PHYSIOLOGY

THE ORIGIN OF SLOW RHYTHMIC POTENTIALS IN THE ELECTROENCEPHALOGRAM OF RABBITS

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It is known that the electroencephalograms of humans and animals reflect the presence of various forms of bioelectric activities. The primary forms of rhythmic oscillations in the electroencephalogram of man usually are α-waves. It is, however, possible in some cases to detect a slower rhythmic activity, the frequency of which is apparently close to the frequency of heartbeat.

In a number of cases this activity disappears upon displacement of the dispersing electrode. For this reason, such waves were considered to be the result of the positioning of the electrode over a pulsating vessel. Slow rhythmic oscillations of this type have been described previously. Romano and Engel [6] and E. S. Brezhneva [1] reported the detection of such oscillations on the electroencephalograms of hypertonic cases. Such waves have also been registered in other cases [5]. However, one can only guess as to the relationship of these two forms of oscillations, since simultaneous recording of electroencephalo- and electrocardiograms has been performed in only a few individual cases.

A number of authors [2, 3, 4, 7] describe the appearance of a slow rhythmic activity in animals, in the form of "vascular" or "respiratory" rhythms.

The aim of the present investigation, started upon the suggestion of A. V. Lebedinsky, was to study the origin of the slow rhythmic electric activity in animals. A special method of excitation was used: by application of a braid to the posterior extremity of the animal (in 15 rabbits) or by an electrical discharge of the skin of the posterior extremity (5 rabbits).

EXPERIMENTAL METHODS

The rabbit was immobilized dorsal side up, on a dissecting table. Four needle electrodes were inserted in the skull. This allowed the recording of electroencephalograms at four bipolar points (left, frontal-occipital, occipital-occipital, right frontal-occipital and frontal-frontal). The subcutaneous introduction of needle electrodes in the anterior and posterior extremities made it possible to record electrocardiograms.

The electrocardio- and electroencephalograms were simultaneously recorded by a tracing electroencephalograph. Pneumograms were registered in individual cases. Recordings were taken before the application of excitants, during the excitation – 15 and 30 minutes, 1, 1.5, and 2 hours after the beginning of excitation, and some time after its discontinuance (from 45 minutes to 3 hours after, at intervals of 3, 10, and then every 15 minutes).

The electrical or braid excitations lasted for 2 hours.

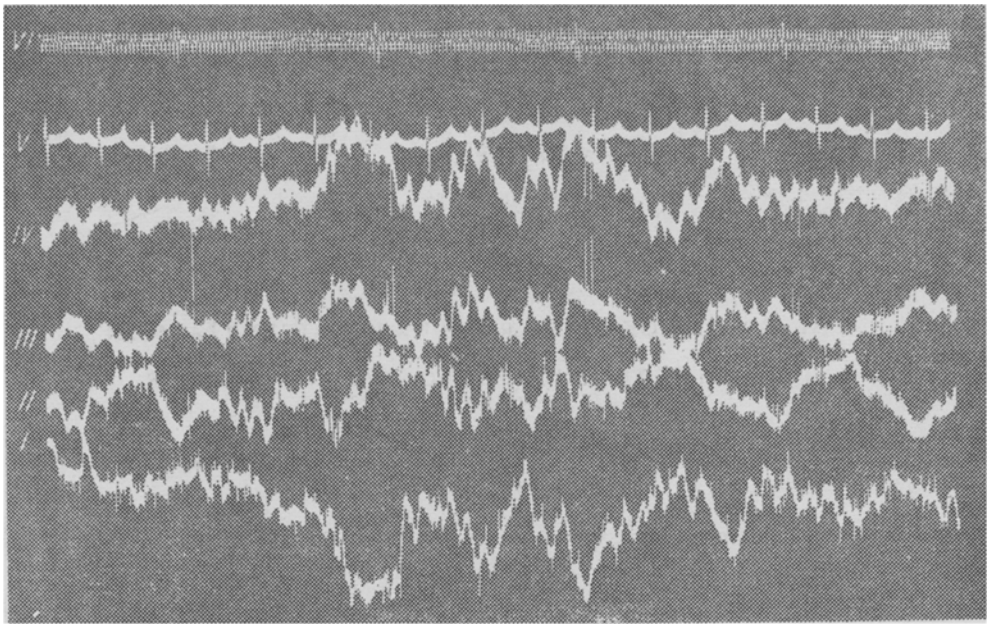

Fig. 1. Normal electroencephalogram of the rabbit.
I-IV) Electroencephalogram; V) electrocardiogram, VI) time tracing (1 second).

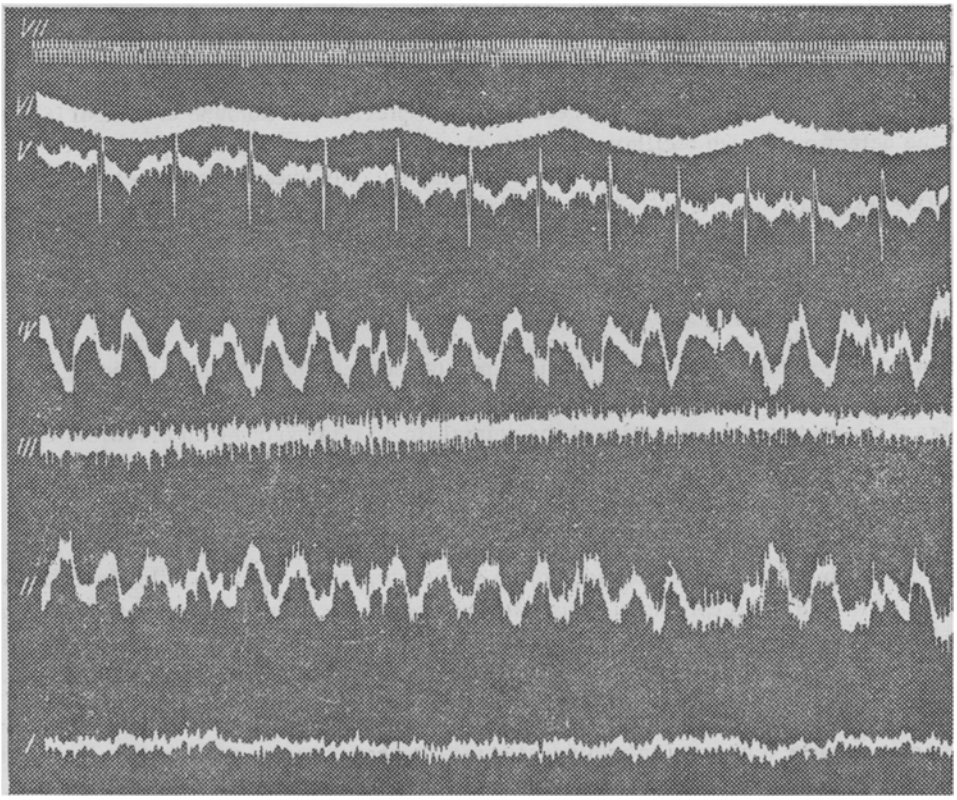

Fig. 2. Electroencephalogram of a rabbit one hour after the application of the braid. The leveling off of Curves I and III and the appearance of rhythmic oscillations on Curves II and IV is clearly seen. I-IV) Electroencephalogram; V) electrocardiogram, VI) pneumogram; VII) time-tracing (1 second).

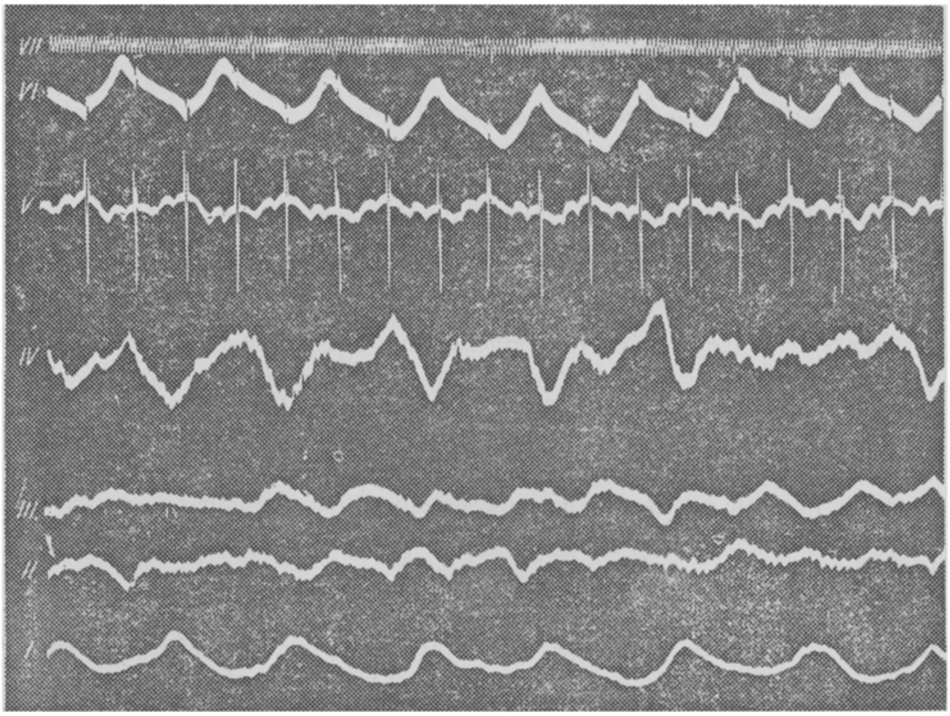

Fig. 3. Electroencephalogram of the rabbit 1 hour 30 minutes after application of the braid.
The tendency of the electroencephalogramic rhythm to follow the respiratory rhythm is apparent. The designations are the same as in Fig. 2.

In 17 experiments the initial background was that of a normal rabbit electroencephalogram. α-like oscillations (similar in form and duration to the α-waves in man, but non-rhythmic), slower waves with a period up to 1 second, and various forms of fast oscillations (12 and more per minute) were noted (Fig. 1).

The α-like oscillations, were first to disappear from the electroencephalogram, recorded immediately after the application of the braid or of the sleeve with electrodes. These are probably also the most sensitive elements in the electroencephalogram of rabbits. During this period the extreme components were preserved. Sometimes fast oscillations appeared or increased at the beginning. This might be explained by the recording of muscular bioelectric potentials. The probability of the latter assumption is enhanced by the fact that some movements started in the animals especially during the first minutes after the beginning of excitation. Groups of slow rhythmic waves were also recorded during the first minutes after the beginning of the exciting action.

It seemed that the already-present slow non-rhythmic potentials were taking on a rhythmic character.

Thus, the slow rhythmic waves followed soon after the disappearance of the α-like oscillations. The time interval between the disappearance of the α-like activity and the rise of rhythmic waves was sometimes only a few minutes. However, "superimposition" of α-like oscillations over these regular slow rhythmic potentials was not observed in a single case.

In the majority of cases, 30 minutes to 1 hour after the application of the braid or the beginning of the excitation current the electroencephalogram consisted entirely of slow rhythmic waves, which, however, were not expressed equally clearly at all points. Such rhythmic activity appeared at two, three, and rarely at all four points. Sometimes, in these cases, the slow waves would disappear from the remaining points, and the electroencephalogram would present a nearly straight, but notched, line (as a result of the presence of fast oscillations) (Fig. 2).

Subsequently, the frequency of the slow rhythmic potentials gradually changed. Most often, the frequency and the amplitude decreased simultaneously.

The slow rhythmic activity often corresponded to the frequency of the heartbeat in some sections of the curve. In some cases as the oscillations slowed down they were synchronized with the respiratory rhythm (Fig. 3).

However, such coincidences were far from being observed in all cases and they never occurred throughout a recording period. Usually, after the excitation period a slow rhythmic activity with a frequency either slightly higher or lower than the rhythm of the heartbeat was observed on the electroencephalogram. The frequency of the rhythmic waves was never a multiple of the frequency of the heart contractions.

The relationship of these waves to the respiratory and heartbeat rhythms will be established only when simultaneous recordings of electroencephalo-, electrocardio-, and pneumograms are taken.

Gradual restoration of the normal rhythm in the electroencephalogram was observed in the majority of cases (14 in all) after the end of the excitation period. The characteristic mechanism of the process could also be followed here. Some speeding up of the rhythm was observed immediately after the end of the excitation period. α-like oscillations again became apparent. The amplitude of the slow waves increase and their rhythmicity was lost. The revival of the α-like rhythm did not last. The α-like rhythm disappeared after 3-10 minutes and slow rhythmic oscillations again reappeared. A more definite reestablishment of the initial rhythm occurred only after 40-60 minutes and more. The changes occurring after both modes of excitation were of the same type.

The appearance of the slow rhythmic oscillations varied with the state of the experimental animal. In weak animals, such a slow rhythmic activity sometimes became apparent right after immobilization of the animal on the table. The same was noticed during an attempt to repeat the experiments on the same animal. In such cases, the subsequent excitation sometimes provoked a short initial "revival", the appearance of α-like oscillations, which faded out when the excitation was prolonged.

The data presented in this paper is insufficient to permit the formation of a hypothesis on the origin of the slow oscillation of biopotentials on the electroencephalogram. However, the conditions under which they originate, and the characteristic peculiarities of the mechanism of their formation and disappearance allow us to assume that these slow oscillations are the result of the development of an inhibition process and a decrease in lability. A progressing inhibitory action and a further decrease in lability may limit this form of electric activity.

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