# ASSESSMENT OF THE TIME COURSE OF THE STATE OF EXTRAOCULAR MUSCLES IN PRINTED LOAD WITH DIFFERENT DESIGN PARAMETERS

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Abstract. The study deals with evaluation of the time course of the state of extraocular muscles of the visual system in 199 pupils of three age groups in printed load, estimated from the ratio of the interference pattern parameters and the symmetry factor introduced by the author. Adaptation of the visual system to its own state (structural and functional organization) was found to occur in many cases due to asymmetric functioning of extraocular muscles. In long work at a close distance this initial (adaptivecompensatory) asymmetry, providing binocular vision, converges with asymmetry caused by visual stress and fatigue. Thus, the study identified three main ways of adapting to work at close distance. Keywords: interference patterns, coefficient of symmetry, binocular vision, printed load, extraocular muscles.

Introduction. Visual work at close distance requires certain changes in the state of the tone of the extraocular muscles of the eyes, forming the visual system, in order to ensure the convergence of visual axes at the fixation object (convergence). In this case, extraocular muscles of the eyes can change their tone symmetrically, or asymmetrically [5,6,11]. In intense visual work at a close distance, extraocular muscles turn the eyeballs in the appropriate direction and hold them in a certain position for a long time, which makes it possible to converge visual axes at the fixation object and to hold its image in the corresponding parts of the retina. The closer the object is to the eyes, the greater the effort develops in the inner, upper and lower muscles of the eyes. This, in turn, causes a change in the shape of the interference patterns of the eyes. Depending on the initial structural and functional state of extraocular muscles of the eye, the reaction to visual load can be expressed in a symmetrical increase in effort, which leads to redistribution of internal stresses in the corneas of the eyes and preservation of the symmetry of interference patterns of the right and left eyes. Unfavorable conditions of visual load (too small objects, low illumination, etc.) or the presence of “defects” in the visual system trigger an increase in the asymmetry of the visual system function, affecting the form of interference patterns and, accordingly, the magnitude of their parameters of the right and left eye [1,2,8,9,12]. Material and methods of the study. Photo-registration of the pupils in the time course of visual load was carried out with the help of photophthalmoscope FOSP-1. After photographic registration of the interference patterns of the eyes under study and the processing of photographic materials, photoprints were obtained, which were used for the assessment of the state of the parameters of interest. The study of the effect of the text load on the functional state of the visual system in students of different age involved 119 children (60 boys and 59 girls) aged from 7 to 15 years. The visual load was induced by dosed work in the form of reading and recognizing letters. According to age, each subject was given a fixed visual load in the form of Anfimov's tables. The font size for which was 10 (soft reading, SR) and 7 (hard reading, HR) typographic items. The study was conducted in two stages within two days. Each of the subjects performed both tasks, which involved searching and highlighting certain letter in the text of the table [3,7,10]. Results of the study. To carry out quantitative evaluation of the time course of the state of extraocular muscles, estimated by the ratio of interference patterns parameters, we introduced a symmetry coefficient [4]. This indicator was calculated before and after intense visual load with

different types of printed load. The calculation was made as follows: photographic prints of interference patterns of the eyes of the subjects were used to determine the lengths of the intervals of the interference rhomb diagonals, which were normalized (i.e., divided by the average diameter of the cornea of the corresponding eye), and then the differences between the lengths of the corresponding segments of the right and left eyes before and after the load. These differences were added and integrative values were obtained characterizing the asymmetry of the functioning of the extraocular muscles before and after the load. Then the difference between the asymmetry indices was calculated by subtracting the initial value from the final value, after which the difference was divided by the initial value. We called the obtained



relative indicator in percent the coefficient of symmetry. If the figure obtained as a result of the calculation did not exceed 20%, then it was considered that the degree of stress of the extraocular muscles in the time course of visual load was preserved, hence the visual load did not cause a significant asymmetric rearrangement in the visual system. If the indicator had a minus sign, it meant that after visual load the system was more symmetrical than before it, therefore, the visual load was adequate to the capabilities of the system. If the index exceeded 20% and had a plus sign, the load caused an increase in the asymmetry of functioning and was unfavorable for the visual system. The results of calculating the coefficient K for different conditions of visual load are presented in the table. Each average value of the coefficient was aligned with the percentage of people who have it in a given age group. Table 1. Symmetry coefficient values in different types of visual load Boys Age Soft reading Hard reading Coefficient % (number of subjects %) К “+” К “-” К “+” К “-” 7-10 years old 88,4 (57 %) -45 (43 %) 131 (73 %) -46 (27 %) 11-12 years old 147 (60 %) -55 (40 %) 110 (70 %) -40 (30 %) 13-15 years old 109 (50 %) -51 (50 %) 83 (60 %) -48 (40 %) Girls 7-10 years old 124 (64 %) -61 (36 %) 50 (58 %) -36 (42 %) 11-12 years old 120 (71 %) -23 (29 %) 70 (58 %) -30 (42 %) 13-15 years old 86 (53 %) -40 (47 %) 102 (57 %) -28 (43 %) Each average value of the coefficient was aligned with the percentage of people who have it in a given age group. According to the table it is obvious that in every age group, both girls and boys, there are coefficients K of different signs, indicating the diversity of the response of the muscular apparatus to the load and denoting two main ways of adapting to the text load. In all age groups, both boys and girls, both types of texts caused an evident increase in the asymmetry of functioning in a larger percentage of cases (except for the subjects of the older group, where the number of persons with both types of reaction was the same) than its decrease. The K values exceeded 20% more than four times. This may indicate that the visual load, even corresponding to the hygienic requirements, leads to a functional reorganization of the visual system. This fact should be taken into account when, at an early age, children are taught to read, not observing the rules of visual hygiene, which can cause formation of asymmetric visual system, up to development of strabismus. In soft reading, in a sufficient percentage of cases, symmetry was enhanced (in comparison with the initial state). However, negative values of K in module were at least half less than positive ones; i.e. initial and final parameters differed among themselves to a much lesser extent. In hard reading in the group of boys, a larger number of individuals had a positive K, which indicated that this type of visual load did little to support the symmetrical functioning of the muscular system. The modulus of negative K values was lower in almost all groups than in soft reading. As for the age aspect, the coefficient K had different time course in groups of boys and girls. In the group of boys in hard reading positive K decreased with age with simultaneous decrease in the percentage of people who have it. Negative K, having values close in magnitude with positive in the younger and older groups, with age was observed in a larger number of individuals. This indicates

that with age, the boys' muscular system adapts to the text load and retains a certain stereotype of symmetric functioning even under adverse conditions. In the group of girls with an equal number of persons with positive and negative K, its values varied in different ways. The values of positive K increased with age, and the magnitude of negative K decreased with age. The results of the study make it possible to consider different reactions in boys and girls to hard reading. In the group of boys with age, the tendency to more symmetrical functioning of the visual system increased, in the group of girls – vice versa. Conclusions. As our studies have shown, in many cases adaptation of the visual system to its own state (structural and functional organization) occurs due to asymmetric functioning of extraocular



muscles. This occurs when there are structural or functional differences between the right and left eyes, and at the same time, binocular functioning is necessary. In long work at a close distance this initial (adaptive-compensatory) asymmetry, providing binocular vision, converges with asymmetry caused by visual stress and fatigue. In this case, the end result can be of three kinds. First, there may be an increase in the initial asymmetry or its appearance (in the case of the initial symmetrical functioning of the extraocular muscles of the right and left eyes). In this case, the values of the coefficient K will be positive. Secondly, if the symmetrical functioning or initial asymmetry remains, the coefficient K will be zero. Thirdly, if work at close range has resulted in a more symmetrical functioning of the visual system than before work, then the values of the coefficient K will be negative. Thus, we have identified three main ways of adapting to work at close distance.

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