IMPELLENT REACTION OF THE CHOICE AS THE INDICATOR OF THE FUNCTIONAL CONDITION OF STUDENTS

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Abstract: The urgency of research on revealing overfatigue of students at an early stage is caused by care of preservation of their health and working capacity. Knowledge of the changes occurring in an organism under influence intellectual, emotional and physical activities, influencing on physical and intellectual working capacity, are important for the control over exhaustion of students, that, in turn, will allow to arrange struggle against a developing exhaustion. In given clause opportunities of use of diagnostic testing of a functional condition of the student by means of the special test by definition of time of complex impellent reaction of a choice are considered. In research some techniques of diagnosing of early exhaustion are compared. The estimation of their efficiency on the basis of the statistical analysis of the data received during experiment is given. As a result of carried out research it was possible to define the applied importance of the test for definition of time of complex impellent reaction of a choice in an opportunity of diagnosing of a condition of exhaustion at students at earlier stages. Its efficiency in comparison with a number of other techniques is revealed. Clause is intended for the experts working with students of the internal, correspondence or remote form of training.

Keywords: exhaustion, the control, a degree of exhaustion, impellent reaction, measurement of time of reaction, the computer program.

1 Introduction

Undue fatiguability, especially of mental workers, which undoubtedly include students, leads to nervous overexertion. The condition that has arisen under the influence of the work done and affects the level of efficiency is called fatigue. Subjectively fatigue is felt as a feeling of fatigue, the physiological essence of which consists in signalling the body about the need to stop or reduce the intensity of the work. Fatigue is a complex and diverse phenomenon. In a number of researches (Ilyin, 2005; Leonova & Kuznetsova, 2015; Astrand, 1972; Barht, 1980). fatigue is associated with central inhibition. The intensification of inhibitory processes, which, in the opinion of these authors, occurs under the influence of a powerful stream of proprioceptive impulses from tensely working muscles, and also as a result of biochemical changes in blood, leads to an efficiency decrement. Recognizing the exceptional role of the cerebral cortex in controlling motor and autonomic functions in the process of intense muscular activity, as well as in the development of fatigue, it is impossible to ignore the significance of local factors, i.e., changes in the functional state of the neuromuscular apparatus. The manifestation of the first signs of significant, especially severe fatigue is a biologically necessary protection from the development of exhaustion of the body, a signal to stop a work. A strong-willed effort can force the body to continue working, which will only relieve fatigue or, much more dangerous, lead to a state of overfatigue. Overfatigue can be the result of great physical and mental stress. The consequences of nervous fatigue are illnesses, and above all illnesses of the cardiovascular system.

Thus, fatigue is a consequence of the complex interaction of peripheral, hormonal and central-nervous factors with the leading significance of the latter ones. In the research of fatigue, reaction time indicators are often used. In many researches it has been proved that after prolonged stress loads a significant increase in the simple visual and motor reaction is observed, which in turn is accompanied by a decrease in the accuracy of the task (Ilyin, 2005).

The characteristics of motor reactions in researches are used, among other, to identify the typological features of higher nervous activity, and also to assess the functional state of the organism in norm and pathology (Laszlo & Livesey, 1977; Tamminga et al, 2002; Dorzhu & Ondar, 2018)

The reaction time is one of the most convenient indicators for studying the nervous processes dynamics. The reaction time is the time interval between the presentation of the stimulus (signal) and the beginning of the response of the subject to the signal conditioned by the instruction. The time of the simplest motor reaction, which fixes the fact of the appearance of a signal (the "detection reaction" SMRT [simple motor reaction time]) is in the range of 0.15-0.3 seconds. For complex reactions, the allocation of one of several possible signals (the "distinction reaction" CDRT [complex discrimination reaction time]) or the choice of one of several answers (the "selection reaction" CCRT [complex choice reaction time]) it increases.

We hypothesized that using the test of the definition of CCRT it is possible to diagnose the state of fatigue that occurs to students at earlier stages. To confirm this hypothesis, a research was conducted at the Department of Physical Education and Sports of the Naberezhnye Chelny Institute of FSAEI HPE "Kazan (Privolzhsky) Federal University".

2 Methodology

The response time to the light signal was recorded with the help of the "Reaktiomer-6" program (Bolgov, 2016; Bolgov, 2018). On a computer monitor in a random place, with an asynchronous time delay of 1 to 3 seconds, a visual object is displayed in the form of a color circle. We used techniques with display of one color (SMRT [simple motor reaction time]) and three colors (complex choice reaction time). Depending on the color of the circle, certain keys are pressed on the keyboard. In the first and second tests, 8 attempts are given. It takes into account the average result and the number of errors made during testing (premature pressing of a key or selection of a key that does not match the color of the circle)

The reaction time largely depends on the complexity of the problem to be solved by the subjects. When measuring the complex choice reaction time, Hick's law is manifested (V. E. Hick, 1952) - the experimentally established dependence of the complex choice reaction time on the number of alternative signals. This dependence is expressed by a logarithmic function:

$$RT = a * \log (n + 1)$$

where RT is the average value of the reaction time that averaged over all alternative signals; n is the number of equally probable alternative signals; a is the proportionality coefficient (Hick, 1948).

To track physical fatigue, we used a six-moment trial. The evaluation of the level of performance is made by summing up the six results of the pulse measurement before and after the load.

Special researches have shown that the sum of the results of all researches gives a more reliable estimate than individual researches (Muller et al, 2011). Therefore, this functional test is recommended. It includes: 1. After a 5-minute rest to count the pulse for 1 minute in prone position. 2. Quietly rise up, stand for 1 minute and count the pulse for a minute. 3. Calculate the difference between pulses in prone position and in stand position and multiply this figure by 10. 4. Make 20 full deep squats for 40 sec; during squats, the arms are vigorously lifted forward, and when standing up they are lowered down. Immediately after squats sit down and count the pulse for 1 min. 5. Calculate the pulse within the 2nd minute after the squats. 6. Calculate the pulse within 3 minutes after the squats. 7. Put all the figures together. The aggregate indicator is not constant. It varies depending on the state of health, fatigue and level of fitness. At the same time, for us it was important not the absolute aggregate indicators' value itself, but its changes for the same person. Decreasing in time indicators can mean started overwork.

To further control the students' fatigue, the A. B. Leonov and I.V. Shishkin "Degree of chronic fatigue" method was used (modification - 2003) (Nikanov & Novoztsev, 2003; Villalobos

Antúnez et al, 2013). The questionnaire "Degree of chronic fatigue" is a standardized method of questionnaire type, aimed at revealing the degrees of chronic fatigue. The technique includes 36 statements corresponding to the most typical symptomatology of chronic fatigue, affecting both sensations of physiological and psychophysiological discomfort, and disturbances in the course of various mental processes. For responses of the surveyed, the reduced scoring scale is used: "Yes" (the experience is distinctly expressed, 2 points); "Yes-No" (the experience is expressed ambiguously, 1 point); "No" (the experience is completely absent, 0 points). The qualitative description of the syndrome of chronic fatigue was characterized by the degree of expression of its main components, which is determined by the specific weight of different groups of symptoms in the general index of chronic fatigue:

1. symptoms of physiological discomfort;
2. decreased of overall well-being and cognitive discomfort;
3. violations in the emotional-affective sphere;
4. reduction of motivation and changes in the sphere of social communication.

The main indicator of the implementation of the technique was the index of chronic fatigue (ICF).

In addition to standardized diagnostic tests, the method of individual conversations was used. This method allows the student to reflect those changes that occur in his state of health, general vitality and habitual behaviour in a more free form.

All the obtained test data were subjected to statistical processing using a statistical package for the social sciences of SPSS with the following criteria:

- verification of the normality of the distribution was carried out by the Kolmogorov-Smirnov criterion;
- to test the hypothesis of the difference of two average values, a paired two-sample Students' T-test ($t_{Student}$ = 2,012; when n = 48; a = 0,05) was used.

The experiment involved 48 students at the age from 17 to 20. Measurements of the reaction and a six-moment trial were made at the beginning of physical education classes in the last week of September and December (Tuesday and Friday). A of 192 measurements were made in total. The survey on the method "Degree of chronic fatigue" was conducted once in late December.

3 Results and Discussion

The results of the six-moment trial. At the end of December, only 6 students recorded a significant deterioration at the level of $p < 0.05$ in the absolute total score. Thus, it can be assumed that only 12.5% of students from the total number of the experiment participants have signs of physical fatigue.

Measurement of the complex choice reaction time. The students' complex choice reaction time was differed insignificantly from the TR obtained by Hick's formula (an average of +0.03 sec). At the same time, in September the result was better for 38% of students instead of calculated one in December - only 25%.

Checking the test results with the Kolmogorov-Smirnov test showed that all the data obtained during the measurement of the reaction time correspond to the normal distribution (Z Kolmogorov-Smirnov statistics from 0.62 to 0.82 for $p>0.7$).

Statistical analysis of the data revealed a significant increase in the CCRT at the end of the week in September and December. At the same time, there was no significant difference between the SMRT (see Table 1). It is indicative that in December the deterioration of the CCRT on Friday, in comparison with Tuesday, was observed for 62% of the students, and in September – only for 38%. In December, along with the increase in the CCRT, the number of errors (up to 17) increased sharply (see Table 1).

Table 1. The results of the study of SMRT and CCRT for students (M ± m), n=48

Reaction type		September	December
SMRT (sec)	Tuesday	0,290 ± 0,035	0,298 ± 0,044
	Friday	0,287 ± 0,037	0,301 ± 0,05
	$t_{Student;}$ p	1,158 ; p=0,252	1,890; p=0,065
CCRT (sec)	Tuesday	0,630 ± 0,071	0,647 ± 0,074
	Friday	0,645 ± 0,085	0,662 ± 0,082
	$t_{Student;}$ p	2,721; p<0,01	4,965; p<0,01
CCRT errors (total)	Tuesday	4	6
	Friday	7	17

We assume that the accumulated fatigue is reflected in an increase of the speed in the complex choice reaction with a simultaneous increase in the number of errors. If during the September testing the number of errors at the end of the week increased slightly, then the error growth rate in December is significant (see Table 1). Thus, for 68% of students from the total number of the experiment participants were found signs of fatigue in CCRT terms.

In individual interviews, all students who had a deterioration of results in the December testing complained about the deterioration of well-being.

According to the results of the questionnaire "Degree of chronic fatigue", the index of chronic fatigue was calculated (ICF).

Calculation formula:

$$ICF = (\sum onDS) - (\sum onRS) + 12$$

where ∑onDS is the sum of points for the questionnaire - Direct statements (30 questions); ∑onRS is the sum of points for the questionnaire - Reverse statements (6 questions); 12 is the correction factor.

To make a diagnostic judgment about the degree of chronic fatigue, the following grades of ICF are used:

≤ 17 points - No signs of chronic fatigue

17 < ICF ≤ 26 points - Initial degree of chronic fatigue

26 < ICF ≤ 37 points - Expressed degree of chronic fatigue

37 < ICF ≤ 48 points - Strong degree of chronic fatigue

By the results of the questionnaire analysis, ≤17 points were scored by 37 students (77%). In the range of 17-26 points - 10 students (21%) and more than 26 points - 1 student (2%). In

other words, the fatigue was revealed in 22% of students from the total number of the experiment participant.

4 Summary

The methods of fatigue diagnosing presented in the research showed different results of fatigue detection for students at the end of the semester. A six-moment trial revealed signs of physical fatigue for 12.5% of the students from the total number of the experiment participants, the " Degree of chronic fatigue" questionnaire identified fatigue for 22% of students, and 68% of students reported of fatigue by the CCRT.

5 Conclusions

We suppose that using the test of the definition of the CCRT it is possible to diagnose the state of fatigue that occurs to students at earlier stages. To combat the developing of the fatigue, it is possible to recommend a temporary decrease of the capacity of the physical and mental load.

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