 [380,00; 424,00]#	397,50 [375,00; 424,00]#
Indicator of dynamic muscular endurance of movement of the subdominant hand, number of clicks	370,00 [348,00; 389,00]*	355,50 [306,00; 368,00]
Indicator of functional asymmetry	1,09 [1,04; 1,15]*	1,14 [1,09; 1,25]
Age, years	19,00 [18,00; 19,00]	19,50 [18,00; 20,00]
Sports experience (eSports), years	7,00 [5,00; 8,00]	–
Total sports experience, years	12,00 [8,00; 13,00]	12,25 [9,00; 15,00]

Notes: # $p<0.001$ – significant difference between the indicators for the dominant and subdominant hand according to the Mann-Whitney test; * $p<0.05$ – significant difference between III and IV groups according to the Mann-Whitney test.

However, no such correlations were found in the group of amateur students.

The analysis of the research results became the basis for the development of evaluation criteria for the tapping test indicators for cyber athletes (Table 4).

DISCUSSION

The evaluation criteria of indicators can become the basis for creating an express diagnosis of dynamic muscular endurance of hand movement, the functional state of the neuromuscular system of cyber-athletes, and thus allow for a differentiated assessment and management of the training process in this sport.

In our opinion, in the context of eSports competitions, it is important to note that hand movements of the athletes play a key role in the execution of game commands and strategies. Agility and precision of movements can determine the speed and efficiency of an eSports player in the gameplay. This becomes an especially important aspect for those who exhibit a pronounced kinesthetic sensitivity and agility. Their high agility allows them to quickly and accurately react to changes in the game, perform complex combinations of movements and ensure a high level of accuracy when conducting battles or performing other tasks.

Attention appears as an important factor in this context, and it can have different characteristics such as concentration, persistence, volume, distribution, switching, etc. These characteristics of attention are widely studied in various fields of sports psychology [17].

A higher level of DME for the subdominant hand and a smaller functional asymmetry according to the tapping test indicators in e-athletes were associated with a more successful performance of the attention test (respectively, $r = 0.70$, $p<0.05$; $r = –0.69$, $p<0,05$). Also, a tendency was revealed: a greater number of clicks in the tapping test for both hands corresponded to a greater speed of information processing according to the «Landolt Rings» test (Table 3). This fact can be a professionally determined result for cyber-athletes and amateur students, because their subdominant hand works on the keyboard and responds to strategic and tactical tasks, and the dominant hand works with the mouse.

According to the results of research by domestic specialists in the field of physical culture and sports, the tapping test can be used to diagnose the functional state of athletes, as well as specific features of adaptation to stressful situations [18, 19, 20]. DMV of hand movement according to the taping test was related to sports experience in game sports, the state

Table 3. Correlations of the tapping test indicators and cognitive indicators according to the Landolt Rings, Creative Imagination tests in e-athletes (n = 10), r^s

Indexes	Correlations, r^s					
	CL1	CL2	CL3	CL4	CL5	TU
DME 1, number of clicks	–	–	–	0,55	0,61	–
DME 2, number of clicks	**0,82****	**0,67***	**0,70***	0,62	0,62	–
FA, DME 1/ DME 2	**-0,67***	**-0,72***	**-0,69***	–	–	-0,57

Notes: DME 1 – an indicator of dynamic muscular endurance of the movement of the dominant hand; DME 2 – an indicator of dynamic muscular endurance of the movement of the subdominant hand; FA is an indicator of functional asymmetry; CL 1 – the number of symbols viewed in 5 minutes, the «Landolt Rings» test; CL2 – the number of missed symbols in 5 minutes, the Landolt Rings test; CL 3 – success rate, Landolt Rings test, points; CL 4 – an indicator of the speed of information processing, um. unit; CL 5 – information processing speed indicator, points; TU – indicator according to the «Creative imagination» test, points; *statistical significance of correlation coefficient $p<0.05$; **$p<0.01$.

Table 4. Evaluation criteria of tapping test indicators for e-athletes

Indexes	High level	Average level	Low level
Indicator of dynamic muscular endurance of the movement of the dominant hand, the number of clicks	> 404,00	381,00 – 404,00	< 381,00
Indicator of dynamic muscular endurance of the movement of the subdominant hand, number of clicks	> 389,00	348,00 – 389,00	< 348,00
Indicator of functional asymmetry	< 1,03	1,03 – 1,15	> 1,15

of psychophysiological functions of athletes [21], and the level of sports qualification among representatives of speed-endurance sports [22].

For e-athletes engaged in «non-muscular» sports, it is important to consider the role of motor activity in maintaining optimal physical and mental qualities [23]. Despite the lack of physical activity, the presence of sufficient motor activity can affect metabolic processes in the body, contributing to the stimulation of the psychophysical and intellectual capabilities of the individual [23-25].

CONCLUSIONS

1. Based on the analysis of the scientific and methodological literature and the generalization of the practical results of the studies of experts in the psychophysiology of sports and our own research, it was found that dynamic muscular endurance (DME) according to the indicators of the tapping test (the maximum rate of movement of the dominant and subdominant hand) can be used as a model characteristic for monitoring and forecasting the functional state of athletes.
2. A higher level of DME for the subdominant hand and less functional asymmetry according to the tapping test indicators in e-athletes were associated with a more successful performance of the attention test (respectively, $r = 0.70$, $p<0.05$; $r = –0.69$, $p <0.05$). Also, a trend was revealed: a greater number of clicks in the tapping test for both hands corresponded to a higher speed of processing information according to the Landolt Rings test.

PROSPECTS FOR FURTHER RESEARCH

It is interesting to conduct a further study with a correlation analysis between the studied psychophysiological indicators and the results of the competitive activity of cyber-athletes.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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