Розділ IV. Фізіологія людини і тварин

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State of psycho-physiological functions in persons with a weak degree of acquired myopia

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Abstract. The purpose of the study was to study the features of the higher nervous activity (HNR) in persons with an acquired form of mild myopia. The psychophysiological research program included the study of the neurodynamic properties of the HNR according to the methodology of M. V. Makarenko using the "Diagnost-1" software. Against the background of acquired myopia of a weak degree, there is an improvement in the functional mobility of nervous processes, the speed of central information processing, indicators of attention, volumes of short-term memory, and semantic memory.

Key words*:* myopia, higher nervous activity, latent periods of choice reaction, processing of information.

Стан психофізіологічних функцій у осіб із слабким ступенем набутої короткозорості

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Резюме. Метою дослідження було вивчення особливостей вищої нервової діяльності (ВНД) у осіб із набутою формою короткозорості слабкого ступеня.Програма психофізіологічного дослідження включала вивчення нейродинамічних властивостей ВНД згідно методики М. В. Макаренка за допомогою програмного забезпечення «Діагност-1». На тлі набутої короткозорості слабкого ступеня відбувається покращення функціональної рухливості нервових процесів, швидкості центральної обробки інформації, показників уваги, обсягів короткочасної пам'яті, смислової пам'яті.

Ключові слова: короткозорість, вища нервова діяльність, латентні періоди реакції вибору, обробка інформації.

INTRODUCTION

Considering the unsatisfactory state of health of the population of Ukraine [14,17] promising for modern science should be considered research aimed at study of the peculiarities of the functioning of the human body in its presence dysregulatory and premorbid conditions. Visual impairments attract significant attention of researchers, and acquired myopia is considered one of the

most common vision abnormalities worldwide [18, 19], which significantly affects the quality of human life.

Myopia of the acquired form is formed, as a rule, during the school period learning and stabilizes during the second decade of a person [10]. According to Center of Medical Statistics of the Ministry of Health of Ukraine myopia during the last decade is among the top three most common ophthalmological diseases

population [10, 17]. Cases of myopia are recorded in 2.3-31% of schoolchildren; by according to other data - from 5-10% in preschoolers to 40% in teenagers or from 4-8% in the first classes up to 46-52% in graduation [12]. Among students, this percentage is even higher is 25-42% [11].

According to literary sources, acquired myopia develops over time life as an adaptive response of the visual sensory system in response to long-term work at a close distance and, as a rule, does not lead to complex pathologies complications. That is why medical-biological and socio-economic consequences myopia is essential for society [11]. Scientific publications of Sheiko V. I., Makarenko M. V., Kush Yu. I. [15; 16] show that myopia is an acquired form accompanied by dysfunction of the immune system and improvement of some indicators of neurodynamic functions, but in these works there is no data on psychophysiological functions against the background of acquired myopia. Therefore, our research is relevant and expands and deepens previously obtained data on neurodynamic and psychophysiological functions against the background of acquired myopia.

The purpose of the study was to study the features of higher nervous activity (HNA) in persons with an acquired form of mild myopia.

MATERIALS AND METHODS

Volunteers who were divided into two groups participated in the study: I (control) are practically healthy (80 men); II - persons who suffer from mild acquired myopia (50 men). Myopia was diagnosed by an ophthalmologist [13]. Age of volunteers was 24-30 years old. All studies took place at the beginning of the working day and week, on days of maximum mental capacity from Tuesday to Thursday, from 9:00 a.m. until 11.00 in the morning. It is this period that corresponds to the maximum level of physiological functions [2].

The psychophysiological research program included studying neurodynamic properties of the HNA according to the methodology of M. V. Makarenko with the help of software "Diagnost-1" (determining the time of the latent period simple visual-motor reaction, one-out-of-two and two-out-of-three choices stimulus, establishing the level of functional mobility of nervous processes).

The speed of central information processing (SCIP), which is calculated as a difference time of the latent periods of the choice reaction (LP CR) and simple visual-motor reaction (LP SVMR), is a quantitative measure of the assessment of the integrative activity of higher departments of the central nervous system

and reflecting the structural and functional organization of brain activity in

conditions for performing complex analytical and synthetic work [8, 9]. Research indicators of psychophysiological functions (attention and short-term memory) was carried out by standard diagnostic methods: "Correction test, "Schulte tables", "Memorizing 10 words/numbers", "Memory for numbers/words", "Semantic memory".Attention and short-term memory were studied one by one one for each volunteer.

According to features of the functional activity of brain structures and generally accepted recommendations for conducting psychophysiological studies, the duration of each the testing block did not exceed 30-40 minutes, and was carried out if necessary breaks [1]. The participants of the experimental group were tested in the condition of vision correction. The entire set of tests was carried out on the basis of the Department of Biology in Nizhyn Gogol State University.

The obtained data were subject to mathematical and statistical processing using STATISTICA 8.0 programs. For initial preparation of tables and intermediates Microsoft Excel 2010 package was used for calculations, with the help of which an analysis of the "normality of the sample" was carried out. For quantitative indicators calculated the arithmetic mean (M) and the standard error of the mean (m), for qualitative features - relative (в %) frequency.

To compare the values of indicators of the control and experimental groups, there were tangent methods of parametric statistics were used, the results are presented as Student's t- criterion. The reliability of differences was established using confidence probability index (p) less than 0.05, 0.01 and 0.001.

The work was carried out in compliance with bioethical norms relevant principles of the Helsinki Declaration of Human Rights, the Convention of the Council of Europe on human rights and biomedicine and relevant laws of Ukraine. All volunteers gave written consent to participate in the study [3, 4].

Research results and their discussion. Analysis results of neurodynamic indicators shows (Table 1) that in the group of persons with a weak degree in acquired myopia, the time of LP of SVMR is longer by 17.8 ms (7%; $p=0.045$) than in the control group. At the same time, a decrease in the time of LP RC of one out of three was found stimuli by 24.7 ms (6%; $p=0.008$) and the time of LP RC of two of the three stimuli by 52 ms (12.6%; $p<0.001$), which indicates a higher level of complex sensorimotor reactions in the group of persons with a weak degree of myopia, in comparison with participants with normal vision. The average group value of the SCIP indicator is also less reliable by 70 ms (42%; $p<0.001$) than in the control.

Table 1

The state of neurodynamic indicators of persons with a weak degree of acquired myopia

Indicator	Control group (n=80), M±m	Group of persons with acquired myopia weak degree (n=50), M±m
LP SVMR	247,95±5,68	264,77±6,68*
LP RC1-3, ms	394,32±6,19	368,67±6,71**
LP RC 2-3, ms	415,11±6,64	361,91±5,72***
FMNP,s	73,4±0,6	70,8±0,8*
SCIP, ms	167,16±6,42	97,14±6,13***

Note: * - the value of the degree of probability (p) according to the Student's t-test:*-p<0,05; ** p<0,01; *** p<0,001.

Regarding the functional mobility of nervous processes (FMNP) it was found that its level with a weak degree of myopia is significantly higher: transit time of the corresponding test by myopic participants was 2.6 s lower (p=0.011) than in the control group.

Therefore, the data obtained by us indicate the presence of reliable differences in sensorimotor response and neurodynamic functions (on the example of FMNP) between participants with a weak degree of acquired myopia and participants with normal vision. In the conditions of a weak degree of acquired myopia, it was found delay of simple visual-motor reactions (prolongation of the time of LP SVMR) and acceleration of complex sensorimotor reactions (decreasing the time of LP RC1-3 and RC2-3), FMNP (reducing the time of the corresponding test) and SCIP.

According to the results of the "Correction test" method, conducted under normal conditions testing conditions (task 1) and the "Schulte Table" method, it can be stated that with a weak degree of myopia, attention indicators exceeded (p<0.05- 0.001) control values (Table 2).

So, the total number of marks reviewed (S), the number of correctly crossed out

signs (M), as well as the volume of visual information (Q) in the group of people with weak myopia are greater (p<0.001) than in the control group: by 77.4 and 20.3 signs respectively S and M, by 16.2% - according to the Q indicator. The number of errors made at performance of task 1, in the group of myopic persons was 3.2 times smaller (p<0.001).

Accordingly, the level of accuracy (A) and efficiency (E) of the work in this data in the experimental group are slightly higher than in the control, and the P indicator, which reflects the level of mental capacity, exceeds the value of practically healthy people by 22% (p<0.001). At the same time, an increase in speed was detected in processing of information (V) and speed of choice (T, pace of work) in a group of people with weak myopia by 23% (p=0.029) and 19.3% (p=0.021), respectively. General the level of concentration of attention (CA) with weak myopia is better (5.3%; p<0.001) than among individuals of the control group.

The time to switch attention, established according to the technique of the "Schulte Table", in group of myopic persons is significantly smaller by 41 s (14.6%; p<0.001), in comparison with participants with normal vision.

When performing the "Correction test" test, in which the quality was entered as the factor of internal inhibition of the change of letters for crossing out (task 2), the following changes in attention processes were observed (Table 2).

Table 2

Indicators of attention of persons with a weak degree of acquired myopia under normal conditions testing

Indicators	Control group (n=80), M±m			Group of persons with acquired myopia of a weak degree (n=50), M±m		
	Task 1			Task 2		
	1	2	3	1	2	3
Total number of revised signs, S	403,5±1,85	648,9±2,59	324,9±1,43	480,9±2,16***	655,4±2,53	345,1±1,52***
Quantity is correct crossed out signs, M	102,9±0,92	16,7±0,46	79,5±0,97	123,2±1,07***	23,1±1,01***	89,7±0,98***

The number of admitted errors, n	3,5±0,41	2,4±0,30	5,6±0,49	1,1±0,3***	0,6±0,24***	2,0±0,17***
Visual volume information, Q	239,5±1,42	385,2±2,13	192,8±1,13	285,4±1,74***	389,1±2,10	204,9±1,33***
Accuracy coefficient, A	0,97±0,04	0,88±0,06	0,93±0,05	0,99±0,03	0,97±0,05	0,98±0,03
Work efficiency, E	99,12±0,06	99,6±0,08	98,3±0,12	99,76±0,07***	99,91±0,07**	99,43±0,09***
Processing speed information, V	1,91±0,13	3,15±0,19	1,48±0,12	2,35±0,15*	3,23±0,19	1,66±0,12
Selection speed, T	3,36±0,18	5,41±0,21	2,71±0,13	4,01±0,21*	5,46±0,25	2,88±0,16
General productivity, P	389,9±1,45	568,6±2,16	303,5±1,44	476,5±1,29***	634,4±2,15***	337,7±1,48***
Level of concentration attention, CA (%)	93,29±0,35	75,4±0,92	86,83±0,41	98,19±0,38***	94,45±0,70***	95,68±0,37***

Note: * - the value of the degree of probability (p) according to the Student's t-test: * $p<0.05$; ** $p<0.01$; *** $p<0.001$.

Under the conditions of the internal inhibition processes in the group of persons with weak degree of myopia, almost the same ($p>0.05$) volumes of the processed were found of the test material according to S and Q indicators, in comparison with the control data. The speed characteristics of attention processes also had similar values: reliable there were no differences in V and T indicators in the comparison groups. But the number of errors (n) and the number of correctly crossed out characters (M) differed significantly: the average group value of n persons with weak myopia is smaller by 1.8 signs (4 times; $p<0.001$), M, respectively, is 6.4 times higher (38%; $p<0.001$) than among individuals with normal vision. In general, the level of attention of people with a weak degree of myopia when performing work under difficult conditions can be considered the best: indicators work efficiency, general productivity and concentration of attention exceeded control group data by 3% ($p=0.005$), 11.6% ($p<0.001$) and 25.3% (p<0.001) in accordance.

The results obtained during the "Correction test" with another change letters and performance of work on the background of a noise stimulus (task 3), testify to storage of higher qualitative and quantitative indicators of attention in a group of peoples with myopia, in comparison with the control values (Table 2).

So, when performing the task under the conditions of simultaneous action of internal and external factors external inhibition was found in the group of volunteers with a weak degree of myopia better ($p<0.001$) quantitative and qualitative results: average group values of S and Q are larger by 6%, M by 12.8%, and the quantity n - 2.8 times smaller. At the same time, for speed parameters of attention of statistical differences between the experimental ones groups were not detected. It should be noted that participants with myopia performed work somewhat faster than participants with normal vision: with a weak degree in myopia, V and T indicators are higher by 12.2% and 6.3%, respectively. By the account above the average group values of the "accuracy" indicators work", "general mental performance" and "concentration of attention" in the case of weakness degree of myopia is greater by 5.4%, 11.3% ($p<0.001$), 10.2% ($p<0.001$) respectively, than among persons with normal vision. Work efficiency is also there significantly ($p<0.001$) better in the group of people with myopia.

Conducting an additional analysis of the studied indicators obtained by different conditions of the test, made it possible to identify specific traits in the character adaptation to the introduction of influencing factors in research groups.

A comparison of the results of task 1 and task 2 showed less growth volume of visual information and speed indicators of attention in peoples with weak myopia, in comparison with the control group. Yes, if the participants have with normal vision, P, Q, V and T indicators increased by 45.8%, 60.8%, 65% and 61% respectively from its initial level (value in task 1), then in the group comparison, they increased by 33%, 36.3%, 37.4% and 36.2%, respectively. Similarly,if in the control the number of errors (n) decreased by 31.4% and the level of CA decreased by 19.2%, then in the comparison group - by 45.5% and 3.8%, respectively.When compared results of task 1 and task 3 revealed that in the control group the values indicators P, Q, V and T decreased from the level in task 1 by 22%, 19.5%, 22.5% and 19.3%, respectively, and in the group with a weak degree of myopia, it decreased more significantly: by 29%, 28.2%, 29.4% and 28%, respectively. The number of n in the control increased by 60% of the initial level, the level of CA decreased by 7%, and in the comparison group the data the indicators changed by 81.8% and 2.6%, respectively.

Summarizing the above, it can be stated that participants with weak by the degree of acquired myopia are characterized by the best quantitative and qualitative ones and speed parameters of attention under normal conditions of work performance, compared with participants with normal vision (control group). For those in

difficulty testing conditions (under the influence of braking processes) in the experimental group is a higher level concentration of attention is due to a greater extent to the preservation of the best quality of processing material. An increase in the speed of work and the amount of visual information in the conditions task 2, although a little less manifestation than in the control group, but the level concentration of attention was more stable in persons with weak myopia.

Given the better overall state of attention in individuals with a weak degree myopia, we can conclude about greater stability and better training under the influence of internal inhibition factors of this category of persons.

The results of the study of the volumes of short-term memory by its types and types testify to the presence of probable ($p<0.05$-0.001) differences between the control group and participants with mild myopia according to the "vision memory for numbers" and "auditory memory for numbers" (Table 3).

So, the amount of short-term visual memory for numbers in the group of people with a weak degree of myopia is significantly ($p=0.015$) higher by 8.8% (on average is 12.46±0.37 characters), and the volume of short-term auditory memory for numbers is significantly ($p<0.001$) smaller by 12.5% (on average it is 11.94±0.34 marks), in compared with the indicators of the control group. Average group volume value of short-term visual memory for words does not statistically differ between groups comparison. At the same time, during the auditory memorization of words, myopic participants show slightly better results (by 3.9%; $p>0.05$) than in participants with normal sight.

Table 3

Indicators of short-term memory of persons with a weak degree of acquired myopia

Indicator	Control group (n=80), M±m	Group of persons with acquired myopia of a weak degree (n=50), M±m
Visual memory for numbers	11,45±0,17	12,46±0,37*
Visual memory for words	16,68±0,15	16,69±0,42
Auditory memory for numbers	13,65±0,16	11,94±0,34***
Auditory memory for words	15,42±0,19	16,02±0,36
Semantic memory	17,52±0,16	18,14±0,32
Visual memory	14,06±0,23	14,58±0,27
Auditory memory	14,51±0,22	14,23±0,26
Memory for numbers	12,47±0,21	12,46±0,27
Memory for words	16,10±0,18	16,35±0,23

Note: * - the value of the degree of probability (p) according to the Student's t-criterion:* $p<0,05$; ** $p<0,01$; *** $p<0,001$.

According to the level of semantic memory, among persons with a weak degree of myopia, higher results of memorizing pairs of words were found (by 3.5%), but these differences are not statistically significant in comparison with the control ($p>0.05$).

Having analyzed the volumes of short-term memory obtained from different analyzer systems, i.e. by its types, it is possible to note a tendency to improve visual memory (by 3.7%; $p>0.05$) and decrease the level of auditory memory (by 2 %; $p>0.05$) under conditions of myopia of the acquired form of weak degree (compared to people with normal vision). However, it should be noted that there are no probable differences in the features of memorizing stimulus material addressed to the 1st and 2nd signal systems (numbers/words): the volumes of short-term memory for numbers and words are almost the same ($p> 0.05$).

Therefore, features of short-term memory against the background of myopia of a weak degree should be considered improved visual memorization of numerical material and simultaneous deterioration of its memorization through the auditory analyzer.

The study of neurodynamic properties showed that, compared to the control group, all participants with myopia had larger LP SVMR. With a weak degree of myopia, a decrease in the time of LP RC2-3, SCIP and FMNP was found in accordance with the control indicators.The results obtained by us in the group of volunteers with myopia of an acquired form of weak degree coincide with the previously obtained data of V.Sheiko [16], which additionally confirms the opinion of the researchers about the "training effect" of the nervous system and the functional restructuring of the higher departments of the nervous system in the conditions of acquired myopia , which is considered as an adaptive systemic response of the body to increased visual work at a close distance [15, 16].

The study of psychophysiological functions shows that in the group of participants with myopia, better qualitative indicators of attention and the level of its concentration were recorded than among the people of

the control group. According to indicators of short-term memory (visual/auditory and memory for numbers/words), semantic memory, probable differences were found in myopic humans compared to control data.

The data we obtained regarding the features of the HNA of myopic persons partially coincide with those presented in the literature [1, 2, 5, 6, 7, 12]: a more pronounced decrease in visual memory and attention in 10-11-year-old schoolchildren with high myopia is reported in comparison with healthy peers and peers with mild myopia; a decrease in the volume and speed of visual information processing in 12-13-year-olds with myopia is shown; adolescents with moderate myopia in terms of attention parameters (volume, switching speed) did not differ significantly from children with normal vision, except for the stability of attention, which was significantly higher in myopia. Analysis of short-term visual memory showed a decrease in characteristics in the group of myopic children.

Summarizing the results of the study, it should be noted that there are currently no data in the literature regarding the features of GNI in acquired myopia of a weak degree in people aged 24-30 years, which emphasizes the importance of this work. It should be emphasized that the existing studies do not provide an opportunity to fully compare the data obtained by us, as they are devoted to other age groups and/or individual values of myopia.

CONCLUSION

Thus, against the background of acquired myopia of a weak degree, there is an improvement in the functional mobility of nervous processes, the speed of central processing of information, indicators of attention, volumes of short-term memory (visual/auditory and memory for numbers/words), semantic memory.

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