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The Influence of Study Load on the Functions of the Visual Sensory System of Students

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ABSTRACT

In the conditions of higher professional education, great demands are placed on the health of students. The introduction of computer technologies into the learning process, the constant increase in the diverse information flow, the social conditions of students' life cause a significant strain on the mechanisms of adaptation of the body. This is clearly observed in first-year students who find it quite difficult to adapt to new educational and social conditions. The need to study a significant number of literary sources, prolonged work at the computer and the use of various electronic gadgets has a negative impact on the visual analyzer, causing its overstrain and further leading to a decrease in the quality of vision. Accordingly, the search for ways to eliminate or minimize the negative impact on the visual analyzer is relevant and the relevance will only increase over time, as electronic systems, computers and various gadgets are increasingly actively used.
The aim of the study is to determine the impact of the educational load on the functions of the visual sensory system of students.
The results of the study proved that the visual sensory system is an indicator of mental fatigue during training sessions. The natural process of adaptation stabilizes the functional state of the visual sensory system and causes less changes.
The results of the study can be used in the planning and organization of the educational process in educational institutions.
Key words: *Study load, Visual sensory system, Functional state, Students*

INTRODUCTION

Maintaining the level of health is one of the most important problems for students and the university, as the preservation of the contingent is one of the conditions of the government order for the training of specialists. One of the significant reasons for the low adaptive capacity of freshmen is poor physical fitness and an unsatisfactory state of health of freshmen [1-4].
Perception of information, its primary processing, and memorization depend on the properties of nervous processes and the activity of the visual sensory system, which perceives 95% of all incoming information. This position is confirmed by the research [5, 6], where it has been found that the main thing in the perception of information and performance of accuracy of operative movements belongs to "urgent visual perception".

The research has shown that a high level of activity of the visual sensory system provides instant and accurate reorganization of any mental and motor activity [7-10].
Academic loads during the day affect, first of all, the visual sensory system. That is why the study of the influence of study load on the functions of the visual sensory system was the purpose of the research.

MATERIALS AND METHODS

Participants
First-year students of Kursk State Medical University and Moscow Polytechnic University (n=395) young men and women aged 17-18 years participated in the study.

Procedure
Determination of the functional state of the visual sensory system was carried out before the beginning of the class and after it. Using the ADM-2 adaptometer, the number of difference thresholds of relative sensitivity, increase in the brightness of the luminous flux, and dark adaptation were determined. In addition, the threshold of remote vision was measured with the help of Best's device according to the method of Zaksenveger. To characterize the state of mobility of nervous processes latent tension time (LTT) and latent relaxation time (LRT) of muscles were recorded [11, 12].

RESULTS AND DISCUSSION

The study of LTT and LRT characterizes the inhibitory-excitatory processes of the central nervous system (CNS), which predetermine the speed of perception of information coming from sensory systems [4]. Dynamics of NMSI of the visual system of students presented in **Table 1**.

Table 1. Dynamics of LTT and LRT indicators (ms) of students

Indicator	Stages of education	Measurement intervals	M±m	max	min	V, %
LTT	At the beginning of the semester	Before the first class	153,8±2,09	174,3	136,4	16,1
		After the first class	179,9±1,74	193,2	165,6	14,3
		Before the second class	162,5±1,93	180,3	148,5	10,5
		After the second class	181,5±1,75	195,5	166,7	14,2
		Before the third class	175,7±0,98	199,3	172,4	10,8
		After the third class	203,7±3,54	240,6	185,4	19,6
	At the end of the semester	Before the first class	156,6±0,78	175,3	140,3	14,7
		After the first class	177,3±1,52	193,4	165,7	14,8
		Before the second class	168,8±0,87	188,3	156,4	18,5
		After the second class	178,3±1,27	198,5	165,3	27,8
		Before the third class	168,4±0,78	195,5	168,8	8,82
		After the third class	195,5±1,78	207,3	177,5	28,7
LRT	At the beginning of the semester	Before the first class	301,5±2,2	330,5	283,4	17,7
		After the first class	330,7±0,95	340,5	285,7	8,8
		Before the second class	299,3±1,15	338,7	288,6	7,8
		After the second class	335,7±2,17	380,5	298,3	8,3
		Before the third class	310,8±2,05	345,3	288,4	7,7
		After the third class	344,6±2,13	360,8	285,6	7,9
	At the end of the semester	Before the first class	297,4±1,72	338,5	278,6	7,3

	After the first class	317,4±1,53	340,8	268,6	7,5
	Before the second class	301,7±1,27	336,4	278,5	7,9
	After the second class	320,4±2,17	338,5	288,3	8,2
	Before the third class	305,8±1,38	235,6	280,7	8,05
	After the third class	328,5±1,57	238,6	275,6	8,3

The research materials show that freshmen have reliable changes in the indicators of LTT and LRT after each class. Thus, after the first class, the index of LTT increased by 16.6%, after the second class by 11.5%, and after the third class by 16.8% (P<0.05). It is worth mentioning that during breaks between classes, the index of LTT tends to recover. However, with the accumulation of general fatigue, a reliable increase is observed. The most significant increase in the LTT indicators is observed after the third class, which with the initial level is 37.8% (P<0.001). The lengthening of LTT is also characterized by significant changes in intragroup indicators of the difference between maximum and minimum values. Thus, after the first class, the difference was 28.6 ms, after the second class – 32.4 ms, and after the third class – 55.2 ms (P<0.001) [13].

At the end of the term, there is a tendency to decrease the index during the academic day, which is explained by the natural adaptation of students to study loads. Thus, after the first class, the index of LTT increased by 9%, after the second class by 7.8%, and after the third class by 11.2% (P<0.05). Improvement of adaptation mechanisms contributed to a decrease in the intragroup difference between the maximum and minimum values of LTT. After the first class, this difference was 22.6 ms, after the second – 35.2 ms, and after the third – 40.6 ms (P<0.001).

By analyzing the indicators of LTT it can be seen that they reliably increase during the academic day. At the beginning of the semester, there is a reliable increase in LRT after the first class by 9.3%, after the second by 12.5%, and after the third by 10.9% (P<0.05). At the end of the semester, the dynamics of the indicators stabilize and the difference between the indicators before and after classes decrease. After the first-class LRT increases by 4.2%, after the second – by 4.5%, and after the third – by 7.5% (P<0.05) [14].

By analyzing the dynamics of LRT indicators it has been found that intragroup indicators between maximum and minimum values reach from 50 ms to 75 ms (P<0.001), which indicates that students are not sufficiently capable of rapid muscle relaxation. This fact causes fatigue while holding a sitting posture during the academic day.

An indicator of the functional activity of the visual sensory system is the number of minimal sensations of increasing brightness of the luminous flux. Accumulation of physical (immobile maintaining a sitting posture), mental and emotional fatigue causes a decrease in the number of minimum sensation increments (NMSI) of students [15].

It is found that after the first class, NMSI decreased by 22.8%, after the second class – by 15.8%, and after the third class – by 18.6% (P<0.05). Significant stress during the perception of visual information breaks photochemical processes in the receptor apparatus of the eye, which causes a decrease in its distinctive abilities.

Table 2. Dynamics of NMSI of the visual system of students

Stages of education	**Measurement intervals**	**Threshold number M±m**	**max**	**min**	**V, %**
At the beginning of the semester	Before the first class	22,01±0,6	26,3	17,2	11,7
	After the first class	17,6±0,3	22,3	14,2	7,8
	Before the second class	19,5±0,5	23,4	15,3	8,6
	After the second class	16,3±0,7	21,4	14,7	10,4
	Before the third class	18,4±0,3	21,4	15,5	11,1
	After the third class	14,0±0,2	18,5	10,6	12,3
At the end of the semester	Before the first class	23,7±0,5	27,5	17,4	8,7
	After the first class	19,3±0,6	26,8	15,3	10,7
	Before the second class	22,1±0,4	25,6	18,2	11,8

	After the second class	18,9±0,5	24,3	16,8	10,5
	Before the third class	18,8±0,5	23,6	17,4	8,5
	After the third class	16,6±0,3	23,8	15,4	12,3

There is a significant increase in intragroup variability towards the end of the academic day, which is connected with an increase in the difference between the maximum and minimum values of the NMSI. While after the first class, the difference between the maximum and minimum values was 34.8%, after the third class it was 55.6% (P<0.001) [16].

At the end of the semester, there is a certain tendency towards stabilization of NMSI, which indicates an increase in the general adaptation of students to study loads. It has been found that after the first class, NMSI decreased by 14.2%, after the second class by 16.7%, and after the third class by 17.4% (P<0.05).

Dark adaptation is an indicator of the mobility of the receptor apparatus of the eye. The speed of visual sensation after light adaptation in complete darkness is a typical indicator of the recovery of photochemical processes after a significant decrease in visual purple (rhodopsin) during a vision in the light. The studies of dark adaptation in the process of students' academic days have shown substantial changes.

Table 3. Indicators of dark adaptation (s) of the visual sensory system

Stages of education	Measurement intervals	M±m	max	min	V, %
At the beginning of the semester	Before the first class	25,1±1,4	33,2	18,4	9,7
	After the first class	29,2±1,1	36,4	21,3	10,2
	Before the second class	28,3±1,07	36,7	18,6	9,9
	After the second class	35,1±0,9	41,6	22,7	13,5
	Before the third class	31,2±1,7	38,5	21,7	12,3
	After the third class	43,2±1,2	51,4	33,4	14,2
At the end of the semester	Before the first class	23,2±1,3	31,4	23,8	8,7
	After the first class	27,8±0,9	37,2	23,4	13,3
	Before the second class	27,8±1,1	36,5	18,4	9,8
	After the second class	33,8±0,9	42,5	19,4	13,5
	Before the third class	30,7±1,5	38,7	21,3	12,6
	After the third class	38,1±1,2	48,5	26,7	13,8

At the beginning of the semester, the following dynamics of dark adaptation indicators have been found: after the first class, the adaptation time increased by 16.2%, after the second class – by 25.9%, and after the third class – by 38% (P<0.001).

Consequently, the accumulation of general physical and emotional fatigue causes a slowdown in the reaction of perception of the receptor apparatus of the eye in the dark. The dynamics of group averages depend on the difference between the maximum and minimum values. Thus, the maximum indicator after the third class increased by 54.5% compared to the initial one, and the minimum one – by 27.7% (P<0.001).

Despite the significant changes in intragroup indicators, the coefficient of variation ranges within 14.4%. The development of general adaptation mechanisms of students at the end of the semester tends to positive dynamics of indicators of dark adaptation.

It has been found that after the first class the time of dark adaptation increased by 14.8%, after the second class by 17.2%, and after the third class by 21% (P<0.01).

Intragroup variations in the dark adaptation indicators are observed against the background of a minor overall coefficient of variation. The maximum index after the third class increased by 45.7% in relation to the initial one, whereas at the beginning of the semester, this increase was 55.3% (P<0.05). The minimum index of dark adaptation after the third class at the beginning of the semester increased by 14.3%, whereas at the beginning of the semester, the increase in dark adaptation time was 18.3% (P<0.05) [17].

One of the important functions of the visual sensory system is remote vision. The acuity of remote vision informs the CNS about approaching or distant objects. This function provides accuracy of motor actions in complex-coordinated sports activity, in driving vehicles, and in operator activity. The materials of the study are presented in **Table 4**.

While analyzing the indices of students' remote vision, it should be mentioned that this index is twice as high as that of athletes, which means that if athletes have 2-3 mm, students have 7-8 mm.

Table 4. Dynamics of remote vision indicators among students

Stages of education	Measurement intervals	M±m (мм)	max	min	V, %
At the beginning of the semester	Before the first class	7,6±0,1	8,1	6,5	9,2
	After the first class	8,4±0,1	8,3	5,8	12,5
	Before the second class	7,5±0,06	8,6	6,7	13,7
	After the second class	8,6±0,03	8,8	6,ё1	10,2
	Before the third class	7,5±0,1	8,3	6,5	11,3
	After the third class	8,8±0,04	8,8	7,1	14,7
At the end of the semester	Before the first class	7,6±0,07	8,2	6,6	10,7
	After the first class	7,8±0,02	8,3	6,4	12,6
	Before the second class	7,5±0,1	8,6	6,8	11,9
	After the second class	8,1±0,09	8,7	7,1	13,4
	Before the third class	7,7±0,03	8,5	6,9	12,7
	After the third class	8,2±0,01	8,8	7,4	14,8

The study of remote vision threshold among students during the academic day showed regular dynamics. At the beginning of the semester, there is a reliable increase in the threshold of remote vision after each class: after the first class – by 10.5%, after the second class – by 14.6%, and after the third class – by 17.5% ($P<0.05$). By the end of the academic day, the maximum values are measured to a lesser extent - 8.6% and the minimum values to a greater extent – 22.3% [18].

At the end of the semester, there is a certain stabilization of remote vision indicators as a result of an increase in general adaptation to study loads. The following dynamics can be observed: after the first class, the remote vision index increased by 7.9%, after the second class – by 8.8%, and after the third class – by 9.5%. Intergroup indicators have increased in the following way: maximum values - by 7.2 % and minimum values – by 15.3 %.

CONCLUSION

Thus, the studies show that the visual sensory system is an indicator of mental fatigue in the process of educational activities. The natural process of adaptation stabilizes the functional state of the visual sensory system and causes fewer changes.

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