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COMPARATIVE ANALYSIS

OF COGNITIVE CHANGES UNDER THE INFLUENCE OF EXAMS STRESS IN HEALTHY AND MENTALLY RETARDED ADOLESCENTS AGED 14-16

ANÁLISIS COMPARATIVO DE LOS CAMBIOS COGNITIVOS BAJO LA INFLUENCIA DEL ESTRÉS DE LOS EXÁMENES EN ADOLESCENTES SANOS Y CON RETRASO MENTAL DE 14 A 16 AÑOS

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ABSTRACT

This paper analyzes the psychophysiological changes that occur during the impact of exam stress on healthy and mentally retarded schoolchildren aged 14-16 years. Psychological and cognitive indicators were studied. The experiments were carried out in three stages: a regular school day (control); and before and after exam. An analysis of the data obtained showed that during the exam in healthy schoolchildren psychophysiological changes occur, i.e. high level of indicators of tension (anxiety) and weakening of cognitive indicators, etc. After exam, a tendency to return these indicators to the control level was observed. Unlike healthy children, mentally retarded schoolchildren at control exam showed a high level of anxiety; cognitive performance was 35% below normal. In exam period, these indicators remained at relatively constant level. A comparative analysis of the data obtained showed that, depending on the level of mental development of schoolchildren, exam stress creates a psychoemotional state in schoolchildren and this can have a serious impact on their health.

Keywords: adolescence, exam stress, emotional tension, anxiety indicators, cognitive indicators, psycho-emotional state, oligophrenics, memory, attention, depression.

RESUMEN

Este artículo analiza los cambios psicofisiológicos que se producen durante el impacto del estrés de los exámenes en escolares sanos y con retraso mental de 14 a 16 años. Se estudiaron indicadores psicológicos y cognitivos. Los experimentos se realizaron en tres etapas: un día escolar regular (control); y antes y después del examen. Un análisis de los datos obtenidos mostró que durante el examen en escolares sanos ocurren cambios psicofisiológicos, es decir, alto nivel de indicadores de tensión (ansiedad) y debilitamiento de indicadores cognitivos, etc. Después del examen, se observó una tendencia a devolver estos indicadores al nivel de control observado. A diferencia de los niños sanos, los escolares con retraso mental en el examen de control mostraron un alto nivel de ansiedad; el rendimiento cognitivo estaba un 35% por debajo de lo normal. En el período de exámenes, estos indicadores se mantuvieron en un nivel relativamente constante. Un análisis comparativo de los datos obtenidos mostró que, dependiendo del nivel de desarrollo mental de los escolares, el estrés de los exámenes crea un estado psicoemocional en los escolares y esto puede tener un impacto grave en su salud.

Palabras clave: adolescencia, estrés de exámenes, tensión emocional, indicadores de ansiedad, indicadores cognitivos, estado psicoemocional, oligofrénicos, memoria, atención, depresión.

INTRODUCTION

The issue of emotional stress, its research, diagnostics and modern methods for correction has become more urgent for society in recent years. It is no coincidence that instability and uncertainty in society lead to constantly increasing and intensifying stress factors (social, psychological, physical). The emergence of emotional tension and, ultimately, a sharp increase in mental and psychosomatic diseases, weakened immune system, disorder of adaptive functions and reductions in life expectancy are related to stress. All this is reflected in the heredity and gene pool of the population (Aftanas, 2000; Bodrov, 1995; Meyerson, 2011).

It is known that emotional tension is a special mental state, which is closely connected with the emotion formation and is reflected not only in physiological phenomena, but also in the body's motivation, cognitive, volitional and other psychological indicators. According to the general opinion, emotional tension (especially when tension reaches the level of stress) is the result of the interaction between the individual and the external environment, along with the nature of situation. For this reason, the conditions and nature of stress in one person may not coincide with another person's reactions. And the final result proves the importance of studying the relationship between the individual and the environment in which the individual lives. Currently, the elimination of emotional stress has become an urgent problem because of the inability of the human body to meet its leading social or biological needs as a result of the proliferation of long-term adverse conditions caused by various conflict situations (Bacherikov et al., 1995; Loboyako, 1981; Vedhara & Nott, 1996).

The role of the regularities of formation of cognitive processes in the perception of the environment serves as one of the most essential problems. The adequacy of this type of activity ensures the survival and stability of the organism in the environment. Manifested through these psychophysiological indicators in humans, it is identified adaptive, individual-psychological abilities and different features that arise in the process of personality development (Bodrov, 1995). However, the integration features of psychophysiological mechanisms under the influence of emotion depend on the individual's ability to perceive the environment. Modern research in this area is mainly based on the provisions of cognitive theory (Launer et al., 1994). According to this theory, cognitive processes ensure the quality and intensity of emotional reactions by correctly assessing the nature of real conditions that have arisen.

The analysis of the studies conducted to address this problem at the present time proves that the main focus

is on the study of the organizational factors and the characteristics of the functions of the body in the context of various stressors. Psychophysiological aspects of emotional stress, its processes of formation of brain mechanisms have been less studied. In such conditions, the regularities of the reflection of adequate information equivalence in brain activity, as well as the characteristics of personal determination and the development of cognitive processes in emotional stress of various etiologies have not yet been fully studied.

METHODS

In this regard, it is of interest to experimentally study the effect of emotional stress on the psychophysiological indicators of two groups of adolescents, depending on the level of mental development. The aim of the research is to study cognitive processes in students during exam depending on the level of emotional tension. Along with the study of cognitive processes, anthropometric, vegetative and psychological indicators in adolescents were studied. The aim is to comprehensively assess the mechanisms of action of emotional tension. There is an interest to determine the psychophysiological changes caused by exam stress and to clarify the relationship between cognitive processes and emotional stress. The exam process is a classic model of emotional tension. The studies were conducted among 120 healthy schoolchildren from the Ecology Lyceum No. 291 in Baku and 60 schoolchildren aged 14-16, of the special boarding school in Sumgayit for children with mental and physical disabilities, who were diagnosed with dementia (oligophrenia).

The following psychotests were used in the study of psychological indicators: Spielberger - Individual and situational anxiety through the Khan's test, general anxiety through the Taylor test, depression test on the depression scale. Among cognitive processes, short-term memory (through the "Memory by number" test), visual memory (through the pictorial visual memory table), voluntary attention (through the "Placement of numbers" test) were mainly studied. The experiments were conducted in three stages: on one of the usual school days (1-1.5 months before exam); pre-exam period (45 minutes before exams); 2 hours after exam.

DEVELOPMENT

The results of the study of psychological and cognitive indicators are presented in Table 1 and Table 2. The results of research show that under the influence of emotional stress, changes occur depending on the level of mental development. At present, the psycho-emotional changes observed are assessed as the body's adaptive response

to situation. It is known that emotional tension allows for the emergence of adaptive behavior as a reinforced purposeful reaction in the process of evolution, and enhances the reception of information, accelerates the course of neurophysiological processes (Leontiev, 2000; Wolf et al., 1995). The integration of psychophysiological mechanisms of body is a decisive factor for the emotional state, allows body to adapt to different extreme conditions, to develop adequate response, and thus leads existing conditions to common psychological level (Vedhara & Nott, 1996).

Table 1. Effect of exam stress on the psychophysiological indicators of practically healthy adolescents.

Age of schoolchildren	14 years			15 years			16 years		
	a	b	c	a	b	c	a	b	c
Situational anxiety	30,82 ±1,02	45,87 ±1,33 ***	40,29 ±0,26 **	31,92 ±1,55	46,18 ±1,86 ***	34,83 ±0,92	31,88 ±2,05	46,53 ±1,94 ***	33,76 ±1,05
Individual anxiety	40,47 ±0,66	45,93 ±0,55 ***	43,26 ±1,92	44,78 ±2,04	46,04 ±1,88	45,29 ±1,04	46,98 ±2,13	48,94 ±1,86 *	45,92 ±1,74
General anxiety	25,27 ±0,73	42,82 ±0,75 ***	38,34 ±0,79 ***	26,78 ±1,73	45,74 ±0,89 ***	34,76 ±1,96 **	29,89 ±1,15	48,33 ±0,94 ***	38,69 ±1,24 ***
Depression indicator	42,03 ±1,23	41,57 ±0,96	40,27 ±1,24	42,44 ±0,77	44,83 ±1,24	41,36 ±1,09	44,02 ±0,84	45,49 ±1,33	44,26 ±1,83
Short-term memory	7,25 ±0,23	5,91 ±0,25 *	5,97 ±1,08	7,55 ±1,28	5,93 ±0,29 *	7,09 ±1,05	5,87 ±0,34	5,01 ±0,34	6,29 ±1,04
Visual memory	9,55 ±0,57	7,03 ±0,54 **	8,22 ±0,19 *	11,54 ±0,57	9,67 ±0,94 *	10,23 ±0,77	10,88 ±0,86	9,28 ±1,02 *	10,23 ±0,94
Voluntary attention	22,16 ±0,49	20,29 ±0,43 **	20,33 ±0,46 **	23,64 ±0,84	21,44 ±0,74 *	22,14 ±0,76	23,38 ±0,67	21,17 ±0,77 *	22,27 ±0,46

Note: a - ordinary school day, b - before exam, c - after exam; •- $p < 0,05$, ** - $p < 0,01$, *** - $p < 0,001$.

Table 2. Effect of exam stress on the psychophysiological indicators of oligophrenic students.

Age of schoolchildren	14 years			15 years			16 years		
	a	b	c	a	b	c	a	b	c
Situational anxiety	41,22 ±1,03	41,45 ±1,36	41,83 ±0,75	41,96 ±1,65	41,43 ±1,75	38,94 ±1,66	40,72 ±1,25	43,83 ±1,57	42,94 ±0,98
Individual anxiety	47,33 ±0,58	47,67 ±1,84	47,01 ±0,45	47,18 ±1,04	46,29 ±1,82	46,93 ±1,09	50,57 ±1,19	49,82 ±1,54	48,85 ±1,43
Short-term memory	3,36 ±0,66	3,67 ±0,92	3,29 ±0,72	4,02 ±0,26	3,75 ±0,84	4,09 ±0,35	2,67 ±1,02	2,09 ±0,65	2,43 ±0,86
Visual memory	8,27 ±0,59	9,75 ±0,74	9,05 ±0,66	8,55 ±0,56	9,97 ±0,84	10,99 ±0,66	8,93 ±0,84	8,29 ±0,99	7,95 ±0,69
Voluntary attention	7,64 ±0,53	7,92 ±0,48	7,01 ±0,57	7,96 ±1,02	7,04 ±0,59	7,06 ±0,46	8,44 ±0,98	7,65 ±0,39	6,69 ±0,66

Note: a - ordinary school day, b - before exam, c - after exam

However, the integration features of psychophysiological mechanisms under the influence of emotional tension depend on individual's ability to perceive the environment. For this reason, modern research is mainly based on the provisions of cognitive theory (Lazarus, 1991), that is, cognitive processes ensure the quality and intensity of emotional reactions by

correctly assessing the nature of real situation. However, the regularities of the brain's response to information reaching the brain, the development of cognitive processes in emotional stress of various etiologies, and the characteristics of personal determination are not clear enough, and the genesis of their brain mechanisms is relatively understudied.

Psychophysiological changes in adolescents due to emotional stress can have a negative impact on their development, laying the groundwork for neuropsychiatric and somatic illnesses that are likely to occur in the future. Adolescents form a special group in society: they are at a faster stage of development of the emotional sphere and cognitive processes, as they are at the end of childhood and the beginning of the future independent life. During adolescence, a child's belief system and personal qualities are developed. In particular, the effects of emotional stress at these early stages of development can lead to more serious complications and adaptive disorders, resulting in changes in behavior, psychological state, temperament, and in loss of health (Meyerson, 2011; Rosch, 1996).

It is known from the literature that under the influence of emotional stress, first, the normal course of cognitive and intellectual processes change (Launer et al., 1994; Rosch, 1996; Shcherbatykh, 2000). In stress conditions, normal human activity depends on the course of adaptation processes. It is known that the end product of adaptation processes in brain is the formation and fixation of new functional system. Adaptive processes include the interaction system, serving as the basis of memory, and the adequate change of the system during times of stress. On the other hand, the inability of the human body to meet its basic social or biological needs as a result of long-term adverse conditions caused by various conflict situations also creates emotional stress (Aftanas, 2000; Wolf et al., 1995).

This, in turn, leads to change in behavior and disruption of inter-system communication. During the experiments, along with the methods of psychological testing, the behavior of students during exams was observed. A feeling of excitement was observed visually among the majority of practically healthy schoolchildren. Thus, changes in psychological parameters and cognitive indicators during exam process, and changes in vegetative indicators once again prove the tension of the body's regulatory systems during this period. It is known that the body's close contact with the external environment is carried out by homeostasis self-regulatory systems, which reveal the ability to control and combine various functional processes. Changes in the environment cause tension in homeostasis, which,

at best, creates a new functional state corresponding to all parameters or conditions. As a result, the emotional tension is eliminated. Thus, the stress process can be considered as a normal physiological adaptation response aimed to compensate homeostasis in emotionally tense situations (Abdi & Sharma, 2004; Dmitrieva et al., 2006).

The results of personal studies showed that during exam, under the influence of emotional stress, depending on the level of mental development, adolescents develop psychophysiological reactions that are clearly manifested. In this case, the degree and duration of emotional arousal depends on the degree of perception of the factor influencing objectively and the psychophysiological characteristics of the personality. It is known from the literature that stress affects the whole organism, and the reaction of living things is different in such situations (Cohen et al., 1983; Hedden et al., 2005). People are extremely sensitive to the effects of stress, and an interesting feature is the ability to respond adequately to changes in the external environment. The most common responses to stress are fear, anxiety, and so on (Loboyako, 1981; Shcherbatykh, 2000).

While the results of our personal experiments revealed that healthy adolescents had a moderate level of anxiety during psychological testing on a normal school day, a high level of anxiety was observed before exam process. After exam, the anxiety dropped to a medium level. Unlike healthy adolescents, mentally retarded adolescents showed lower levels of anxiety in all three cases. The obtained facts once again prove that the change in the level of anxiety depends on the emotional assessment of situation. Increase in anxiety levels was reflected in behavioral changes, anxiety, and clearly manifested neurotic states. As noted, stress is a complex integration of the body's defense systems against environmental factors. The body reacts to environmental factors through the physiological and psychological mechanisms of adaptation (Can-on, 1981).

As a rule, the former are aimed at maintaining homeostasis and against environmental factors, while the latter provide a program of behavioral activity to minimize the stress of physiological systems and are aimed at removing the organism from the area of said factor. That is, during stress, the body reacts both with non-mental response and personal mental reactions - negative emotions (the response can often be limited), and the corresponding act of behavior takes place. An increase in the level of excitement before exam serves to get the body out of the tense situation. However, it should be noted that in all experiments, healthy adolescents did not experience depression. The results showed that the mental functions of

the Central Nervous System (CNS) can adapt to the situation. As a result of incomplete adaptation processes and incomplete formation of CNS functions, there is an increase in mental indicators and an increase in anxiety. Against the background of other levels of anxiety in mentally retarded adolescents, only the individual level of anxiety was high. The findings suggest that while the situation of emotional tension is not perceived by mentally retarded adolescents and is not able to give emotional value to the situation, the presence of constant internal tension in such people has led to increase in individual anxiety. It is known from the literature that emotional tension creates conditions for the emergence of adaptive behavior as purposeful reaction strengthened in the process of evolution, and consequently, the perception of information and the pace of neurophysiological processes increase (Abdi & Sharma, 2004; Cohen et al., 1983; Hedden et al., 2005).

The integration of the psychophysiological mechanisms of living organism is a decisive factor for the emotional state, allowing living things to adapt to different extreme conditions, the formation of adequate reactions, and ending with the formation of common psychological level. Nevertheless, the integration features of psychological mechanisms under the influence of emotional stress depend primarily on the ability to perceive the environment. Among neurophysiological functions, cognitive processes play basic role (Belopolskaya, 1999; Can-on, 1981). The studies showed that cognitive processes change depending on the level of mental development under the influence of emotional stress. First, let's look at short-term memory. In practically healthy adolescents, short-term memory on normal school day was within norms among 14-15-year-old adolescents but was below norm in only 16-year-olds (5.87 ± 0.34 points). In the older age group, short-term memory was lower than normal on ordinary school day, which can be explained by the fact that they also assess the testing process as an emotionally stressful situation and excessive tension of cognitive processes.

It is known from the literature that the intensification of cognitive processes sometimes results in stress and manifests itself in the flow of self-awareness processes. In our experiments, this condition was observed in the upper age group of adolescents. During exam, a decrease of about 18% compared to the usual school day was observed in all age groups. This can be attributed to the acceleration of the processes of delay in the CNS due to the impact of emotional stress and the development of the body's defense reactions (Abdi & Sharma, 2004; Hedden et al., 2005). After exam, in the upper age groups, who realized that the factors affecting stress were completely eliminated, the indicator was observed to be in basic

level, while in 14-year-olds it was 17% lower than the usual school day. As we noted, the process of activation of cognitive processes during exam can serve as a factor in the emergence of emotional tension. The delay of these processes after exam can play the role of eliminating one of the stressors, which can allow the body to return to its permanent state due to its adaptive capacity (Launer et al., 1994).

Due to the incomplete formation of adaptation processes in minors, there was a delay in the process of returning the studied indicator to the level of normal school day. The results of short-term memory in mentally retarded adolescents were completely different. Thus, the said indicator on ordinary school day was 3.35 ± 0.64 points, i.e., 47.8% below the normal level. Although a relative change was observed in studies conducted under the influence of emotional stress, the results were not reliable. The literature also shows that short-term memory for mentally retarded adolescents fluctuates between 2.5 and 3.5 points (Blonsky, 2001; Petrov, 1995). The lack of significant changes under the influence of emotional stress proves once again that this group of adolescents has defective perception and memory processes are underdeveloped. It should be noted that as the physiological age increases, the short-term age indicator decreases.

Interesting facts were obtained during the study of visual memory among cognitive indicators. Thus, among practically healthy adolescents, visual memory was approximately 40–52% higher than normal in all experiments. The relative changes that occurred during exam were unreliable and remained within norm. This result is due to the fact that healthy adolescents have the opportunity to remember familiar images without any difficulty, and the normal functioning and perception of vision analyzers. Similar results were obtained in mentally retarded adolescents. Thus, it is known from literary sources that the perception of vision is of special importance and has its own significance for mentally retarded adolescents. Most of this group of people perceive the environment through their perception of vision. Unlike healthy adolescents, the increase in testing time allows mentally retarded adolescents to fully comprehend and remember the object being described. The main reason for this is the delay in the processes of analysis and synthesis due to the weakening of the functions of the cerebral cortex, which is peculiar to oligophrenics (Petrov, 1995). Peresleni and Rozhkova (1996) have found in specific experiments that the analysis of sensory information in mentally retarded adolescents is very slow and selective. Based on the results of our studies, we can say that the number of errors in the memory of familiar objects is minimized in mentally

retarded adolescents. Since the images used in the test were familiar to mentally retarded adolescents and the duration of time was increased, the results were within the norm.

It is known from the literature that as a result of emotional stress, significant changes occur in attention processes (Shcherbatykh, 2000). Thus, voluntary attention plays an important role in the regulation of cognitive processes (Leontiev, 2000; Wolf et al., 1995). It is through voluntary attention that a person concentrates and seeks a way out of the emotional situation and acts purposefully. Voluntary attention protects the CNS from receiving excessive information and facilitates the perception of necessary information (Vedhara & Nott, 1996). The results of our study prove that voluntary attention in healthy adolescents remains within the norm, despite a significant decrease and change due to emotional stress. Cognitive impairments in mentally retarded adolescents were once again reflected in the results of voluntary attention. A relative change was observed which resulted from the effect of emotional tension. Thus, the literature states that voluntary attention disorder is one of the main symptoms in mentally retarded adolescents (Bacherikov et al., 1995; Petrov, 1995). Low levels of voluntary attention are characterized by a number of disorders: small memory span, poor endurance and easy shift of focus from one object to another, lack of interest in focusing on areas of interest and unfamiliar objects, and so on. Even the slightest irritation can lead to diversion of attention. Thus, their weak voluntary attention has a negative effect on purposeful activity and ability to work (Bryazgunov & Kasatkina, 1999; Petrov, 1995).

The lack of reliable change during exam can be explained by the poor assessment of condition. The main role as a dominant factor in the regulation of intellectual activity in the context of emotional tension is the harmony of personality, the degree of compatibility between desired and real work and the achievement of goals. As practically healthy adolescents aimed to achieve high results during exam, they also had high levels of emotional tension, which negatively affected the course of cognitive processes, which was reflected in the process of self-awareness. Several studies have noted that, depending on the nature of the threat, not only in anxiety and worry, but also in cognitive processes perceiving the threat as risk and its assessment process take place. According to researchers, two independent reactions to stress by humans are distinguished: emotional (anxiety, etc.) and intellectual (risk assessment, analysis of the existing threat at cognitive level) (Lazarus, 1991). Other sources state that the emotional response may include fear, concentration difficulty, aggression, a number of autonomic stress reactions,

and agitation. Other sources make it clear that there is a link between increased levels of anxiety and cognitive processes.

According to Yerkes-Dodson Law, there is a U-shaped connection between the strength of the body's arousal and performance of task. The level of irritability required for optimal behavioral activity is at the center of the scale. According to the second law of the YD principle, the more complex the task, the lower the level of irritability is required to achieve maximum success. Levels of irritability that increase during the solution of simple task may lead to the impossibility of solving more complex task. The same is true for humans. For example, a medium level of arousal may not be enough to solve a task. Increase in the level of anxiety will lead to violation of normal human behavior and violation of the performance indicators of task (Molen & Hoit, 1986). We witness this law in our personal experience. At the average level of arousal, the number of errors during testing was minimal. The decrease in the number of correct answers by mentally retarded students with high levels of individual anxiety and in all adolescents with increased levels of anxiety during exam once again reflects the close link between emotional stress and cognitive processes.

It is known that under the influence of stress factors, both physiological and psychological processes are activated simultaneously and work in combination. Activation mechanisms play important role in the development of psycho-emotional tension: emotional resilience plays an important role in a person's reactions to emotional stress conditions such as emotional endurance, will characteristics, self-induction level, arousal, etc. It determines the level of emotional tension in such situation (Bacherikov et al., 1995; Meyerson, 2011). People with high emotional resilience often have an adequate response of active type. It was found that the response to stress depends largely on the characteristics of the nervous system: the regulation of nervous processes, the level of emotional tension, temperament, adaptation to situation, and so on.

All of the abovementioned and the literature once again prove that the main role in the emergence of emotional tension plays the activation of cognitive processes, the ability to understand the real situation and emotional evaluation. Cognitive processes play a key role in the development of emotional stress, depending on the level of mental development under the influence of test stress that we used experimentally, leading to the development of psychological and autonomic reactions, cognitive and perceptual processes, the results of which is reflected, as in our example, in the learning process and life activities of adolescents (difficulty in mastering learning material,

fatigue, headaches, insomnia, sometimes unreasonable aggression and depression, sometimes loss of appetite due to the development of autonomic dysfunction, diarrhea, vomiting, fever, hand tremor, etc.). Taking into account the above-mentioned, it is possible to increase the self-confidence of teenagers before exam period, to adapt them to real exam process by creating conditions similar to exam process, and to reduce the level of emotional tension that can arise through a series of psychological conversations. And this is the basis for ensuring the development of healthy future.

CONCLUSIONS

Emotional stress during exam caused psychophysiological changes in adolescents aged 14-16, depending on their level of mental development. It was found that the deeper the changes in the studied psychological, cognitive and vegetative indicators, the more they are observed even after the cessation of the emotional stress effects. Thus, an increase in the arousal level, depending on the level of mental development, leads to the activation of cognitive processes by emotionally assessing exam conditions.

The research results prove the negative impact of situational anxiety on the cognitive processes of adolescents, depending on the mental development level. This is less common in oligophrenics who are unable to properly assess emotionally stressful situations.

In oligophrenic adolescents with mental retardation, the ability to give emotional value to the situation is weak because the process of perceiving the environment is difficult. The high levels of individual anxiety in adolescents with mental retardation indicate high activity of the internal component of emotional stress.

Comparative analysis of psychophysiological indicators of practically healthy and mentally retarded adolescents under the influence of emotional stress shows that the level of development of cognitive processes does not depend on anthropometric indicators and that the temperament, physiological age, sexual maturity, mental development level, and adaptation processes are interrelated. Emotional stress affects the activity of information retrieval in healthy adolescents, leading to impaired attention, logic and memory. These changes are most common in healthy 14-year-olds.

Comprehensive assessment of the psychophysiological changes observed under the influence of emotional stress, depending on the level of mental development, can be considered as one of the most promising areas for

prophylaxis of neuropsychiatric and somatic diseases in adolescents and for development of prevention plan.

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