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IMPACT OF EXECUTION OF CREATIVE TASK ON EVOKED BRAIN ACTIVITY

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In the article changes in evoked potentials (EP) resulting from the execution of creative verbal tasks have been studied. Analysis of amplitude characteristics of evoked potentials caused by light stimuli revealed a significant increase in the amplitude of N_{200} component in frontal and prefrontal areas of the left hemisphere. An increase in the amplitude of N_{200} component in the temporo-parieto-occipital areas of the right hemisphere was also revealed. The obtained data lead us to the assumption that implementation of creative tasks with expressed elements of complexity is accompanied with significant activity of the frontal and temporo-parieto-occipital areas of the cerebral cortex.

***Keywords*:** frontal cortex, posterior associative area, evoked potentials, creative process.

Introduction. The element of creativity is present in all activities carried out by a human being. Being the most important component of human activity, creativity requires active participation of both hemispheres of the brain. In many studies the leading role in the realization of the creative process is assigned to the frontal areas of the cerebral cortex. Thus, according to the works by Heilman et al. [1], activation of the frontal lobes is necessary for the development of divergent thinking and the ability to make alternative decisions, meanwhile the process of creative innovation, in its turn, requires activation of the connections between the frontal areas, temporal and parietal lobes, which are the sources of information for the frontal cortex. Increased activity of the frontal lobes of the cerebral cortex is illustrated in works studying the organization of the brain during creative activity using data obtained by EEG monitoring [2–6]. Works by Bekhtereva and Carlsson [7–8] concerning changes in regional blood circulation in the brain during creative activity, confirm the bilateral involvement of frontal lobes in the creative process. Nevertheless, the question concerning the facilitation of creative activity by the brain requires further study, since an alternative viewpoint exists, according to which the creative process is accompanied by decreasing activity in the frontal lobes [9–11].

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The aim of this particular study was to look into the dynamic changes in levels of activity of cortical areas of student-subjects during the execution of creative tasks. The task was to register evoked activity in the left frontal (F_3), right frontal (F_4), left prefrontal (Fp_1), right prefrontal (Fp_2), left temporal (T_3), right temporal (T_4), left temporo-parieto-occipital (TPO_L), and right temporo-parieto--occipital (TPO_R) regions of the cerebral cortex.

Materials and Methods. 26 student-subjects from natural sciences faculties of YSU took part in the study. The task that the subjects were assigned to complete consisted of creating a story based on a set of words different from semantic fields, thus providing the task with a high level of complexity. Examples of such words are: wind, roof, thinking, horse, forget, star, watch, manuscript, open, sea, laugh, tree, break, twirl, talking, table. The subject was tasked with writing a story within 1 *h* and was given instructions to exercise originality in decision making. The method of registering evoked potentials (EP) as an indicator of the functional status of the studied cortical regions was used to study changes in the neurophysiological indicators of the cerebral cortex. Registration of evoked activity as a result of light stimuli was carried out both before (T_0) and after (T_1) the completion of the creative task, in order to determine changes in the activity of the cortex. EP was registered monopolarly, according to the 10/20 international system, from 4 symmetrical regions of the right and left hemispheres of the cerebral cortex: F_3, F_4, Fp_1, Fp_2, T_3, T_4, TPO_L, TPO_R. Light flashes of moderate intensity (0.4 *J*) with exposition were used for the stimuli. The length of each flash was 50 μs with 3 *s* ("FTS-21") intervals between each flash. An average of 32 reactions to light flashes was recorded. Changes in the value of the amplitude of negative N_{200} component were studied. The period of analysis was 500 *ms*. Analog-to-digital conversion of EP and processing of parameters was carried out using EPREC and EPPROC programs. The data obtained were subjected to statistical analysis using the *t*-test of dependent pair (SPSS software package).

Results and Discussion. Statistical analysis of the data has revealed certain changes in the value of the amplitude of N_{200} component during creative activity. An increase in the amplitude of N_{200} component was detected in F_3 and F_4 (see Table). Significant changes were detected in the left hemisphere ($p \leq 0.001$) and unreliable changes were detected in the right hemisphere.

Dynamics of changes in the value of the amplitude of N_{200} component of visual EP of investigated areas of brain cortex

	F_3	F_4	Fp_l	Fp_2	T_3	T_4	TPO_L	TPO_R
T_0	3.24±1.57	3.002±0.76	3.90±1.62	3.41±1.40	1.62±0.34	1.79±0.62	3.92±1.26	4.36±2.12
T_1	5.04±1.55	3.45±1.12	5.29±1.14	3.22±1.51	1.55±0.76	1.81±1.03	4.25±1.96	6.18±2.01
p	p≤0.001	–	p ≤ 0.01	–	–	–	–	p ≤ 0.01

A significant increase ($p \leq 0.01$) in the amplitude of N_{200} component from 3.90 μV at T_0 to 5.29 μV at T_1 was detected in the prefrontal region (Fp_l) of the left hemisphere, while no changes were detected in the right hemisphere. The amplitude

of N_{200} component did not change in the temporal regions of the right and left hemispheres (T_3, T_4). The amplitude of N_{200} component did not change in TPO_L either. In TPO_R, execution of the creative task results in significant change of 1.82 μV ($p \leq 0.01$) in the component being studied.

Thus, the results of our experiments illustrated a significant increase in the amplitude of N_{200} in F_3, Fp_l and TPO_R. Particularly active "participation" of the frontal cortex is an evidence of the instrumental role of the anterior regions of cortex in facilitation of creative processes. The reliable increase of the amplitude of the component N_{200} in frontal areas of the left hemisphere points towards increased activity in the cortical structure, which according to a number of authors [1, 2, 7, 8, 12], actively participates in divergent thinking. The increase in the amplitude of the component N_{200} in TPO_R points towards the involvement of the posterior associative region of the right hemisphere in the creative process. The particularly high activity of the temporo-parieto-occipital region observed in the right hemisphere is the evidence of the participation of the right TPO region in solving cognitive verbal problems, which is most likely due to the fact that it integrates the meaning of the words that are combined into a lexical construction. According to the research by O. Razumnikova [13], the best indicators of verbal intellect are based on primary involvement of speech zones in the right hemisphere, which most likely enable faster processing of verbal stimuli. The involvement of the temporo-parieto-occipital region in the creative process is illustrated in researches by a number of authors [14, 15], which indicates the involvement of this region in the success of the process for finding new original solutions. Relying on the hypothesis by A. M. Ivanitski [15] concerning the notion that the topography of coordination centers of cortical zones during intellectual activity is determined basing on the characteristics of the intellectual operations in questions, convergence of cortical connections occurs in the foci of the parietal-temporal cortex during figurative thinking and frontal cortex during abstract thinking. We assume that during execution of a creative task with an element of complexity convergence of cortical connections occurs with active involvement of frontal and temporo-parieto-occipital cortical zones, confirming the significance of these zones in facilitating organization in the brain for creative activity.

Conclusion. Thus, the study revealed that creative activity with elements of complexity is carried out with active participation of both frontal and temporo--parieto-occipital zones of the cerebral cortex. The increase of activity in the parietal-occipital region we consider as a reflection of the process of searching for new original solutions of the foregoing task.

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