EFFECT OF STIMULATION OF RECTAL RECEPTORS OF DOGS ON THE ELECTRICAL ACTIVITY OF THE BRAIN

N. N. Lazuko

From the Department of Physiology (Director: P. S. Kupalov, Member Acad. Med. Sci. USSR), Institute of Experimental Medicine (Director: D. A. Biryukov, Corresponding Member Acad. Med. Sci. USSR), Acad. Med. Sci. USSR, Leningrad.

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There is very little published material on the effect of stimulating various internal organs on the electrical activity of the brain of animals and men.

F. M. Lisitsa [2], in critical experiments on rabbits and dogs, observed alterations in cortical potentials during stimulation of the stomach and rectum by disten ion of rubber balloons inserted therein. He found an initial raising of the amplitude of the alpha waves on the electroencephalogram (EEG), followed by a lowering of amplitude and and an increase in fequency. This author regarded the lowering of the amplitude of the alpha waves as an effect of inhibition, and he connected it with reflex cardiovascular changes.

V. E. Delov [1], showed in critical experiments on rabbits that the action of various agents on internal organs was reflected in the bioelectrical activity of definite regions of the cerebral cortex, by "initial inhibition with subsequent raising of electrical activity."

P. O Makarov [3] showed that distention of the human stomach lowered the amplitude and the frequency of the electrical activity of the cerebral cortex.

The present paper reports the results of extensive experiments designed for investigation of alterations in the biopotentials of a dog's brain due to systematic prolonged stimulation of the rectal receptors.

Our experiments were performed on one dog, which had been subjected to excision of the temporal muscles. The dog was trained to lie still on the bench in a screened room. The rectum was stimulated by means of a specially constructed attachment made of Plexiglass, 5.5 cm long and 1 cm in diameter, which caused moderate distention of the rectum lasting continuously over the 15 minutes of the experiment. Recording of the cerebral biopotentials was made from the right and left temporal regions, from silver electrodes attached to the skin with the aid of Mendeleev adhesive. Recordings were made using a cathode oscillographic equipment with a 2-channel amplifier. The range of frequencies was from 2 to 500 cps.

EXPERIMENTAL RESULTS

We first recorded the EEG for both hemispheres, in order to ascertain the normal electrical activity of the brain under the experimental environmental conditions. The normal electrograms were practically symmetrical for both sides, with respect to amplitude and frequency, with a constant alpha-like activity, manifested by waves of a frequency of about 6 per second and a potential of 25 μv, and a beta-like activity, consisting of waves of a frequency of about 38 per second and an average potential of 10.5 μv (Figure 1).

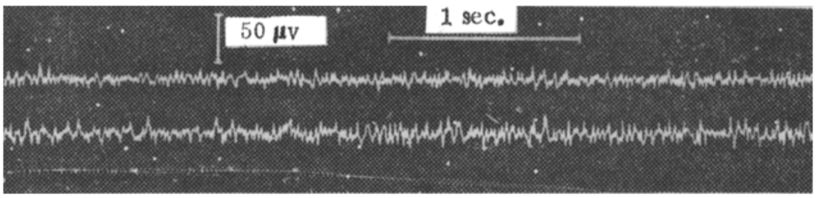

Fig. 1. EEG of the temporal region (before stimulation). Explanation of tracings (from above down): left hemisphere, right hemisphere, stimulation marker.

Having determined the initial background electrical activity, we proceeded to the systematic stimulation of the rectum, by insertion of the bougie, which caused a moderate sustained distention of the sphincter as well as of the rectum itself.

We performed 185 experiments, in all. During the first 3 days of the experiments the dog manifested some uneasiness. By the 7th day it lay quite still.

During the first 20 days of experimentation the EEG showed increase amplitude of the alpha-like activity, up to 30 μv, and of the beta-like activity, with a marked preponderance of the latter. The average frequency was 50 per second, and the potential varied from 22 to 40 μv (Figure 2).

On the 30th day of experimentation slow waves began to appear from both hemispheres, with a frequency of about 4 per second and a potential of 30 to 60 μv. At the same time bursts of spike potentials appeared on the EEG, chiefly from the left hemisphere, of a frequency of 22 per second and a potential of 46 μv, on the average (Figure 3). The nature of the EEG remained steady thereafter over a month. In order to ascertain the stability of these changes, the dog was left alone for 2 weeks, after which the experiments were resumed, but without applying the stimulus.

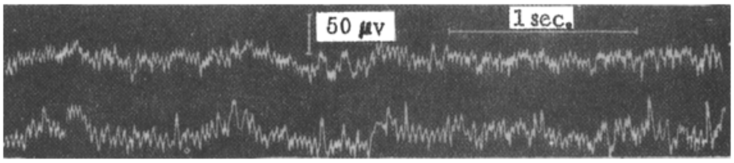

Fig. 2. EEG from the temporal region recorded during the first 20 days of experimentation involving stimulation. Intensification of fast waves, with a pronounced preponderance of beta-like activity at the moment of rectal stimulation.
Explanation of tracings as in Figure 1.

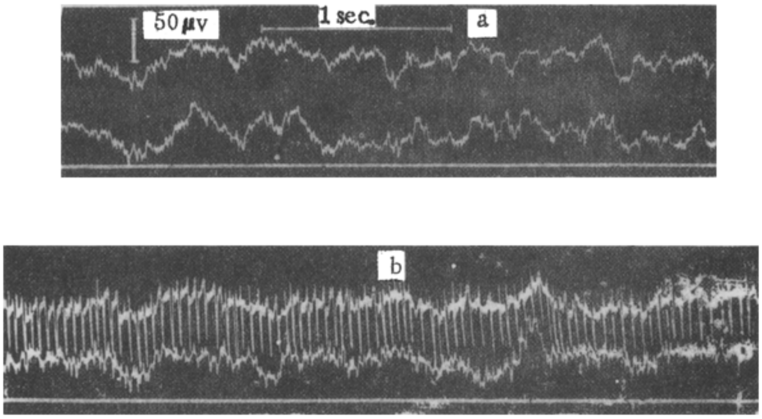

Fig. 3. EEG of the temporal region. Changes appearing on the 30th day of stimulation experiments.
a) Slow waves; b) spike potentials in the left hemisphere.
Explanation of tracings as in Figure 1.

No change was seen in the EEG for 13 days after the rest period, the same slow waves and spike-shaped oscillations being observed as before the rest period. The slow waves disappeared altogether on the 14th day. The spike potentials continued for 30 days of observation, although they occurred much less frequently towards the end of this period. Notwithstanding the rest and the cessation of stimulation, however, the EEG displayed a growing increase in the amplitude and frequency of fast rhythms, and bursts of activity of muscular origin began to appear (Figure 4).

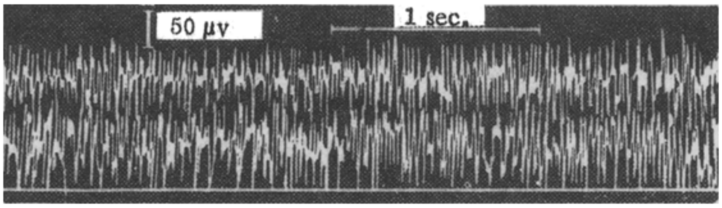

Fig. 4. EEG from the temporal region after cessation of rectal stimulation. Marked increase in amplitude and frequency of fast oscillations in both hemispheres.
Explanation of tracings as in Figure 1.

An abrupt change in the behavior of the animal was observed a month after the beginning of a new series of experiments. The dog resisted being taken to the experimental room, and tried to get off the bench when there; it sat in a corner of the dog house, and ate reluctantly. In order to exclude the possible effect of the experimental environment, which the dog would associate with the preceding experiments, we transferred it to a second screened room, where the observations were continued for a further 15 days. This did not, however, affect the nature of the EEG or the behavior of the animal.

We concluded, on the strength of the EEG changes and of the behavior of the animal, that it had developed a neurotic condition. We applied bromide treatment, in order to strengthen the inhibitory process. The electrical activity of the brain began to subside on the 3rd day of treatment, and had reverted to the initial level by the 10th day, when behavior of the dog was again normal.

Our experiments show that a gradual raising of excitability of nerve centers, including those of the brain, supervenes as a result of a continuous stream of afferent impulses entering the central nervous system as a result of mild stimulation of the rectum. As a result, the excitatory process was intensified, this being reflected in the EEG by increased amplitude and frequency of fast waves of beta-like activity. The administration of bromide, which strengthens the inhibitory process, fairly quickly restored the balance between the basic nervous processes – excitation and inhibition. The persistence of the state of heightened excitability in the absence of stimulation of the rectum may most probably be explained on the basis of conditioned reflex connections with the experimental environment.

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