REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

OPTIMIZATION OF STRESS EFFECTS INTERACTIVE LEARNING PROCESS ON ADOLESCENTS AND YOUNG PEOPLE

Speciality: 2411.01 – Human and animal physiology

Field of science: Biology

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Baku – 2022

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SUMMARY OF THE DISSERTATION WORK

Relevance and development of the topic. Stress or emotional tension, which plays an important role in mental and physical activity, has a significant impact on health. Stress is a physical reaction of body to biological and social demands and harmful effects. It is believed that the functions of these physical reactions ensure behavioral activity during mental processes[1].

Depending on the functional state of a person, reaction is developed to emotional factors. Although these reactions, on the one hand, have a positive effect on human activity and his mood, on the other hand, destructive factors lead to unpleasant consequences[2,3].

The functional state of an organism changes depending on its stages of development. As many functions in a child's body are not fully formed, children are very sensitive to various influences, including emotional factors, so stress factors can cause them to develop more diseases than adults. From this point of view, the study of psychophysiological indicators during the impact of stress factors caused by various teaching methods, including traditional and interactive (English "inter" - interaction, "act" - action) methods on children, adolescents and young people can be considered relevant.

One of the characteristics of interactive learning is the emotionality of the learning process and learners[4]. Active learning technology promotes active thinking, rapid processing of

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[1]Селье, Г. Концепция стресса, как мы ее представляем в 1976 г. Новое о гормонах и механизме их действия / Г. Селье // - Киев.: Наукова думка, - 1977, - 196 с.

[2]Aminov A.V. Təlim və emosional gərginlik arasında funksional əlaqələrin inkişafında biogen monoaminlərin iştirakı / A.V. Aminov. - Bakı, - 2012. - 138 s.

[3]Məmmədov, Z.H., Qələmqaş R.Ə. Erkən emosional gərginliyin təlim və yaddaş proseslərinə və baş beyində biogen monoaminlərin miqdarına təsiri. Bakı , 2012, - 138 s.

[4]Mahmudova, K.F. Təlim prosesində şagirdlərin fizioloji xüsusiyyətlərinin nəzərə alınması (yeniyetməlik yaş dövrü) / ped. üzrə fəlsəfə doktoru dissertasiyasının avtoreferatı / - Bakı, 2015. – 23 s.

information, conditions for active discussion, creative decision-making, collective solution of learning and cognitive problems, etc.

The early start of systematic training and the intensification of the learning process using new technologies have led to an increase in the number of students who have difficulty adapting to the learning process. According to some data, the number of children with learning difficulties in schools is 15-40%[5]. From this point of view, the "general adaptation syndrome" introduced to science by H.Selye is characteristic[1]. Because the majority of children who do not succeed in education and have an undesirable level of health are students who can not adapt to the factors of learning[6].

Depending on the difference between stress reactions, genetic characteristics of the peripheral nervous system and predominance of partly sympathetic or parasympathetic nervous system people are classified as "sympathicotonic" and "vagotonic". This classification system is taken into account in the treatment of "stress disorders"[6]. Activity and behavioral reactions lead to the intensification of vegetative reactions in animals[7]. Therefore, it is expedient to study the vegetative indicators during impact of stress factors created by interactive learning on a child organism.

It is important to study the dynamics of changes in some indicators, including monoamines (MA), involved in the neuro-humoral regulation, during the impact of various stress factors on human body. However, since it is impossible to conduct appropriate experiments on different structures of the human central nervous

[5]Безруких, М.М., Макарова Л. В. Педагогическая физиология. Курс лекция / М.М. Безруких, Л.В. Макарова / Под редакцей М. М. Безруких. Москва, - 2013, - 491 с

[6]Забутый, М.Б. О генезе вестибуло-вегетативных расстройств в условиях невесомости / М.Б. Забутый // Косм.биология и авиац. медицина, - 1976, №5, - с. 85-88.

[7]Давудов, В.В. Проблемы развивающего обучения. Опыт теорического и экспериментального психологического исследования / В.В. Давудов,Москва, "Педагогика", - 1986, - с.240.

system (CNS), rabbits are preferred as an object of experiment. Models are used in physiological research for the effectiveness of the experiment[8]. Therefore, as a more appropriate "model" for studying the effects of stress on the human body, it may be more successful to clarify the effects of forced hunger and thirst on animals. This is because, the MAergic system of the brain is closely involved in the change of the general intracellular tension of metabolic processes in the body[9].

MA mediators play an important role in the regulation of memory processes, as well as the processes of awakening and delay in the CNS[10]. MAs play an important role in the organization of the organism's behavior at the molecular level, as well as in its formation.

Objectives and goals of the research. The aim of the research is to optimize the stress factors that arise in the process of traditional and interactive learning in secondary schools and have a negative impact on students' health and mastery of learning materials.

The objectives to achieve the goals are as follows:

1. To study the psychophysiological indicators in the body of students affected by stress factors that arise during the use of traditional and interactive learning methods

2. To determine the stages of rapid development in order to assess the health and normal development of children and adolescents, and to explore ways to optimize the stressors arising in the process of interactive learning, which adversely affect the health

[8] Степанова, Л.Г. Оптимизация показателей физиологическиих систем организма животных в условиях стресс–модели (Текст) / Л.Г. Степанова, Т.А. Томова, Е.Ю. Просекина // Бюллетень экспериментальной биологии и медицины, - 2014. Т. 157, №5, - с. 580-583.

[9] Məmmədov, Z.N. Emosional gərginliyin beynin elektrik aktivliyinə və yaddaş proseslərinə təsiri / Z.N. Məmmədov, A.V. Aminov // Müqayisəli fiziologiya və biokimyanın müasir problemləri, - Bakı: - 2006, - s. 99-109.

[10] Судаков, К.В. Общая теория функциональных систем / К.В. Судаков, -М., Медицина, - 1984, - 223 с.

of students, mastery of learning materials;

3. To determine the amount of dopamine (DA), noradrenaline (NA) and serotonin, or 5- hydroxyptryptamine (5-HT) in the tissues and mitochondrial fraction of orbital, limbic, sensory, visual cortex of cerebrum, also cerebral column and hypothalamus in rabbits in order to study the effect of non-specific irritants (forced starvation and thirst factors) on the dynamics of changes in MA

4. To determine the amount of DA, NA and 5-HT in the tissue and mitochondrial fraction of various structures of the brain of rabbits after cessation of the effects of non-specific irritants (factors of forced starvation and thirst).

Research methods. Interactive teaching methods were used. State anxiety and trait anxiety were determined by the Spielberg-Khan test, and temperament characteristics by the V.M.Rusalov test. Visual and auditory memory is determined by the ability to memorize 10 simple, dervative and complex words. Statistical calculation of the quantity or percentage of the obtained indicators was carried out by Wilconson's (Manna Whitney) U criterion.Blood pressure (BP) was measured by the Korotkov method to determine the parameters of the autonomic nervous system.

All experiments were carried out in accordance with the principles of animal protection used for experimental and other scientific purposes in the International Declaration of the European Union. The brain is divided into structures. The universal fluorimetric (biochemical) method was used to determine DA, NA and 5-HT. Mitochondrial fractions were isolated from the studied tissue of the structures of the brain. Statistical calculation of the results of the study of MAs was carried out by the Fischer-Student method.

The main provisions of the thesis defense:

1. Optimizing the stressors created by the interactive learning process by taking into account the physiological characteristics of students in the learning process (TAPCS) is an effective and adequate tool in terms of students' health and mastery of teaching materials.
2. The identification of behavioral defects in the organism, especially

in the CNS developed at school and correction of such defects in a timely manner by teachers, parents and health workers will ensure the normal physical, mental development and health of children, as these defects have a negative impact on health and learning success of children.

3. At 1, 3 and 5 days of forced thirst and starvation, the level of DA and 5-HT is lower and the level of NA is higher in the tissue and mitochondrial fractions of various brain structures of rabbits compared to the control. The changes that took place depended on the type and duration of stress and the studied structure.

4. Partial recovery of DA, NA and 5-HT levels in tissue and mitochondrial fractions of brain structures after cessation of water and food deprivation

Scientific novelty of the research. For the first time, as a result of research, the scientific idea predicted in the learning process as "TAPCS as a mean of optimizing the stressors arising in the process of interactive teaching (IAL)" was confirmed by solid evidence. For the first time in Azerbaijan, students studying in secondary schools were tested for disorders of the structures of forehead, temporal lobes, limbic system and subcortical structures, which perform the majority of psychophysiological functions (memory, attention, perception, motivation, emotion, stress, etc.) and the ways of correcting the defects were shown.

After exposure to non-specific irritants (forced starvation and thirst), the levels of DA and 5-HT in various structures of the brain decrease, while the level of NA increases. Changes in DA, NA, and 5-HT levels in brain structures decrease after the exposure to the nonspecific irritants ended.

It was found that the forms of stress caused by specific and non-specific factors and having a single physiological mechanism differ from each other in terms of severity and duration.

By classifying students into active-constructive, active-non-constructive, passive and neutral groups according to their participation in the discussion of interactive learning materials, the dynamics of exchange of student number between group I and other

groups (i.e. increase in the number of students in group I and decrease in other groups) may be an indicator of interactive learning success.

Theoretical and practical significance of the research. The theoretical and practical significance of the scientific novelties obtained in the research process is great. In accordance with the purpose of our study, our main goal was to determine the adaptive response of the developing organism to changes caused by stress in tissues and cells of the body at the molecular level. Due to the change caused by non-specific irritants (forced water and food deprivation) at the cellular level at the level of DA, NA and 5-HT, the negative impact of emotional stress arising in the process of interactive learning on health and mastery of teaching materials has been successfully optimized through TAPCS. Secondary school teachers can improve the level of mastery of teaching materials, as well as ensure the health of students by optimizing the level of stress that arises not only in the IAL process, but also in traditional classes through TAPCS. In addition, the success rate of a lesson can be assessed using a classification based on students' levels of participation in the discussion of IAL materials.

In addition to the above, the test method[11] can be used in secondary schools to diagnose and correct CNS defects caused by physical damage in cognitive structures and stress, and which do not show signs of impairment.

Approbation and application. Dissertation materials were discussed at the following scientific meetings:Modern problems of biology (Sumgayit, October 23-24, 2018), Actual problems of modern biology (Baku, February 5, 2019), XV International Interdisciplinary Congress "Neuroscience for Medicine and Psychology» (Sudak, Crimea, Russia, May 30 – June 10, 2019), VI Congress of Russian Biophysicists (16-21.09.2019, Sochi),Scientific

[11]Дэниэль, А. Изменити свой мозг – измениться и жизнь / А. Дэниэль / Пер. с англ. Е. Кудашкиной. М.: Эксимо, - 2009, - 445 с.

seminars of ASPU department of Physiology (Baku, 2018, 2019), XVI International Interdisciplinary Congress "Neuroscience for Medicine and Psychology» (Sudak, Crimea, Russia, October 6-16, 2020).

Name of the organization where the dissertation work was carried out: The dissertation work was carried out at the Azerbaijan State Pedagogical University of the Ministry of Education of the Republic of Azerbaijan.

Published works. 8 scientific articles and 6 theses on the topic of the dissertation were published.

The total number of characters of the dissertation material by indicating the number of characters of each structural unit. The dissertation is written on a computer in 155 pages (214756 characters). It includes the "Chapters of contents" (4437 characters), "Introduction" (12585 characters), "Summary of literature" (65881 characters), "Materials and methods" (10581 characters), "Experimental part" (72515 characters), "Discussion" (57318 characters), "Conclusion" (2686 characters), "List of literature" (36953 characters) and the "List of abbreviations" (835 characters). The dissertation is illustrated with 17 tables and 16 graphs (12495 characters). The bibliography includes 240 sources, 13 in Azerbaijani, 82 in Russian and 145 in English.

MATERIALS AND METHODS OF RESEARCH

Interactive teaching methods were used in the research-based learning processes conducted with individual learning methods with reference to traditional methods[12,13].

In our study, we have carried out our experiments under the conditions of information tensionon students of V, VI, IX, X and XI grades (123 in total) in schools 260 and 265 of Khatai district of

[12]Fərəcov, Ə.N. Təkamül fiziologiyası / Ə.N.Fərəcov, T.Ş.Həsənov – Bakı, - 2004, - s.109.

[13] Paşayeva, M.N. Biologiyanın tədrisində interaktiv təlim metodlarından istifadənin imkan və yolları: / biologiya üzrə fəlsəfə doktoru dissertasiyası /Bakı, - 2009. – 154 s.

Baku.

State anxiety and trait anxiety were determined by the Spielberg-Khan test [14], and temperament characteristics by the V.M.Rusalov test[15].

Special paper blanks with 10 simple, derivative and complex words are made to determine visual and auditory memory. The person participating in the resear should read and memorize the words for 30-35 seconds. As soon as the time is up, a blank with the words is taken and the student writes the words which he/she has memorized on a piece of paper. Evaluation is made according to the number of words memorized and spelled correctly. Hearing memory, like visual memory, is defined on paper blanks with words written on it. However, the words are read by the researcher for 30-35 seconds, or played on a tape recorder. A table is compiled on the basis of the quantity or percentage of the findings and statistical calculation is carried out by Wilconson's (Manna Whitney) U criterion.

BP was measured by the Korotkov method to determine the parameters of the autonomic nervous system.

The experiments were also performed on animals (as a model). All experiments were carried out in accordance with the principles of protection of animals used for experimental and other scientific purposes of the International Declaration of the European Union[16].

The brains of 60 3-month-old rabbits, taken as a research model, were divided into structures[17]. The amount of DA, NA and 5-HT at the tissue and mitochondrial levels was determined on the basis of samples taken from various brain structures, i.e. orbital,

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[14] Шкала тревоги. Тест на тревожность Спилберга Ханина http://clinica.nsk.ru/info/testy/testy-na-stressy-depressiyu-trevozhnost/shkala-trevogi-test-na-trevozhnost-spilbergera-khanina/

[15]Опросник структуры темперамента Русаловаhttps://psychojournal.ru/ost.html

[16] European convention for the protection of vertebrate animals used for experimental and other scientific purpose: Council of Europe 18.03.1986.- Strasburg, 1986. - 52 p.

[17]Светухина, В.М. Цитоархитектоника новой коры мозга в отряде грызунов / В.М. Светухина // Арх. Анат. Гистол. и эмбриол., - 1962, т.42, №2, -с. 31-45.

limbic, sensory and motor, visual cortex, brainstem and hypothalamus.

The experimental animals were divided into control and experimental groups. The experimental group, in turn, was divided into two subgroups: subgroup I was subjected to water deprivation, subgroup II - food deprivation. The first subgroup was divided into 4 subgroups: animals subjected to water deprivation for a). 1 day, b) 3 days, c) 5 days, d) used for expirement 7 days after being subjected to water deprivation for 5 days. The second subgroup was also divided into 4 subgroups: animals subjected to food deprivation for a). 1 day, b) 3 days, c) 5 days, d) used for expirement 7 days after being subjected to food deprivation for 5 days.

Universal fluorimetric method was used to determine DA, NA and 5-HT[18]. Mitochondrial fractions were isolated from the tissue of the studied structures of the brain[19]. Statistical calculation of the results of MA study was carried out by the Fischer-Student method[20,21].

RESEARCH RESULTS AND DISCUSSION

1. Investigation of the impact of stress factors caused by the traditional and IAL processes on the psychophysiological indicators of students

All kinds of difficulties arising in the learning process,

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[18] Коган, Б.М. Чувствительный и быстрый метод одновременного определения дофамина норадреналина, серотонина и5-оксиндолуксусной кислоты в одной пробе / Б.М. Коган, Н.В. Нечаев / «Лабират. дело», - 1979, № 5, - с. 301.

[19] Somogyi, J. Preparation of brain mitochondria / J. Somogyi, A. Fonjo, I. Vincze // Acta Physiol. Acad. Sci. Hung., - 1962, v.21, - p. 295-300

[20] Лакин, Г.Ф. Биометрия / Г.Ф. Лакин // М., изд-во «Высшая школа», - 1990, - с. 352-353.

[21] Рокицкий, Ф.П. Биологическая статистика / Ф.П. Рокицкий - Минск: высшая школа, - 1973, - с. 330.

including the fact that the volume of homework does not correspond to the potential of the student, their functional state, individual characteristics, including temperament types, memory and attention span, the effect of hormonal changes on behavior of adolescents, failure to identify and correct morpho-functional defects in students, failure to take into account their functional state, the fact that teachers have superficial knowledge about preventive measures and strengthening of children's health, regardless of their specialization, retardation, hyperactivity, attention deficit syndrome, ignorance of left-handed children, and other problems increase emotional tension (microstress) in children.

Unlike traditional learning, active learning creates stressful emotional tension when students discuss pre-planned and structured questions in accordance with the purpose of the topic being taught. As stress does not have an unequivocal effect on children's health, as it is accompanied by positive or negative emotions, depending on their functional state, motivation and level of success. In both cases, children are exposed to certain levels of stress.

Comparing the psychophysiological and vegetative indicators of stress factors arising in the learning process conducted by an active learning method can be very effective. By determining the psychological and behavioral characteristics of children according to the indicators that reflect emotional stress, it is possible to study the level of anxiety in the CNS, in particular in higher nervous activity, under the influence of stress factors, and children's ability to adapt to stressful conditions. By applying the temperament test, we can divide students into groups according to the types of the nervous system and take into account their psychophysiological characteristics during the process of teaching.

By determining visual and auditory memory, we can identify the speed of children's reaction to visual and auditory information and their ability to remember this information (memory volume). With the help of attention and logical indicators, we can reveal the level of development of intellectual activity in the interactive learning process and the speed of individual reactions to stressors.

The degree of influence of stress factors can be determined on the basis of the activity levels of the sympathetic and parasympathetic nervous systems, determined on the basis of BP and cardiovascular system indicators.

2. Characteristics of the impact of stress factors arising in the process of interactive learning on the psychophysiological indicators of students

In order to study the status of autonomic indicators, the highest and the lowest blood pressure and pulse pressure were measured in adolescents and young people on normal school days, before and after IAL, as well as individual temperament (or nervous system types), trait anxiety were determined in students.

The average coefficients of state anxiety and trait anxiety levels of adolescents and young people on normal days, before school and after IAL differ significantly from each other. After school, the highest increase is observed in trait anxiety indicators. The increase in the level of state anxiety after school is less noticeable.

When a post-IAL lesson is conducted using the traditional teaching method, the level of excitement in adolescents and young people in a short period of time becomes closer to the level before the lesson (average ratio of initial state). There is a clear difference between the recovery time of initial state of active and partially passive students. In addition, initial state of anxiety indicators in 12-14-year-old students recovers more slowly than 15-16-year-old students. This fact is evidenced by vegetative indicators.

The recovery time of trait and state anxiety (optimal working time) depends on the type of nervous system, in particular on the functional state of the body. We determined the recovery period of initial state based on vegetative indicators.

As the indicators of state and general anxiety in adolescents aged 12-14 years are at moderate level before school, they do not differ from normal school days. However, since the discussion of

training materials and debates during IAL process increase emotional tension, the state anxiety after the lesson increases by 50% in adolescents and by 40% in young people aged 15-17. Trait anxiety, on the other hand, increases most among adolescents (18%). Insignificant increase is observed in young people (3-5%). At this time, the general anxiety is high (61%).

Analysis of the post-IAL functional state shows that the level of state anxiety is high at the end of the lesson and although it gradually decreases (within 1.5 hours) and becomes close to the average level or the pre-lesson level, it is 6-7% higher. The recovery period depends on the students' discussion activities and temperaments.

Higher level of anxiety in adolescents aged 12-14 years after IAL and slower recovery than young people is due to incomplete development of hormonal balance and some functional indicators, including adaptation, due to puberty.

3. The effect of emotional stress on the volume of short-term visual and auditory memory

The active participation of adolescents and young people in the discussion of IAL materials also depends on the amount of their memory.

There is a sharp change between visual and auditory memory levels before and after IAL. Both the volume of visual memory and the volume of auditory memory increase significantly ($p<0.001$).

On normal days, the average coefficient of short-term visual memory is 40%, while it is 50% higher before class, and after IAL it increases by 20% to 70%. Since 80-90% of information is perceived visually, such an increase should be considered natural. There is a relatively small increase in auditory memory (10%).

Like adolescents, young schoolchildren aged 15-17 have a significant increase in both visual and auditory memory due to the effects of emotional (microstress) factors in the IAL process. Although the total memory volume of young people is higher than

that of adolescents, the increase in memory volume occurs in the same way as in adolescents.

In the discussions held during the IAL class, students are asked new questions that they were not familiar with before. The topic is discussed by memorizing such questions and answering the questions correctly based on the information stored in the long-term memory. The discussion should focus on reducing the factors that cause emotional tension or stress in students by focusing on social relationships.

4. Optimizing the effect of stress factors arising during interactive learning on psychophysiological indicators of students

Since the scientific basis for improving the level of training and teaching is a physiological mechanism, TAPCS is a must in the teaching process conducted by pedagogical methods and principles. Children of similar character were divided into 4 groups. The first four groups included students with the same temperaments, and group V (mixed group) included students with different temperaments.

Psychophysiological indicators were determined before and after the lesson, taking into account the physiological properties. While in adolescents on the eve of IAL the level of state and trait anxiety was 29.62±1.03 and 38.46 ±1.45 points, respectively, on the eve of IAL, taking into account physiological properties, this level decreased to 27.15±1.01 and 35.23±1.30 points. It seems that the preparation for the lesson to be held with TAPCS also had a positive effect on the emotional tension of the children.

Maximum, minimum BP and pulse pressure in adolescents and young people were measured before the lesson and after IAL conducted by TAPCS, and at the same time the level of state and trait anxiety was determined in students. The higher level of sympathetic tone was recorded. However, this level was lower than that observed after normal IAL. The level of state and trait anxiety on the eve of the IAL differed little from the indicators observed on the eve of the

IAL held by TAPCS.

After normal IAL, the level of state anxiety was 44.28 ± 1.96 points (figure), while the level of trait anxiety was 48.35 ± 1.75 points. These values decreased significantly after IAL conducted by TAPCS and amounted to 36,22±1,52; 39,12±1,24 points ($p<0,001$) respectively.

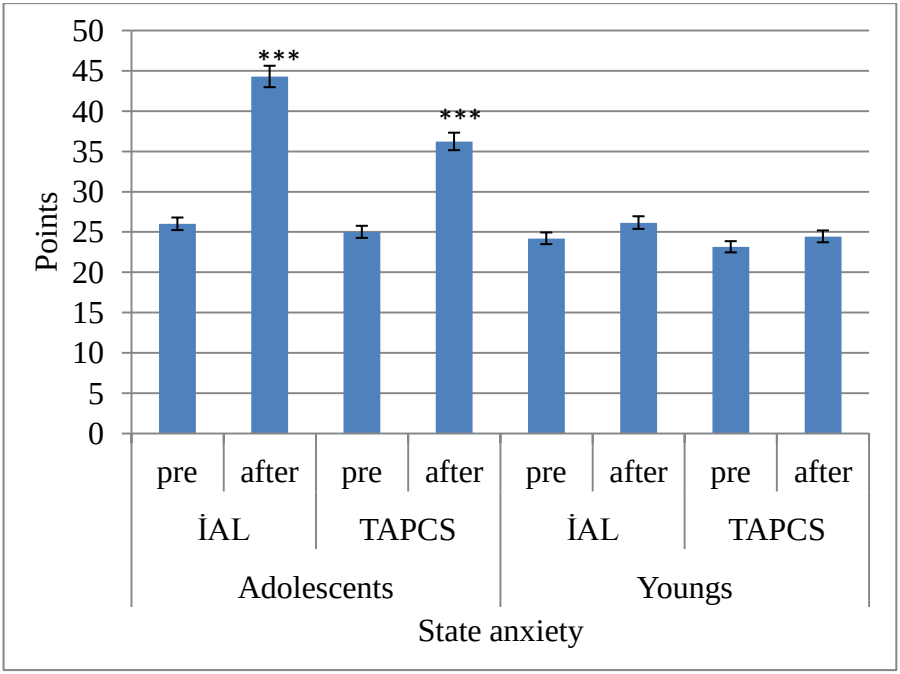

Figure. Effect of stressors on the state anxiety level of adolescents and young people, ***- $p<0,001$.

In general, the level of state and trait anxiety in adolescents on the eve of IAL conducted by TAPCS and after IAL is significantly reduced compared to traditional, the same IAL indicators. This "demonstrates that TAPCS is the most adequate means of optimizing the stressors created by interactive learning."

There is no significant difference in the level of state anxiety in young people before the usual IAL and on the eve of the lesson

conducted by TAPCS. The level of state anxiety after the lesson increases on both indicators, but the level of state anxiety after IAL (25.44±2.04) conducted by TAPCS is lower than the level after normal IAL (26.15±1.80). There was an insignificant difference between the two indicators obtained on the eve of the usual IAL. A similar change is observed in the level of trait anxiety among young people.

Depending on the functional state of adolescents and young people, the difference between the recovery time of initial state of active and passive students in the discussion is observed even after the IAL conducted by TAPCS. In adolescents aged 12-14 years the recovery time of initial state of anxiety indicators is slower than those aged 15-16. However, the recovery period after IAL conducted by TAPCS is much shorter than the period after IAL. These facts are also evidenced by vegetative indicators.

The recovery period in the types of anxiety depends on the activity and temperament types of the students participating in the discussion. Normal level of anxiety in adolescents is recovered later than in adolescents. This feature, which is observed in adolescents, is associated with puberty.

5. Optimizing the effect of emotional stress on the volume of short-term visual and auditory memory

In adolescents, there is a sharp change in visual and auditory memory levels before the IAL conducted by TAPCS and after the IAL. In this case, both the volume of visual memory and auditory memory increases significantly. This increase is confirmed by statistical probability ($p<0.001$).

If there is no difference between the levels of short-term visual memory before the IAL, as well as before the lesson conducted by TAPCS, the amount of short-term visual memory after the lesson conducted by TAPCS increases by 10% ($p<0.001$). A corresponding increase is also observed in short-term auditory memory.

The total volume of short-term visual memory in young people

aged 15-17 is higher than in adolescents. However, although the level of short-term visual memory before intellectual lesson is higher than in adolescents, this level does not differ from the level before the lesson conducted by TAPCS ($p<0.05$).

The results obtained after the lesson differ from each other. Thus, the volume of short-term visual memory after the lesson conducted by TAPCS is higher than the level after IAL ($p <0.001$). Similar results are observed in the volume of short-term auditory memory.

Before both forms of the lesson, the average coefficient of short-term visual memory is 70%. However, after a lesson conducted by TAPCS, the amount of short-term visual memory increases by 90% ($p<0.001$). The corresponding increase is also recorded in auditory memory ($p<0.001$).

In general, young schoolchildren aged 15-17, as well as adolescents, have a significant increase in both visual and auditory memory due to the influence of emotional factors arising in the teaching process conducted by TAPCS compared to the post-IAL level. This increase occurs naturally in young people as well as in adolescents.

The increase in short-term visual and auditory memory after IAL is accompanied by an increase in the levels of state and traitanxiety. The level of state and trait anxiety is also increasing in the process of IAL conducted by TAPCS. However, this level is significantly lower than the increase after the usual IAL. It seems that the decrease in the level of anxiety to a relatively normal level leads to the neutralization of stress factors that negatively affect memory, and the volume of short-term visual and auditory memory has increased to some extent. Probably, during the lesson conducted by TAPCS the leading role of the students in the lesson, the sincere humanistic relations between teachers and students and among students increased the volume of memory because it optimized the emotional memory.

In addition, as in IAL, the increase in the amount of short-term visual and auditory memory in the lesson conducted by TAPCS is

natural.

6. Study of the amount of DA, NA and 5-HT in different brain structures of rabbits kept under conditions of forced water deprivation

The amount of DA in the brain tissue of 3-month-old rabbits exposed to water deprivation for 1, 3, and 5 days was 7-17%, 15-27%, and 26-41% lower, respectively, than in the control value. Under appropriate conditions, the amount of NA was 16-23%, 22-30% and 29-39% higher, respectively, and the amount of 5-HT was 7-15%, 13-23% and 18-32% less.

The amount of DA and 5-HT in the tissues of different brain structures of rabbits subjected to water deprivation for 1, 3 and 5 days is usually lower than in the control, and the amount of NA is higher. Water deprivation lasting for 1 day caused relatively little changes in the amount of neurotransmitters in some of the studied brain structures. Sometimes these changes are not valid. However, the amount of these neurotransmitters in the hypothalamus has caused significant changes.

As the duration of forced water deprivation increased, there were highly reliable changes in the amount of neurotransmitters in the tissues of all the structures of the brain studied.

In mitochondrial fractions of the brain structures of 3-month-old rabbits exposed to water deprivation for 1, 3 and 5 days, the amount of DA was 9-21%, 16-33% and 27-43% lower, respectively, compared with the control, the amount of NA was 17-29%, 25-36% and 33-47% higher, the amount of 5-HT was 10-22%, 18-30% and 20-35% lower.

Water deprivation lasting for 1, 3, and 5 days in the mitochondrial fractions of the brain of rabbits caused the same changes as in the tissue of studied structures at DA, NA, and 5-HT levels, but the changes in the mitochondrial fraction were slightly higher than in the tissue.

7. Changes in the amount of DA, NA and 5-HT in different structures of the brain of rabbits exposed to food deprivation

In the brain tissue of 3-month-old rabbits subjected to forced food deprivation for 24 hours, 72 hours, and 5 days, the amount of DA and 5-HT was lower and the amount of NA was higher, compared to control as in the case of water deprivation. Under appropriate conditions, a decrease in the amount of DA was respectively 5-13%, 11-25% and 22-35%, an increase in the amount of NA was 14-19%, 19-25% and 26-32%, a decrease in the amount of 5-HT was 2-9%, 4-15% and 18-27%.

As in the case of water deprivation, changes in the amount of DA, NA and 5-HT in the tissues of different brain structures of rabbits exposed to food deprivation varied depending on the duration of food deprivation and the structure. Starvation has led to a decrease in the levels of DA and 5-HT and an increase in NA in the tissues of various structures of the brain.

Starvation lasting for 5 days resulted in more significant changes in the levels of the 3 neurotransmitters studied in the tissues of all structures of the brain compared to 1 day and 3 days, and food deprivation lasting for 3 days compared to 24 hours. The levels of DA, NA, and 5-HT in the hypothalamus were significantly altered under appropriate conditions compared to other structures studied.

In the mitochondrial fraction of the brain structures of 3-month-old rabbits kept under the conditions of forced food deprivation for 1, 3 and 5 days, the amount of DA was 8-20%, 14-28% and 25-37% lower, the amount of NA was 10-26%. 21-32% and 27-43% higher, the amount of 5-HT was 5-13%, 9-18% and 16-28% lower than the control.

Although the decrease in 5-HT level under the conditions of starvation for 1 day was slightly higher than that in the tissues of the studied structures, the changes in other studied structures, except the hypothalamus were not reliable. Changes under the conditions of starvation lasting for 3 days are valid in the hypothalamus and

brainstem. There was both an increase and a reliable change in the amount of 5-HT in the mitochondrial fractions of all studied structures under the conditions of 5-day food deprivation.

Changes in the levels of all neurotransmitters in the mitochondrial fractions of various brain structures of rabbits subjected to food deprivation were slightly lower than in water deprivation.

8. Changes in the amount of DA, NA and 5-HT in different structures of the brain of rabbits after cessation of water and food deprivation

In subsequent experiments, the amount of DA, NA and 5-HT in different structures of the brain was assessed 7 days after 5 days of water and food deprivation.

7 days after cessation of 5-day water deprivation in 3-month-old rabbits, the amount of DA in the tissue of the studied brain structures was 6-14% lower than in the control, the amount of NA was 7-18% higher, and the amount of 5-HT was 4-13% lower. was. Under appropriate conditions, the amount of DA in the mitochondrial fraction of brain structures was 8-15% lower, the amount of NA was 8-19% higher, and the amount of 5-HT was 7-15% lower than in the control.

In rabbits, 7 days after cessation of 5-day food deprivation, the amount of DA in the tissue of brain structures was 2-12% lower, the amount of NA was 4-15% higher and the amount of 5-HT was 2-10% lower. Under appropriate conditions, the amount of DA in the mitochondrial fraction of brain structures was 5-14% lower, the amount of NA was 5-18% higher, and the amount of 5-HT was 4-13% lower than in the control.

Although the tendency continued in the tissues and mitochondrial fractions of most of the structures studied 7 days after exposure to water and food deprivation, no significant changes occurred. Changes in the level of prescribed neurotransmitters were close to the control. In contrast to other structures in the hypothalamus, in most cases, especially 7 days after the effects of

water deprivation, there were reliable changes compared to the control.

These results suggest that stressors cause long-term persistent changes in the levels of DA, NA, and 5-HT in brain structures.

Despite the fact that everyone is exposed to many stressors since childhood, stress-related diseases develop only in people with low resistance to stress[22]. The period of sexual maturity - the period of intensive changes in the hormonal and neurological development levels is a period of sensitivity to stress[23].

The effects of stress on cognitive function are determined by a number of factors, such as the intensity, frequency, and control ability of the stressor. Mild stress increases cognitive function, and severe stress impairs cognitive function[24]. Controlled stresses have a positive effect on learning, whereas uncontrolled stress leads to cognitive impairment[25].

Although the impact of stress on cognitive function is related to corticosteroids[26], but they can also be linked to a neuropeptide, a corticotropin-releasing factor (CRF) that controls many aspects of stress response. The MA system affects the control of cognitive elasticity by adaptive methods of CRF modulation to combat acute stress[27].

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It is well known that the NA system is activated in the brain during acute stress[28]. The hypothalamic centers, which encompass neurohormonal regulatory mechanisms, protect normal homeostasis in the body. MAergic mechanisms play an important role in these processes.

MAs are closely related to with most of the indicators involved in the learning process, including memory, attention, perception, emotion, and so on[29,30]. Therefore, we considered it necessary to study the dynamics of MA in order to analyze the physiological mechanism of the impact of stress factors on the student's organism during the IAL process and to explore ways to optimize the resulting stress. To this end, we conducted a study on animals as a model to study the effect of water and food deprivation on the level of MA in the CNS.

The role of serotonin in neuronal and behavioral plasticity is increasingly better evaluated[31]. The importance of plasticity for training is functionally important. NA may increase memory, especially for emotionally exciting events in the context of stress[32].

To conclude the analysis of the mechanism of development of stress forms under the influence of specific and non-specific stress factors, it should be noted that while the physiological mechanism of stress development under the influence of both factors is similar, the

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severity of stress levels varies depending on the intensity and duration.

If the IAL process is carried out in compliance with all the provisions of the manual, it can be assumed that mainly short-term stressors may occur.

It became clear from our individual observations that the period of recovery of the initial state in students who were active in the discussion of the IAL materials was longer than the passive students, despite the fact that the active students had a very positive emotional level. We determined the duration of the recovery process observed in students by vegetative indicators. As organism uses a certain to generate positive emotions, its internal environment (homeostasis) is restored slowly.

Although interactive learning is the not the same as extreme conditions, unusual extreme factors can sometimes be observed in the learning process.

According to the results of our research, the participants of interactive learning materials are classified into 4 groups: active-constructive, active-non-constructive, passive, neutral. According to this classification, an increase in the number of students included in group I and a decrease in other groups according to the levels of participation in the discussion of learning materials under the influence of stress factors arising in the active learning process may be interpreted as an improved learning success.

It was considered expedient to divide the changes in thinking caused by stress into three types: I - activation of thinking, II - the development of passivity in thinking, III - increase of productivity in thinking (without changes in emotional behavior and reflexes)[33].

In general, to conclude the analysis of the effects of stress on cognitive processes and thinking, it can be said that it has an activating, passivating and eliminating effect on thinking, depending

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on the strength of stress factors, the nature of the impact and the temperament of the affected object.

No doubt, extreme stressors cannot be compared with the stress arising during IAL. However, as noted above, the positive effect of eustresis arising in the analysis of a particular problem during IAL, on the mood of active students is obvious.

Summing up the analysis of the results of our research, it can be noted that for the first time, TAPCS was used as a means of optimizing stress factors arising in the IAL process. The following evidence suggests that "TAPCS is an adequate means of optimizing stress factors in the IAL process":1) an increase in visual and auditory memory levels after IAL conducted by TAPCS compared to the values after IAL; 2) an increase in the level of visual and auditory memory after the IAL conducted by TAPCS is accompanied by a decrease in the level of state and trait anxiety; 3) diagnosis and correction of CNS defects that cause misunderstanding and tension in teacher-student and student-student relations; 4) neutralization of negative effects of slow and hyperactive children on teacher-student relations; 5) Adapting the training materials discussed in the IAL process to the age characteristics and potential of students; 6) Taking into account the daily, weekly, monthly and quarterly dynamics of students' functional status (ability to work) in compiling lesson schedules; 7) Taking into account students' temperament types, especially emotional levels, in the IAL process. 8) preparation of daily, weekly, monthly routines (including nutrition, sleep, homework, games and sports activities) in order to ensure the health of students, also teacher and parental control over the implementation of this work.

Based on the results of research by various authors and the results of our research, it is possible to state, that we may provide conditions for the normal functioning of cognitive indicators, including memory, perception, comprehension and thinking, by focusing the impact factors on the creation of "eustres" to relieve stress in the interactive learning process.

CONCLUSION

1. While trait anxiety in adolescents increases to the maximum level due to the influence of anxiety factors arising in the process of IAL, in young people a sharp increase is observed in the level of state anxiety under appropriate conditions. After IAL, depending on the type of nervous system in adolescents and the formation of the ability to adapt to the learning process, anxiety levels are much higher than average, and the initial state is recovered later than in young people.
2. If students are classified into 4 groups (I - active-constructive, II - active non-constructive, III - passive and IV - neutral groups) according to the level of participation in the discussion of training materials under the influence of stress factors in the process of IAL conducted by TAPCS, the level of increase in the number of children (due to the inclusion of children who differ in other groups in group I) can be assessed as an indicator of the success of interactive learning.
3. Students' high motivation and mood, accompanied by a decrease in state and trait anxiety, vegetative indicators, also an increase in visual and auditory memory, which is an indicator of emotional level in the process of IAL compared to IAL conducted by TAPCS demonstrates reduced emotional tension and optimization of stress factors.
4. In order to clarify the neurophysiological mechanism of optimization of stress factors arising in the process of IAL, the dynamics of MA after water and food deprivation was studied as a non-specific form of stress (as a model) in rabbits. Studies have shown that 1, 3, and 5 days of forced water and food deprivation resulted in increased levels of NA and decreased levels of DA and 5-HT compared to the controls in the tissue and mitochondrial fraction of brain structures of rabbits. In the context of water deprivation, changes in MA levels were more apparent than in food deprivation.
5. 7 days after cessation of water and food deprivation lasting for 5 days, the levels of NA, DA and 5-HT partly recovered in the

tissue and mitochondrial fractions of brain structures. Although the recovery of MA level in the context of food deprivation was higher than in the case of water deprivation, complete recovery processes have not taken place. The results show that, depending on the duration of the stress and the type of stress, it causes different changes in the MA system, as well as differences in recovery processes

6. Based on changes in the dynamics of MA in the brain as a result of non-specific stress factors, the emotional tension generated during the IAL process can be explained by changes in the MA system in the brain. The decrease in emotional tension in the IAL is due in part to the fact that the changes in the dynamics of MA in the brain are less than in the IAL.

List of publications on the topic of the dissertation

1. Hacıyeva, E.T. İnteraktiv təlim prosesində şagirdlərin fizioloji xüsusiyyətlərinin nəzərə alınması stress amillərinin optimallaşdırılmasının əsas vasitəsi kimi. // Azərbaycan Respublikası Təhsil Nazirliyi. Azərbaycan Respublikası Təhsil İnstitutu. Elmi əsərlər, 2018, cild 85, №1, səh.113-118.

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LIST OF ABBREVIATIONS

5-HT – serotonin or 5-hydroxytryptamine
BP- blood pressure
CRF - corticotropin release factor
DA - dopamine
İAL – interactive lesson
MA - monoamine
NA - noradrenaline
TAPCS – taking into account the physiological characteristics of students

The defense of the dissertation will be held on « 16 » march in 2022 at « 11:00 » o'clock at the meeting of the Dissertation Council FD1.08 operating under the Institute of Physiology named after Academician Abdulla Garayev of ANAS.

Address:AZ 1100, Baku, Sharifzada street 78.

The dissertation is available in the library of the Institute of Physiology named after Academician Abdulla Garayev of ANAS.

Electronic versions of the dissertation and autoreferat are posted on the official website (www.physiology.az) of the Institute of Physiology of the Azerbaijan National Academy of Sciences named after Academician A.Garayev.

The autoreferat was sent to the necessary addresses on the « 11 » february in 2022.

Signed for publishing: 03 .02.2022
Paper format: 60 x $84^{1/16}$
Volume: 38589 symbols
Circulation: 20