ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Computer Analysis of Cognitive Functions of Students in the Biorhythms of the Brain.

Olga I Klochkova[1]*, Irina V Pogorelova[1], Marina S Startseva[1], Gennadiy A Shabanov[2], and Aleksandr A Rybchenko[2].

[1]Pacific National Medical University, Ministry of Healthcare of Russian Federation, 690002, 2 Ostryakovaave., Vladivostok, Russia.
[2]Laboratory of Ecological Neurocybernetics, Research Center "Arctic", Far East Branch of the Russian Academy of Science (FEB RAS), 690022, 95 Kirova str., Vladivostok, Russia.

ABSTRACT

The article studies the amplitude-frequency spectrum of the brain bioelectric activity function within the range of 27 - 0.13 Hz caused by reading auditory and visual adjectives. Sixteen women aged 18-20 took part in the experiment. The results showed the range of the greatest change of excitation (maximum) and inhibition (minimum) of brain bioelectric activity function. In case of reading visual adjectives, the changes are observed in theta and fast rhythms. It is necessary to conduct further research in order to elaborate the processing mechanisms of visual stimuli neuron in detail.

Keywords: bioelectric activity of the brain; cognitive processes in the brain; visual adjectives; auditory adjectives; brain-computer interaction during the process of reading auditory and visual adjectives on a computer presentation.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

The objective of the current study is to register and conduct the cluster comparative analysis of the brain bioelectric activity differential spectrum function caused by reading auditory and visual adjectives from a computer.

The study continues research on the detection of changes in brain processes during the process of controlling certain types of psychological activity [1].

MATERIALS AND METHODS

The measurements of the bioelectric activity differential function spectrum were performed in the laboratory of environmental neurocybernetics of the SIC "Arctic" FEB RAS on the diagnostic complex "Registrar of the spectrum of electromagnetic brain activity induction (MS MAGEE-01)" which are multi-turn coils for recording brain biopotentials[2,3].The researchers used bipolar leads in frontalis leads according to Kreinlein symmetric scheme with one common vertical electrode located on the sagittal line of the head in the upper part of the fissure of Rolando. The research applied standard biopotential amplifiers with the noise of no more than 1-3 μV, digital filtration with suppression of the signal above 30 and below 0.1 Hz in the investigated area.

As part of the study, fast and slow rhythms were recorded. Fast rhythms include beta (more than 12 Hz), alpha (8-12 Hz), theta (4-8 Hz) and delta (1-4 Hz) ranges. Normally, there are 2 types of delta vibrations: the first one has a cortical origin, the second one is generated in the thalamus. It is known that the intra-cortical delta-rhythm is connected with the slow processes within the cerebral cortex. Slow rhythms are recorded within 1-0.3 Hz. Preparatory activity is an example of slow cognitive activity.

Spectral estimation was carried out with the sampling rate of 0.06 Hz. In the programme spectral analysis, the frequency axis was divided into 840 frequency bands with the width of 3% from the central frequency. Appearing in the frequency band, the amplitudes of the spectral frequencies synergized as a result of FFT. The resulting amplitude set to the central frequency. The logarithmation procedure was applied to equalize the amplitude of the spectral assessment for different spectral frequencies and normalization. A similar approach was applied during the study of long-term reactions of electroencephalogram (EEG) of hippocampus and neocortex in pharmacological studies [6,7]. Only repetitive and stationary oscillations were distinguished. The duration of the analysis period was 160 s.

Adjectives. In this work, adjectives from linguo-psychological dictionary were used (Kolbeneva & Aleksandrov 2010). For the experiment, there was a selection of adjectives associated with highly-differentiated behavior (visual) and low-differentiated behavior (taste) aimed at finding differences by comparing the frequency range of fBA.

Adjectives make up the main part of the affective lexicon[4,5]. During the selection of adjectives, such a complex criterion as imagery (concreteness/abstractness) was taken into account. To eliminate the analysis of mechanisms of distinguishing between concrete and abstract words, concrete adjectives causing more associations were selected. As studies have shown, concrete words are perceived and processed easier than abstract ones, since, presumably, the analysis of more comprehensible, concrete words requires less stress of cognitive resources/

Participants

The experimental group consisted of 16 Russian-speaking women aged 18-20 years without any registered pathologies. Under the conditions of this experiment, it was not planned to identify gender differences and age-related peculiarities of perception. All the participants confirmed their consent to participate in the experiment.

Procedure

In order to identify common patterns, spectral analysis was carried out for all the subjects at once. Each subject had at least six series shot for each type of adjective: 3 measuring without intellectual load

ISSN: 0975-8585

(background) and 3 measuring in the process of computer presentation of 20 adjectives (auditory/visual) connected with senses to a medium and strong degree [4].The data were analyzed after measuring, as it was in the third cycle when the highest number of maximums and minimums of fBA were recorded.

The use of differential fBA allows separating (subtracting) the values of background spectral function. Background measurements are the values of fBA, the last one before the measuring session, when the subject, with his eyes open, sits in front of the notebook with the computer presentation. Normalization and transfer into the nondimensional form of the result, i.e., the differential spectral function of bioelectric activity, as well as the fast Fourier transform (spectral estimate) were performed programmatically on the software-hardware complex ''RS MEGI-01''.

Written in large print, there was one adjective placed in the center of the slide and was demonstrated for 5 seconds, after which there was an empty slide in front of the subject for 3 seconds. Measuring methodology allows reliable record of the total (global) activity of the brain singling out the spectral harmonics in the range of 27-0.13 Hz[2,3].

RESULTS AND DISCUSSION

Differential spectral function of the bioelectric activity. Using the software of the complex, the differential spectral function caused by the bioelectric activity (fBA) for the left and the right hemispheres was studied. The amount of positive and negative peaks of fBA may be higher in both left and right hemispheres (Figure 1). Figure 1 shows a visual graph of the difference between the spectral functions of bioactivity of the brain of excellent students and unsuccessful students in the process of reading visual and auditory adjectives in a computer presentation/ Negative peaks mean that the amplitude of the biological activity of the unsuccessful student brain more than the excellent students. The vertical axis shows the segments of the Central nervous system. The horizontal axis is the frequency spectrum in conventional units. The line on the graph (on the right hemisphere minimum) corresponds to the frequency of 6.49 Hz., This frequency of the theta spectrum is associated with the memory and hippocampus. The graph shows that the amplitude of fBA of the left hemisphere (dotted lines) is more powerful at excellent students then unsuccessful students. These results allow us a visual assessment of cognitive functions of students brain.

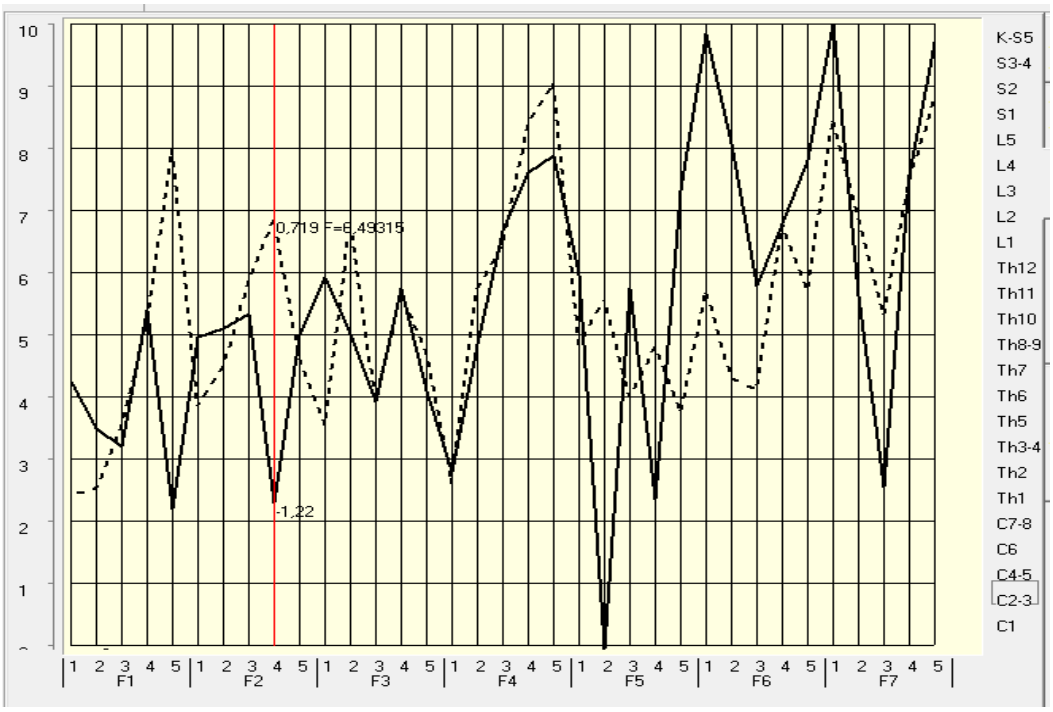

Fig 1: The graph of amplitude values of the differential spectral function of bioelectric activity recorded in the course of reading adjectives. Along the axis of ordinates, the amplitude is in relative units; along the x-axis – frequency functions; the firm line – right hemisphere; the dotted line – left hemisphere.

CONCLUSION

The obtained findings prove that the experience predominantly connected with taste is characterized by a low degree of differentiation, while that predominantly connected with vision has a high degree of differentiation. The number of amplitude maximums of the function of the bioelectric activity varies in the course of reading auditory (predominance in the left hemisphere) and visual adjectives (predominance in the right hemisphere).

REFERENCES

[1] Klochkova, O. I., Shabanov, G. A., Rybchenko, A. A., et al. (2016). Themanifestation of the inertia of thebrainaccording to thespectralfunction of theinducedelectromagneticactivity. *Pacific Medical Journal*, *4*, pp. 26-30. DOI: 10.17238/PmJ1609-1175.2016.4.26–30.

[2] Patent for usefulmodel No. 72395. Application No. 2007145888. Priority of December 3, 2007. Magnetic EEG spectralanalyzer of theadderbiopotentials of thehumanbrain. Authors: LebedevYu.A., Shabanov G.A., Rybchenko A.A., Maksimov A.L. Director General Maksimov A.L. Published: April 20, 2008 Byul. №11.

[3] Ribchenko, A. A., Shabanov, G. A., Lebedev, U. A., et al. (2014). RS MEGI-01 coil recorder of spectrum of magnetoelectric activity of human brain. *Biomedical Engineering*, *47*(6),pp. 282–284.

[4] Kolbeneva, M. G. &Aleksandrov, Yu. I. (2010). *Sense organs, books and applications to the Russian language: Lingvo-psychological dictionary*. Moscow, Russia: Languages of Slavic cultures,Institute of Psychology RAS.

[5] Kolbeneva, M. G. &Alexandrov, Yu. I. (2016). Mental reactivation and pleasantness judgment of experience related to vision, hearing, skin sensations, taste and olfaction. *PLOS ONE*. DOI:10.1371/journal.pone.0159036

[6] Podolskii, I. Ya., Vorobyev, I. V., &Belova, N. A. (2004). Long-term changes in hippocampal and neocortical eeg spectra during pharmacological treatment of cholinergic system. *Journal of higher nervous activity to them. I.P. Pavlova*, *54*(1), pp. 59–67

[7] Baevskij, P. M. &Ivanov, G. G. (2001). Heart rate variability: theoretical aspects and possibilities of clinical use. *Ultrasound and functional diagnostics*, *3*, pp. 106-127.