

CORRELATION ANALYSIS OF RADIOELECTRO- ENCEPHALOGRAMS DURING MENTAL WORK

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Changes in the radioelectroencephalogram (REEG) in man during mental work were investigated under natural conditions of activity (transport supervisors, students during lectures and examinations). A higher level of cross-correlation between biopotentials and the periodicity of the processes was found in areas of the brain participating in the relevant functions in all groups of subjects investigated: in the motor center for speech (Broca's area) in the left hemisphere and the symmetrically opposite region of the right hemisphere. According to published and personal observations, such participation indicates that the speech mechanisms are represented in both hemispheres.

There is no general agreement in the literature regarding responses of brain electrical activity to mental work: in some cases signs of desynchronization, and in others signs of synchronization, are observed in the EEG. The work of Livanov [4] has conclusively shown the functional importance of cross-correlation between brain potentials.

For these reasons it was decided to study the degree of cross-correlation between brain potentials and the intensity of the periodic component of the EEG recorded during mental work.

EXPERIMENTAL

The investigations were carried out on 12 road transport supervisors (employed on this job for between 5 months and 16 years) and high school students in their first and second years of the course (28 during lectures and 13 during examinations). Each investigation consisted of a series of observations, of which the total number was 275. The subjects were healthy, of both sexes, and aged from 18 to 40 years.

The EEG was recorded by means of a combination of two single-channel bioradiotelemetric systems of the BÉP-2 type or an "Almaz" four-channel system [2, 3]. The potentials were recorded by a monopolar or vertical [6] method from the region corresponding to the motor center for speech in the left hemisphere and the symmetrically opposite region of the right hemisphere, as well as from the occipital zones. A type 4EEG-1 electroencephalograph or type 2ÉKPSCh electrocardiograph was used to record the potentials. The tests were carried out in the usual industrial or educational surroundings. Besides visual analysis, the results were subjected to auto- and cross-correlation analysis [4]. The "Promin" digital computer was used to process the material.

Altogether 451 cross-correlation coefficients (C_c) and 10,368 auto-correlation coefficients were obtained, 313 auto-correlation diagrams were plotted, and the same number of coefficients reflecting the ratio between the power of the periodic process and the power of the random process (C_p/r) was calculated.

EXPERIMENTAL RESULTS

Visual analysis showed that the REEG showed negligible change in the transport supervisors during the shift and in the students during lectures, but in the students during examination the changes were con-

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siderable: the chief feature was the appearance of a high-amplitude slow rhythm (up to 13/sec). These changes have been described in more detail elsewhere [2, 3].

The results of cross-correlation analysis of cuts of the REEG showed an increase in the correlation values for the potentials ($C_C > \pm 0.45$) between regions corresponding to Broca's area in the left hemisphere (the motor center for speech) and the symmetrically opposite region of the right hemisphere. This phenomenon was observed in all groups studied. However, it differed in intensity in the members of the different groups: in the transport supervisors correlation increased gradually until the 5th-6th hour of the shift (the time of hardest work), while in the students during examination it increased after the first few minutes, to reach a maximum at the time of answering, when the mean value was $C_C = \pm 0.73$ (before the examination, $C_C = \pm 0.44$, after the examination, $C_C = \pm 0.35$; $P = 0.01$), while in the students during lectures the degree of correlation increased only negligibly toward the end of the lecture. No such marked increase in the degree of cross-correlation between the potentials as in the students during examinations could be found in the other groups tested.

Autocorrelation analysis revealed a periodic component of the REEG even when visual analysis showed only desynchronization phenomena. In all groups, at the most responsible moment of the work, an increase in the intensity of the periodic process (in the slow wave range) was observed, mainly in the regions indicated above. For instance, in some students during examinations, while answering the questions the value of C_p/r rose to 0.93 in recordings from Broca's area, while in recordings from the occipital zones its value was 0.34.

It has been stated [1, 4] that during mental work (laboratory experiments) cross-correlation between biopotentials in the anterior zones of the brain is increased. The present investigations showed that more concrete regions of the brain are concerned in the process of mental work when performed under actual conditions of life. It is well known that Broca's area (left hemisphere) participates in the complex mechanism of speech, for which it is the motor center. Meanwhile, clinical and experimental data [5, 8, 9, 10] indicate that both hemispheres participate in the act of speech. The results of the present investigation also indicate that speech is represented to some extent in the right hemisphere also, and that this hemisphere plays an active part in mental activity.

In a previous paper [3] which described changes in the REEG during muscular activity of a cyclic or acyclic character completely different principles were shown to govern the localization of significant cross-correlation between biopotentials and periodicity of the process and, consequently, participation of different regions of the brain in the performance of that type of activity.

Data in the literature and the results of the writer's investigations thus demonstrate a correlation between the intensity of spatial synchronization of potentials and the state of brain function.

Mental activity carried out in industrial and educational surroundings causes an increase in the degree of correlation between biopotentials and the power of the periodic process in regions of the brain participating in the activity, namely the motor center of speech in the left hemisphere and the symmetrical opposite region of the right hemisphere. This is evidence of the active participation of the right hemisphere also in the act of speech.

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