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DEVELOPMENTAL ASSESSMENT AND DIAGNOSTIC FEATURES OF VISUAL FATIGUE IN STUDENTS

Abstract. The article presents the results of studying the development and degree of visual fatigue in students based on the study of the functional state of the visual analyzer, taking into account the comparative aspect of the influence of the first and second semester of training, as well as the effect of various types of educational load.

Keywords: visual fatigue, color difference threshold, blind spot, critical flicker fusion rate.

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ОЦЕНКА РАЗВИТИЯ И ДИАГНОСТИЧЕСКИЕ ОСОБЕННОСТИ ЗРИТЕЛЬНОГО УТОМЛЕНИЯ СТУДЕНТОВ

Аннотация. В статье представлены результаты изучения развития и степени зрительного утомления студентов на основе исследования функционального состояния зрительного анализатора с учетом сравнительного аспекта влияния первого и второго семестра обучения, а также воздействия различных видов учебной нагрузки.

Ключевые слова: зрительное утомление, порог цветового различия, слепое пятно, критическая частота слияния мельканий.

Relevance. One of the most important features of modern times is the huge amount of information that needs to be processed and assimilated by a person [2]. The process of increasing the amount of information is objective and it is not possible to stop it. It is easy to imagine how much stress the human visual organ has to experience knowing that 90% of the information enters the human brain with the help of a visual analyzer [1]. The issue of visual fatigue development in students is particularly relevant, because pathological conditions can develop (myopia, asthenopia, nystagmus) in addition to the appearance of subjective complaints (headaches, a feeling of heaviness in the eyes, an increase in the number of blinks, etc.) [4].

The study of color differentiation thresholds and blind spot sizes are indicative methods of fine diagnostics of the functional state of the visual analyzer. Their undoubted advantage is also the ability to assess the impact on a person of various factors of the external and internal environment [3].

The critical flicker fusion rate (CFF), changing during the working period, characterizes overall fatigue and human performance. CFF allows you to evaluate objectively the functional state of the body at various stages of human adaptation to the action of stressful educational factors and can serve as a predictive criterion for evaluating the means and reserve capabilities of a person [5].

Purpose of research. To study the degree of visual fatigue in students under the influence of various types of educational load (current classes, tests, exams) using various research methods.

Material and methods of research. We studied visual fatigue in 138 students of the 5th year of medical Institute during the academic year. Students were divided into two groups: the first group consisted of 70 people who were evaluated for the functional state of the visual analyzer (blind spot size, sensitivity threshold of red, green, blue receptors, indicators of CFF) in the 1st academic semester; the second group included 68 people who were evaluated for these indicators in the 2nd academic semester. Among the students of the 1st academic semester there were 42 people (67.7%) with emmetropic refraction, and 28 people (32.3%) with myopic refraction. There were 38 students with emmetropic refraction (54.8%) and 30 students with myopic refraction (45.2%) in the 2nd academic semester. To study the effect of visual load on the visual organ campimetry, anomaloscopy and CFF were performed at the beginning of the training lesson and at its end, at the beginning and at the end of the training cycle (10 training days) in the first and second academic semester. All students were tested for visual acuity, the size of the blind spot on the campimeter, the study of color differentiation on the anomaloscope AN-59, and the determination of CFF on the special device (Light-test №1322).

Results and discussion. Analyzing the data from the campimetry results of the first day of the academic cycle in the first semester, we found that a group of students with emmetropic refraction observed an increase in both the vertical and horizontal dimensions of the blind spot from 11.8±0.1 to 12.2±0.1 ($p<0.05$) and from 8.75±0.2 to 9.27±0.1 ($p<0.05$) at the beginning and end of the training lesson, accordingly. And students with myopic refraction also showed an increase in the horizontal and vertical size of the blind spot from 8.86±0.1 to 9.42±0.1 ($p<0.01$) and from 11.3±0.1 to 12±0.1 ($p<0.01$) at the beginning and end of the training lesson respectively.

When studying the campimetry data of the last day of the training cycle, we noted that a group of students with emmetropic refraction observed an increase in the vertical and horizontal dimensions of the blind spot from 11.85±0.2 to 12.38±0.2 ($p<0.05$) and from 9.13±0.2 to 9.95±0.3 ($p<0.05$) at the beginning and end of the training lesson accordingly. The study of students with myopic refraction also revealed an increase in the horizontal and vertical dimensions of the blind spot from 9.07±0.1 to 10.03±0.3 ($p<0.01$) and from 11.71±0.1 to 12.52±0.1 ($p<0.01$) at the beginning and end of the training lesson respectively. Campimetry studies have shown that in a group of students with emmetropic refraction during the first day of the training cycle in the second semester there is an increase in the vertical and horizontal size of the blind spot from 11.99±0.1 to 12.43±0.3 ($p<0.05$) and from 9.13±0.1 to 9.64±0.1 ($p<0.05$), respectively at the beginning and end of the training lesson. The study of students with myopic refraction also revealed an increase in the horizontal and vertical size of the blind spot from 8.62±0.2 to 9.50±0.2 ($p<0.01$) and from 11.67±0.1 to 12.42±0.2 ($p<0.01$) at the beginning and end of the training lesson.

The results of campimetry data during the last day of the training cycle showed that students with emmetropic refraction showed an increase in both the vertical and horizontal dimensions of the blind spot from 12.01±0.2 to 12.51±0.1 ($p<0.05$) and from 9.36±0.2 to 9.93±0.1 ($p<0.05$), respectively, at the beginning and end of the training lesson. The study of a group of students with myopic refraction also revealed an increase in the horizontal and vertical size of the blind spot from 8.87±0.2 to 10.04±0.3 ($p<0.01$) and from 12.0±0.1 to 12.83±02 ($p<0.01$) at the beginning and end of the training lesson.

Thus, when comparing the results of campimetry during the academic year, we noted that a group of students with emmetropic refraction after prolonged visual load observed a significant increase in the size of the blind spot, both vertical and horizontal from 11.8±0.1 to 12.51±0.1 and from 8.75±0.2 to 9.93±0.1 in the first and second semester, respectively. And students with myopic refraction after prolonged visual load had also an increase in the size of the blind spot, both vertical and horizontal, from 11.3±0.1 to 12.83±0.2 and from 8.86±01 to 10.04±0.3 in the first and second academic semester, accordingly.

Analysis of the results of anomaloscopy during the first day of the academic cycle in the first semester showed that the group of students with emmetropic refraction had a higher sensitivity threshold for the red receptor from 12.2±0.7 to 13.95±0.5 ($p<0.05$) at the beginning and end of the training lesson, respectively. The study of the green receptor sensitivity threshold also showed an increase in the threshold from 11.97±0.7 to 14.01±0.4 ($p<0.05$) at the beginning and end of the training lesson. When analyzing the blue sensitivity threshold, it was found that the threshold became higher from 9.77±0.5 to 11.76±0.5 ($p<0.05$), at the beginning and end of the training lesson, respectively.

Among the group of students with myopic refraction, an increase in the sensitivity threshold of the red receptor was found from 12.35±0.3 to 14.52±0.5 ($p<0.01$) at the beginning and end of the training lesson, respectively. When studying the sensitivity threshold of the green receptor, an increase in indicators from 14.68±0.5 to 12.67±0.5 ($p<0.01$) was observed at the beginning and end of the training lesson. The values of the blue receptor sensitivity threshold also increased from 11.26±0.3 to 13.15±0.3 ($p<0.01$), at the beginning and end of the training class, accordingly.

Analyzing the data of anomaloscopy during the last day of the academic cycle of the first semester, we found that in students with emmetropic refraction, the sensitivity threshold of the red receptor increased from 15.04±0.3 to 16.53±0.4 ($p<0.05$) at the beginning and end of the training lesson, respectively. The study of the green receptor sensitivity threshold showed an increase in the threshold from 14.73±0.5 to 16.22±0.4 ($p<0.05$), at the beginning and end of the training class.

When analyzing the blue threshold, it was found that the threshold became higher from 10.94±0.4 to 12.20±0.4 ($p<0.05$), at the beginning and end of the training lesson, respectively.

When analyzing color perception thresholds in a group of students with myopic refraction, an increase in the sensitivity threshold of the red receptor was found from 14.70±0.3 to 17.03±0.5 ($p<0.01$), at the beginning and end of the lesson, and an increase in the sensitivity threshold of the green receptor from 15.56±0.3 to 17.46±0.4 ($p<0.01$) at the beginning and end of the training lesson, respectively. The values of the blue receptor sensitivity threshold also increased from 12.80±0.2 to 15.15±0.5 ($p<0.01$) at the beginning and end of the lesson, accordingly.

The study of visual acuity revealed that these indicators did not depend on the educational load received by students during ten days of classes.

Analyzing the data of anomaloscopy during the first day of the academic cycle in the second semester, we found that students with emmetropic refraction had a higher threshold of red receptor sensitivity from 17.47±0.3 to 19.70±0.5 ($p<0.05$) at the beginning and end of the training class, respectively. The green receptor sensitivity threshold also increased from 16.75±0.5 to 19.74±1.08 ($p<0.05$) at the beginning and end of the training lesson. When analyzing the threshold of sensitivity of the receptor to blue color, it was found that the threshold became higher from 13.66±0.4 to 15.61±0.6 ($p<0.05$) at the beginning and end of the training lesson, respectively.

When analyzing color perception thresholds in a group of students with myopic refraction, an increase in the sensitivity threshold of the red receptor was found from 16.59±0.6 to 19.27±0.7 ($p<0.01$) at the beginning and end of the lesson, respectively, and an increase in the sensitivity threshold of the green receptor from 16.68±0.6 to 19.78±0.8 ($p<0.01$) at the beginning and end of the training lesson was also noted. The values of the blue receptor sensitivity threshold also increased from 13.54±0.5 to 16.87±0.9 ($p<0.01$) at the beginning and end of the training class, accordingly.

The results of anomaloscopy during the last day of the training cycle showed that students with emmetropic refraction increased the sensitivity threshold of the red receptor from 18.40±0.5 to 20.34±0.5 ($p<0.05$) at the beginning and end of the training class, respectively. The green receptor sensitivity threshold also increased from 17.98±0.5 to 19.80±0.5 ($p<0.05$) at the beginning and end of the training lesson. When analyzing the sensitivity threshold of the blue receptor, it was found that the threshold became higher from 14.94±0.6 to 17.51±0.9 ($p<0.05$), respectively at the beginning and end of the training lesson.

Studying the values of color perception thresholds in a group of students with myopic refraction, we found an increase in the sensitivity threshold of the red receptor from 17.98±0.3 to 19.88±0.7 ($p<0.01$) at the beginning and end of the lesson, respectively, and an increase in the sensitivity threshold of the green receptor from 16.33±0.6 to 19.42±0.2 ($p<0.01$). The values of the blue receptor sensitivity threshold increased from 13.41±0.5 to 16.94±1.08 ($p<0.01$), accordingly at the beginning and end of the training session.

Comparative analysis of anomaloscopy during the academic year showed that a group of students with emmetropic refraction after prolonged visual load has a significant increase in the sensitivity threshold of the red receptor from 12.2±0.7 to 20.34±0.5, the green receptor from 11.91±0.7 to 19.80±0.5 and the blue receptor from 9.77±0.5 to 17.51±0.9, in the first and second semesters of training, respectively. In a group of students with myopic refraction after prolonged visual load, there is also a significant increase in the sensitivity threshold of the red receptor from 12.35±03 to 19.88±07, the green receptor from 12.67±0.5 to 19.42±0.2, and the blue receptor from 11.26±0.3 to 16.94±1.08, respectively.

For the study of visual acuity in the second academic semester, it was also found that the indicators did not change during the ten days of classes.

When analyzing the data of CFF in a group of students in the first and second academic semesters after a long academic load (current classes), there is a decrease in indicators, regardless of the type of refraction. For students with emmetropic refraction during the first day of the academic cycle: in the first semester – 37.2±0.3, in the second semester – 38.3±0.2; during the last day of the academic cycle: in the first semester – 35.7±0.3 at ($p<0.01$), in the second semester – 36.6±0.2 ($p<0.01$). For myopia in students during the first day of the academic cycle in the first semester – 36.1±0.3; in the second semester – 37.1±0.3; during the last day of the academic cycle: in students of the first semester – 34.8±04 at ($p<0.05$), in the second semester – 35.6±0.2 at ($p<0.01$).

In a group of students with emmetropic refraction during the academic year, after a long visual load, there is a smooth decrease in CFF readings from 37.8±0.3 to 35.2±0.3 and from 38.6±0.2 to 36.4±0.2 in the first and second semesters, respectively. In the group of students with myopic refraction after a long visual load, there is also a significant decrease in CFF indicators in the first and second semesters of training, respectively, from 36.8±0.3 to 34.5±0.4 and from 37.3±0.3 to 35.4±0.2.

Conclusion. Research has demonstrated that in the second semester of the academic year the initial indicators of blind spot size and color perception thresholds are higher than those of the first academic semester, and the indicators of the second semester's CFF are significantly lower than those of the first semester, accordingly. The result indicates that there is the accumulation and development of greater visual fatigue in students in the second half of the academic year.

Students after visual and intellectual load at the end of classes, at the end of the academic cycle and during the academic year revealed the development of visual fatigue. A more pronounced degree of visual fatigue is observed in students in the second semester. The study of the size of the blind spot, campimetry, and CFF are sophisticated and informative methods that allow assessing the degree of visual fatigue. Indicators of visual acuity in conditions of visual load cannot serve as the main criterion for assessing visual fatigue. The study of campimetry, anomaloscopy, and CPSM is simple and does not require significant research effort, which is especially valuable in the study of visual fatigue. The result of the study can be used in the development of the curriculum of students for the purpose of rational load distribution.

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