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## CHANGES IN THE FREQUENCY OF EEG WAVES IN THE CEREBRAL CORTEX OF SANGUINE STUDENTS

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The study is devoted to the change of the oscillation of alpha-, beta-, delta- and theta-waves in the forehead and occipital part of the brain during the exam process in V-year students, depending on the temperament of the nervous system. Before starting the study, temperament types of the students' nervous system, their individual and situational anxiety levels were studied. The amplitude of alpha-, beta-, delta- and theta-waves in the foreheads of students of different temperament types was determined and recorded using an electroencephalograph device in all 3 groups: on normal days, before the exam and after the exam. It was determined that there is a noticeable difference in the electrical activity of the brain of students in the V course at all stages.

**Key words:** EEG waves, amplitude, emotional stress, situational and individual excitement, sanguine type of temperament.

## Т.В. Рустамова, А.Г. Казимов ЗМІНИ ЧАСТОТИ ХВИЛЬ ЕЕГ У КОРІ ГОЛОВНОГО МОЗКУ У СТУДЕНТІВ САНГВІНІКІВ

Дослідження присвячено зміні коливань альфа-, бета-, дельта- і тета-хвиль у лобно-потиличній частині головного мозку під час екзаменаційного процесу у студентів V курсу в залежності від темпераменту нервової системи. Перед початком дослідження були вивчені типи темпераменту нервової системи студентів, рівень їх індивідуальної та ситуативної тривожності. Амплітуду альфа-, бета-, дельта- і тета-хвиль на лобі студентів різних типів темпераменту визначали та реєстрували за допомогою електроенцефалографа у всіх 3 групах: у звичайні дні, перед іспитом і після іспиту. Визначено помітну різницю в електричній активності мозку студентів V курсу на всіх етапах.

**Ключові слова:** хвилі ЕЕГ, амплітуда, емоційне напруження, ситуативне та індивідуальне збудження, сангвінічний тип темпераменту.

In modern times, higher education institutions play an important role in the training of professional specialists and in the formation of a completely healthy person [2]. The education of students in higher educational institutions is represented by several important characteristics, and it highly depends on the majors chosen by students, their living conditions, age, gender, nutrition and unhealthy habits and so on [2, 6]. The task of teaching staff in higher education today, based on the targets set, is to select from their

methodical achievements all progressive means and thus to change, modernize, and transform the educational process, ensuring its research and exploratory character [8]. These factors affect the body of students individually and with multiple components, resulting in the change of several psychophysiological functions, especially the reactions of the central nervous system against environmental stressors [9].

One of the leading causes of psychophysiological stress in students is exam stress; it often leads to neuropsychological disorders as the final result. In the literature of recent years, the examination process is indicated as a factor able to cause psychotrauma [4, 7]. Exam stress is accompanied by the emergence of numerous complex psychophysiological changes in the body and affects the vital functions of a person (education, work, sports and so on). Nowadays, there are numerous situations similar to exam stress creating mental tension in the life of a modern person (for example, attestation, testing, competitions, expertise, competition for employment, defence of a thesis or diploma thesis, speeches in society and so on) [7]. In all cases, a person tries to achieve the set goal and depending on the type of higher nervous activity; the achievement may eventually result in psychological tension [6]. The exam session is full of questions creating uncertainty for the students. Already before the exam, the “waiting syndrome” itself creates psychophysiological stress in students [3].

Thus, such cases as violation of the regulation mechanisms in the nervous, vegetative-hormonal, mental and nervous system and finally, changes in the dynamics of perception and memory processes, weakening and breaching of the functions of adaptation to stressful conditions are manifested [7, 10] due to mental tension; insomnia appeared while getting ready for the exam, post-exam achievement and other reasons. In extreme and critical conditions, the importance of the problem of the self-regulation mechanism of physiological functions is high, and it usually arises due to the mobilization of the internal capabilities of the individual, ensuring the adaptation of the person to the conditions.

**The purpose** of the study was to reveal the age characteristics of the changes in the bioelectrical activity of the brain due to the effect of emotional stress caused by the examination process in students.

**Materials and methods.** The study involved 11 healthy sanguine-type male students of 21 years old. All participants studying at Ganja State University. Examinations of those students were carried out taking into account the proposal of the Bioethical Committee of the European Convention (Strasbourg, March 18, 1986). In addition, this research was considered and approved by the Ethics Committee of Ganja State University on October 23, 2017.

The students involved in the examination were divided into three groups: the students involved in the first group were examined 2 months before the examinations on normal days, the students included in the second group – 30 minutes before the examination and the students included in the third group – 30 minutes after the examination. The differences between them are shown as numbers and percentages. Before the experiment, the students’ temperaments were determined using Eysenck’s test [1, 2]. The study was focused on the psychophysiological peculiarities of various types of anxiety. The level of situational anxiety was determined using the test of Spielberg-Hanin and under three different conditions: on normal days (ND), before the exam (BE) and after the exam (AE) and it was determined by the express version of the test questionnaire. In neurophysiological examinations, EEG was recorded for 10–12 minutes at the usual time, before and after the examination, in the left and right cerebral cortex. The indifferent electrode is placed on the earlobe of the ipsilateral ear. Amplitude and frequency-spectral analysis of EEG waves obtained with the help of “Neuron-spectr 16 A” (“Neyrosoft” LLC, Russia) hardware-software complex is carried out. All numerical indicators obtained during the research were statistically analyzed taking into account modern recommendations. All calculations were made in MS EXCEL-2016 spreadsheet and SPSS-22 package program.

**Results of the study and their discussion.** While the frequency of delta waves in the left forehead of the brain of 21-year-old sanguine students was  $2.6 \pm 0.3$  hs on a normal day, this index decreased to  $2.1 \pm 0.2$  hs before the exam, but increased straightly after the exam and was equal to  $3.2 \pm 0.2$  hs ( $P < 0.01$ ) (fig. 1).

Similar regularities were observed in the right forehead of the brain. Thus, the frequency of delta waves on a normal day was  $2.8 \pm 0.2$  hs, before the exam it slightly decreased to  $2.4 \pm 0.2$  hs and after the exam this indicator straightly increased and was equal to  $3.4 \pm 0.2$  hs.

In 21-year-old students with sanguine type, the frequency of theta waves in the left forehead was  $5.4 \pm 0.3$  hs on a normal day and it was partially increased before the exam and was equal to  $5.7 \pm 0.3$  hs. After the exam, this increased indicator decreased slightly and was equal to  $5.2 \pm 0.3$  hs. In the right forehead, the frequency of theta waves on a normal day was  $5.2 \pm 0.5$  hs, and it increased to  $5.9 \pm 0.3$  hs before the exam. This level decreased slightly after the exam and was  $5.5 \pm 0.3$  hs.

Different results were obtained in the frequency of alpha waves in the left forehead of the brain in 21-year-old sanguine type students. Thus, the frequency of alpha waves was  $11.2 \pm 0.4$  hs on a normal day,  $11.2 \pm 0.6$  hs before the exam, and  $11.8 \pm 0.5$  hs after the exam. The frequency of alpha waves in the right forehead lobe was  $11.4 \pm 0.4$  hs on a normal day and before the exam and  $11.8 \pm 0.5$  hs after the exam and it means that practically the frequencies in the lobes didn't differ much from each other.

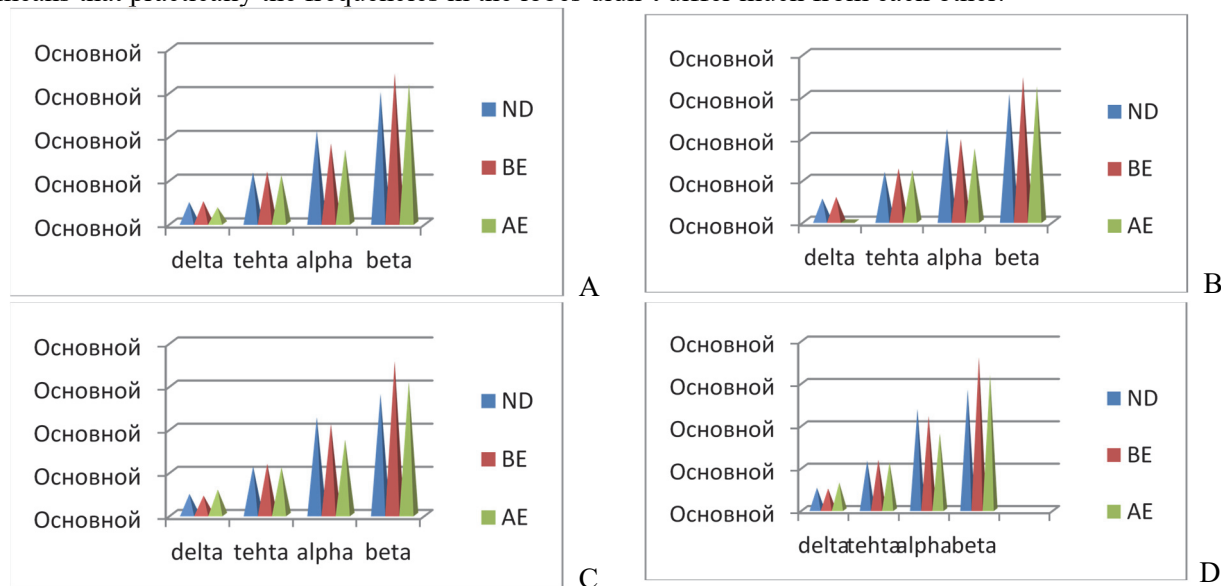


Fig. 1. The dynamics of EEG frequency changes (hs) in forehead (A – left, B – right) and occipital (C – left, D – right) parts of the brain in 21-year-old V-year students with sanguine temperament type in relation to the emotional stress of the exam process.

In sanguine temperament students, the frequency of beta waves in the left forehead of the brain was  $15.2 \pm 0.4$  hs on a normal day,  $15.3 \pm 0.5$  hs before the exam. After the exam, it increased to  $16.4 \pm 0.7$  hs. Similar regularities are noted in the frequency of beta waves in the right forehead. This level was equal to  $15.2 \pm 0.4$  hs on a normal day,  $15.1 \pm 0.5$  hs before the exam and  $15.8 \pm 0.9$  hs after the exam.

The results of the research show that the frequency of delta waves in the left occipital part of the brain of sanguine type students is  $2.3 \pm 0.1$  hs on a normal day, but this indicator slightly increased to  $2.6 \pm 0.3$  hs before the exam, but after the exam this number increased straightly and was equal to  $3.4 \pm 0.6$  hs ( $p < 0.01$ ). Similar regularities are observed in the right occipital part of the brain. Thus, the frequency of delta waves on a normal day is  $2.6 \pm 0.3$  hs, but slightly increased before the exam to  $2.9 \pm 0.3$  hs, and after the exam this number reliably increased and was equal to  $3.4 \pm 0.2$  hs ( $p < 0.01$ ).

In sanguine students, the frequency of theta waves in the left occipital part of the brain was  $5.9 \pm 0.3$  hs on a normal day and decreased to  $5.4 \pm 0.2$  hs before the exam. After the exam, this indicator was at the level of a normal day ( $5.9 \pm 0.3$  hs). In the right occipital part, the frequency of theta waves was  $5.6 \pm 0.3$  hs on a normal day and  $5.7 \pm 0.2$  hs before the exam. This level increased to  $6.1 \pm 0.3$  hs after the exam.

In 21-year-old sanguine students, the frequency of alpha waves in the left occipital part was equal to  $10.4 \pm 0.6$  hs on a normal day and  $11.3 \pm 0.5$  hs before the exam. After the exam, this number decreased to  $9.9 \pm 0.6$  hs. Similar regularities are observed in the right forehead of the brain. The frequency of alpha waves in the right occipital part was  $10.6 \pm 0.6$  hs on a normal day,  $11.8 \pm 0.6$  hs before the exam and  $10.1 \pm 0.6$  hs after the exam and practically it means that the frequencies in the lobes didn't distinguish more from each other.

In sanguine students, the frequency of beta waves in the left occipital part was equal to  $15.4 \pm 0.7$  hours on a regular day and  $15.2 \pm 0.6$  hours before the exam. It was equal to  $16.3 \pm 0.8$  hours after the exam. Similar patterns are observed in the frequency of beta waves in the right occipital region. This level was equal to  $15.6 \pm 0.8$  hs on a normal day,  $15.3 \pm 0.7$  hs before the exam and increased to  $16.9 \pm 0.7$  hs after the exam.

The analysis of the obtained results shows that significant differences in the frequency of certain EEG waves are noted in the forehead and occipital parts of the brain of 21-year-old V-year sanguine temperament students during the examination process. No other straight differences are observed in other waves. The level of emotional anxiety increases during the exam process at some of the students in this course. Therefore, the frequency of EEG waves recorded in the lobes of the brain of sanguine students increases in the frequency of EEG waves before and after the exam. In fact, the exam is a psycho-emotional stress exerting various effects on the functional state of the whole body. The emergence of emotional tension during the exam is the price of both the subjective and objective state of the student. Therefore,

before the exam, the level of individual and excitement in V-year students varies within the range of high scores.

The activity in the central and posterior regions of theta and delta bands at the students involved in the study increased during intense mental activity, the anxiety of the students during negative and positive emotions was relatively similar according to neurophysiological criteria: an analogous neurophysiological pattern is maintained with an increase in the power of delta waves and a decrease in the power of weak-wave components of the EEG during modeling of joy, surprise emotions (i.e. with a “Plus” sign) with the formation of beta and theta activity in the central and posterior regions of the cerebral cortex (more numerous), as well as the asynchronous type of EEG during emotions such as sadness, fear, anger.

In subjects with high stress, the baseline EEG and the EEG in examination stress was beta wave. In subjects with severe stress, the baseline EEG was beta wave and the EEG in examination stress was theta wave [11].

At the same time, low-frequency effects (delta rhythmic) in the forehead and occipital zones of the cerebral cortex during the experience of negative emotions before the exam in these groups were marked less than alpha-activity (in the alpha-2 range). After the examination, asynchronous effects in the left beta range in the forehead zone, as well as significantly lower theta activity in the central and posterior zones of the cerebral cortex were noted. Similar differences were also noted in the work of S.G. Danko [4], where left hemispheric activity in the alpha range (high frequency) interpreted as “curiosity, approach to the stimulus” was described in younger boys and theta-activity of the right hemispheres, which is evaluated as an “avoidance reaction” was described in others.

At the same time, comparative studies contributed to reveal for the first time the certain age differences in the neurophysiological support of different types of psychological activity in boys of different ages. Also, these differences are balanced in different age periods and they have new characteristics in other older ages.

Thus, the exam situation is a factor expressing the psychoemotional reactions of students. Individual psychophysiological reactions develop in students, their direction is determined by the importance of the emotional-stress state of the subject and its individual-typological characteristics under the influence of exam stress.

### Conclusions

1. The frequency of delta, alpha, beta waves in the left forehead part of the brain in the comparison of conditions on normal day and before the exam was straight with the frequency of delta, alpha, beta waves in the left forehead part of the brain in the comparison of conditions on normal day and after the exam.
2. A difference is observed only in alpha waves in the comparison of the indicators of the normal day and the day after the exam in the right forehead. There is no difference between the indicators in the left occipital part.
3. In the right occipital part, the difference of theta waves was straight in the comparison between the conditions before and after the exam.

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