

Analysis of Perceptual-Mnemonic Characteristics of Students in Modern Conditions of Digitalization of Society

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Abstract — The global informatization that has embraced modern society has been introduced into the educational environment extensively. The list of advantages of using information technologies in the modern educational environment is quite wide and continues to be expanded due to the introduction of new forms and methods. But there is a flip side to this process - the "adaptation price" that the modern generation of students has to pay for the information boom and globalization. The purpose of this article is to examine and analyze the perceptual-mnemonic processes of university students in modern conditions of digitalization of society, which is necessary to create the psychophysiological basis of individual learning styles. The identification of these features, as well as the correlative relationships between the properties of individual styles and various psychological and behavioral features of their manifestation in the educational environment will contribute to the formation of a psychophysiological type of the learning process.

Keywords — *perceptual-mnemonic processes, stability attention, concentration of attention, short-term visual memory, short-term verbal auditory memory, digitalization of society, correlation relationships, psychophysiological type of students.*

I. INTRODUCTION

In the modern world, a rapid change is occurring in a qualitative change in the information environment surrounding a person, which is rapidly developing and becoming more and more diverse. In this regard, psychophysiological, mental, behavioral transformations occur, due to the direct, indirect, one-time and long-term effects of information technology on various aspects of the biological and social nature of man. These effects are ambivalent in nature, can be both positive and negative. At the stage of introduction and the beginning spread of information technologies, researchers noted more positive aspects of global informatization, such as the revival of new types and forms of activity, the expansion of the circle of potential communication partners, the development of social contacts, and the inclusion in work at the same time, many sensory systems and images, facilitating the search for necessary information, developing operational thinking, strengthening the role of feedback from ligature and activation of cognitive activity in general [1]. However, as the society plunged into information flows, the authors began to note

pronounced negative consequences of this process, which are manifested in a deterioration in the state of health caused by negative factors of physical inactivity, stress on the visual sensory system, and exposure to electromagnetic fields of different spectra; the emergence of Internet addiction, the intensification of the phenomenon of personification, the exodus of certain skills and abilities (for example, arithmetic), the formation of "clip" thinking in many young people, in which the ability to quickly switch between separate semantic fragments is expressed. But the ability to analyze perceived information is lost and it's difficult to understand the context [1, 2].

The results of such thinking are distraction, hyperactivity, attention deficit, preference for visual images over logic and deepening into the text.

The development of the concept of a psychophysiological model of the learning process is associated with the further study and implementation of such a concept as an individual cognitive style. According to researchers, individual differences in the ways of perceiving information, methods of analyzing, structuring and evaluating one's environment form some typical forms of intellectual behavior, regarding which groups of people are similar and at the same time different from other people, thus cognitive styles are subject to the action of some general patterns of cognitive organization spheres of man. On the other hand, the severity of certain cognitive styles indicates the formation of "within" the individual's experience of certain unique individual-specific mechanisms of regulation of his intellectual activity.

Currently, there is a fairly wide variety of typological approaches related to the concept of "cognitive style". In style studies, along with cognitive styles, they began to single out styles of intellectual activity that characterize individual differences between people in the nature of posing and solving problems, as well as "learning styles", which are manifested in the preferred methods of educational activity of schoolchildren [3]. Thus, there is a need to review the existing conditions of the educational process on the basis of a theoretical, and then practical study of the concept of a psychophysiological model of the learning process in modern conditions. The goal of creating a psychophysiological model of the learning process is the theoretical development of the rationale for the effectiveness of educational activities in modern conditions,

which will contribute to the modernization of approaches, programs, forms and technologies of training, since not the activity itself, but the conditions for its implementation put a strain on the body.

Information technology in modern conditions is both a means of cognition of the world and a tool for influencing a person, including his cognitive sphere. The aim of our study was to study the characteristics of perceptual-mnemonic indicators of students in modern conditions of digitalization of society, which will serve as the basis for the creation of psychophysiological types of individual styles implemented in the educational space.

II. MATERIALS AND METHODS

The study was conducted on the basis of the Pacific National University, Khabarovsk, Russia. The study involved 285 examined respondents, among them 204 university students, 32 schoolchildren, 25 people of mature age and 24 elderly people. Assessment of the characteristics of attention was carried out using the computer hardware complex "NS-PsychoTest" of the company "Neurosoft", Ivanovo, Russia according to the method of "Attention assessment". Examination of short-term sensory memory was carried out using "visual matrices" and a set of words according to the method of V.V. Melnikov. Data processing was carried out using the package of mathematical and statistical programs M. Excel.

III. RESULTS

Psychophysiological status is the characteristics of the human body and personality that determine the potential or realizable opportunities for vocational training and the given requirements for the reliability and effectiveness of a particular professional activity. The psychophysiological status of an individual is characterized by both individual indicators (neurodynamic, psychodynamic, physiological) and integral personality traits (cognitive styles, temperament characteristics, etc.). The basic properties of the nervous system, as genetically determined inclinations of abilities associated with structural features and functioning of the brain, determine the phenotypic manifestation of the potential of a particular individual. The most important component of the psychophysiological status of students is the perceptual-mnemonic system, which includes the processes of attention, memory and perception [4].

Attention is a necessary condition for the effectiveness of educational and cognitive activities. Attention is the dynamic side of all cognitive processes. Its most important characteristics are stability and concentration. An indicator of stability is the high productivity of activities for a relatively long time. Concentration is the degree of focus on an object or work, it is inversely proportional to distraction. The concentration of attention is not under complete conscious control and is subject to fluctuations, which depend on the current functional state and individual congenital characteristics of brain activity [5, 6].

The results of a student study ($n = 159$) using the "Attention assessment" method using the "NS-Psychotest" computer hardware complex show that a greater number of test subjects have high values of attention stability indicators – 52 %. Due to the high level of attention sustainability, students can remain focused on an object or activity for a long time. Our study showed that 42 % of students have medium attention stability; a low level was observed only in 6 % of students [7].

The analysis of quantitative indicators of attention concentration revealed that 64 % of students have a low level of this characteristic, average indicators were found in 35 % of the respondent students, and only 6 % of the examined showed a high concentration of attention [7]. A low level of concentration of attention indicates fluctuations in attention, the presence of involuntary jumps in attention, which interfere with a holistic focused perception of information, which, in turn, can adversely affect the memorization of lecture material, the implementation of practical work. Due to the low concentration of attention, students can make involuntary errors in computational tasks, are often distracted, "lose" the logic of presentation, which ultimately leads to a decrease in the efficiency of learning material.

An analysis of the correlative interactions between the quantitative values of indicators of concentration and stability of attention did not allow one to find reliable values of the correlation coefficient ($r = 0.069$, $p < 0.05$), which indicates the relative autonomy of each of these characteristics of attention. It can be assumed that according to D. Allport's ideas [6] about parallel-distributed information processing systems consisting of many specialized neural modules, the studied attention characteristics are provided by different system brain components, separated both anatomically and functionally, but as a result, they realize coordinated (coherent) work individual modules and the brain as a whole.

An analysis of the correlation relationships of attention characteristics with other psychophysiological indicators, such as the speed of a simple visual-motor reaction, the level of functionality, the stability of the reaction, the functional level of the system, evaluated using the software program "Attention assessment" separately in groups of boys and girls, helped to detect certain differences in quantification of the values of the correlation coefficient [7]. Our study showed that young men have more pronounced intra-level (within the neurodynamic level) functional connections in the implementation of attention reactions, which is manifested in the strengthening of generalized reactions of the body with a deterioration of the functional state, fatigue.

In girls, the maximum correlation in the coefficient was established between the average time of the reaction rate and its standard deviation. Inert-type girls also have a large dispersion of reaction time values during one examination, are more variable in response to simple sensory stimuli. The data obtained may indicate qualitative features in the implementation of attention processes in men and women.

This assumption is confirmed by the studies of N.V. Vol'f, which established cardinal differences in the organization of the frontal-parietal and lateral systems of selective attention in men and women [8].

According to researchers, concentration and stability of attention is better expressed in individuals with a strong nervous system. The concentration of attention depends on the balance of nervous processes and switching attention on the mobility of nervous processes [9].

A.A. Ukhtomsky believed that attention concentration is associated with the functioning of the dominant focus of excitation in the cerebral cortex and is a consequence of excitation in the dominant focus with simultaneous inhibition of the remaining zones of the cerebral cortex. We assume that the development of internal inhibition to a certain extent has a positive effect on the manifestation of the values of stability and concentration attention indicators.

Significant correlation interactions between the strength of the excitation processes and such properties of attention as stability and concentration were not obtained in our study [10]. It can be assumed that under conditions of a normal current functional state, attention indicators show a correlative relationship with the power of inhibition processes and, to a lesser extent, with the power of excitation processes. There were also no reliable correlations between the property of neurotism and the studied indicators of attention, which indicates that these qualities are regulated by various distributed brain systems that operate in a relatively autonomous mode [10].

In our study, it was found that the strongest connections are observed between the concentration of attention and the quality of extra-introversion according to G. Eisenck with the tendency that high and medium values of attention concentration indicators correlate with introversion, low values of attention concentration indicators with extraversion (table 1).

TABLE I. THE VALUES INDICATORS OF THE CORRELATION COEFFICIENT BETWEEN INDICATORS OF ATTENTION AND PROPERTIES OF THE NERVOUS SYSTEM IN STUDENTS OF PACIFIC NATIONAL UNIVERSITY (N = 56)

Properties of the nervous system	Attention Characteristics	
	Concentration of attention	Stability attention
The strength of the excitation processes	0.05	-0.004
The power of braking processes	-0.20	-0.25
The balance of the processes of excitation and inhibition	0.15	0.003
Motility of the nervous processes	0.11	0.16
Neurotism	-0.07	0.01
Extraversion - Introversion	0,26*	0,15

*- reliable values at $p < 0.05$

As can be seen from table 1 correlation coefficient was also found at a level close to reliable between stability and concentration of attention and the strength of inhibition processes [10].

Thus, the activity of the brain is composed of many specialized neural modules that provide for the regulation and

maintenance of various mental processes that work on the principle of parallel-distributed systems, the interaction between which dynamically changes, then intensifies, then weakens, depending on the physiological and mental state of a person.

The study of the volume of short-term sensory memory was carried out in four age groups: schoolchildren 12-14 years old, students aged 18-25 years old, people of mature age 30-50 years old and elderly people 65-80 years old. A total of 126 people took part in the experiment. The results of testing, mathematical and statistical processing of data on average values of indicators of memory volume for two samples have a pronounced tendency to improve the storage of visual information by an average of 25 % from school age to the student period. Then there is a decrease in the results of storing visual information for the mature period by an average of 17 %. An even more pronounced deterioration in the amount of short-term visual memory occurs by old age: an average of 29 % relative to adulthood and 46 % relative to students. Qualitative values of the average results of the volume of short-term visual memory on a percentage scale are characterized as excellent in most students, satisfactory in groups of schoolchildren and people of mature age, and unsatisfactory in the group of elderly people [10].

Comparison of the average values of the results of the volume of short-term visual memory using visual matrices according to the t-test indicates that there are significant differences between the groups of students – mature age ($p < 0.0001$), mature age – old age ($p < 0.0001$), students – advanced age ($p < 0.0001$) [10].

The results of testing the volume of verbal auditory memory are similar to those in visual memory. In the group of schoolchildren, the average values of auditory memory for two samples are 118 % (maximum value 200%), which is indicated as a satisfactory result on a qualitative scale, a group of students shows values 7.5 % better, but in general this level is below average. It should be noted that the verbal auditory memory test results were much worse than those of visual memory in all age groups. But while in schoolchildren and students they were at a satisfactory level, then in groups of people of mature and old age, they were characterized as unsatisfactory.

Processing the results of testing the volume of short-term auditory memory using t-test also revealed significant differences between all the studied groups [10].

A comparison of the results of the dynamics of the volume of short-term visual and verbal auditory memory showed the following:

1. The dynamics of the average volume indicators of short-term visual memory in different age groups coincides with the dynamics of the average results of short-term verbal auditory memory.

2. We did not find information on the correlation of changes in auditory and visual memory in ontogenesis in literary sources; but in our studies, more pronounced changes in the volume of short-term visual memory were revealed in comparison with the similar dynamics of verbal auditory memory in the examined age groups.

3. Verbal auditory memory has an average lower level in all groups, but at the same time by the old age it decreases to a lesser extent – by 30%, while visual memory – by 46%. Thus, in the course of our study, significant differences were found between the average values of the results of testing the volume of short-term visual and verbal auditory memory in the age groups of schoolchildren, students, people of mature and old age (Fig.1).

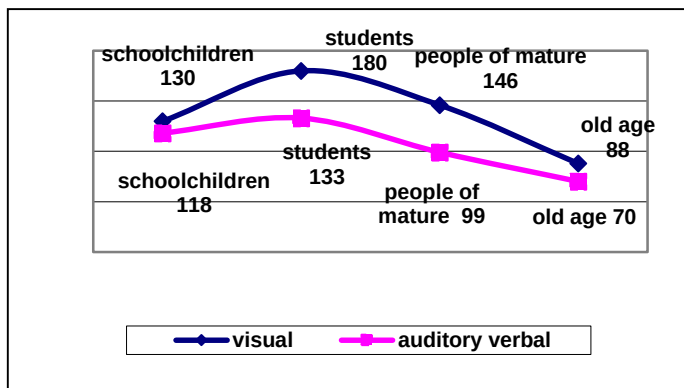


Fig. 1. The dynamics of the mean values of short-term sensory memory in two samples as a percentage in different age groups.

The results of our study show a higher level of short-term memorization of the amount of visual information compared with memorizing the amount of verbal-auditory information in all examined age groups.

IV. DISCUSSION

Thus, in our study, we found a good potential of the study group for attention stability and low concentration of attention.

Researchers believe that information overload of a person helps to reduce the level of concentration of attention, worsens the ability to delve deeply into the content of information and keep it in memory for some time [11]. It is interesting to note that if the volume of the proposed educational material contains more than 2-3 pages of typewritten text, then students carefully read only 1-2 paragraphs of the first page, subsequent pages only look with a cursory glance, not reflecting on the content of the writing, and then read the last paragraph of the text, while remembering only the first paragraphs. In order to increase the effectiveness of educational activities, we recommend that students with a low concentration of attention do not rush to take control and independent work without checking the results. If the work is very important, it is better to postpone it for some time, and then return to the test; perform complex tasks at a time when the functional state is optimal, usually in the morning. The best indicators of sustainability of attention, as a rule, are those students who are interested in their work, are aimed at success.

The lower results of visual memory in schoolchildren obtained in the work are associated with insufficient development due to age-related features of conscious regulation of attention. According to research data, the most significant differences between children and adults are observed at the stage of formation of the engram and are manifested in the

strengthening of regulatory resources to maintain concentration and stability of attention.

It is interesting to note that despite the fact that a mature age (30–50 years) in relation to cognitive processes is characterized as optimal, which is characterized by the manifestation of the highest peak in the development of attention functions, intelligence, active learning, education, and functional memory abilities (especially in relation to short-term memory) undergo a decline. However, this, in general, does not affect the working capacity of people of mature age – labor and creative activity is fully preserved due to the development of volitional processes, arbitrary regulation of attention and motivation.

A significant deterioration in the amount of short-term visual memory in the elderly and senile is caused by certain neurodegenerative processes in the brain, both in the cortex and in the subcortical structures (hippocampus), which leads to impaired consolidation of memory traces and the difficulty of remembering new information [5].

The results obtained on the dominance of perception and memorization of information by students through visual channels must be taken into account in the methodological organization of classes, which should include various ways of visual support of educational material in the form of presentations, tables, graphic diagrams. Modern Internet technologies provide ample opportunities for visualization using 3D models, animations, videos, mental maps. An additional way to enhance the effect of perception and memorization of educational information is the use of examples of practical situations that activate imaginative thinking, contribute to the emotional reinforcement of theoretical information, thereby increasing the effectiveness of the educational process. The amount of short-term memory can be increased both due to the generalization of information according to a logical principle, and due to the multiple variable repetition of information. As the experience of teachers shows, the use of structural logic schemes in the frontal form of organizing cognitive activity of students in practical classes and independent work significantly activates the process of solving problems, completing tasks, etc. This is explained by the fact that logical circuits include theoretical material in a generalized and structured form, which is practically used in solving problems, completing tasks, and at the same time is again comprehended and repeated.

Accessibility and speed of obtaining the required information on the Internet changes our attitude to information and the need to remember it. Based on the structural and informational concept of memory and taking into account the achievements of biochemical studies of memory processes confirming the presence of short-term and long-term memory, it can be assumed that the amount of stored information in short-term memory will increase with constant use of a computer, and long-term, on the contrary, will decrease [11]. As a result, students' knowledge does not become deep, but superficial, not systemic, fragmentary. Researchers suggest that currently there is a tendency to reduce the amount of information stored in the long-term memory of a person. Thus, when using modern technologies in working with information, a certain functional complex is formed, which is aimed not at

memory processes for memorizing the necessary knowledge and skills, but at activating the about memory activity related to the technologies of searching for this information [11]. As a result, a person is weaned to perform those operations that support his memory abilities in a normal functional state. This approach leads not only to a decrease in the functions of a person's memory, but also as a result worsens the level of general and special knowledge, intelligence, and changes the way a person thinks [11].

V. CONCLUSION

According to modern psychological and pedagogical concepts of learning, the success of learning activities can be ensured with the optimal functioning of the five main substructures.

1. Substructures of the relationship between teacher and student, between students, peers, fellow students based on cooperation and mutual understanding.

2. Substructures of behavior – the student's ability to manage and regulate their activities, behavior and communication.

3. Substructures of cognitive activity – when due to the optimal ratio between the individual characteristics of students and technologies, teaching methods provide effective and successful cognitive activity of students.

4. Substructures of physiological support – with high activity of higher nervous activity, mental and somatic health of the schoolchild, student.

5. Substructures of mental states – provides emotional-volitional qualities of students, contributes to the formation of motivation for the learning process.

The activity and effectiveness of the educational process is largely determined by the psychophysiological characteristics of students.

The obtained results of our study, an analysis of literary sources indicate that the psychophysiological component of student youth undergoes certain transformations caused by the systematic use of information technology. In this regard, there is a need to create the concept of a psychophysiological model of training in order to modernize approaches, programs, forms and technologies of education.

The question of the effective use of the individual psychophysiological potential of students seems important both for theory and for solving practical problems of forming a professionally competent, socially active person who works effectively in modern market conditions. Taking into account the individual psychological and psychophysiological characteristics of students involves the development and use of a wide range of diverse educational paths for mastering the

material, more flexible use of educational technologies that activate divergent thinking processes.

The systematic approach in our study was implemented through the study of the correlative relationships of psychophysiological indicators with psychological and physiological characteristics in order to create typological complexes that can be considered as psychophysiological equivalents of cognitive styles with the possibility of their use to optimize students' educational and cognitive activity. Knowing his individual cognitive style, the student adequately organizes his educational activities, skillfully uses the advantages of the style, compensates for the shortcomings due to more flexible adaptation and rationalization of personal resources. The teacher, owning information about the leading styles of cognitive styles in the student group, more effectively uses teaching methods, means and methods of teaching, taking into account the relevant styles, and/or individualizes instruction using a variety of technologies. Thus, the concept of humanization of education is being implemented, which is one of the most important conditions for the quality training of specialists at a university.

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