LOW-FREQUENCY HYPOTHALAMIC AUTOSTIMULATION OF RATS

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Using pulses of 5 Hz it is possible to choose a strength of current which will facilitate continuous autostimulation of the brain in rats. The intervals between pressing the pedal under these conditions amount to 0-6% of the total duration of a 10-min experiment.

Electrical autostimulation is the term given to the behavior of an animal in which it selects, from a series of possible alternatives, the action which leads to electrical stimulation of its brain. In a situation in which the animal regulates the duration of the series of pulses and the intervals between them, both volleys and intervals increase in duration with a decrease in current strength [2, 3, 5, 7]. The time at which brain stimulation is stopped can be presumed to be connected with the combined effect of a series of consecutive pulses. In that case it ought to be possible to select a (low) frequency of stimulation such that this effect is minimal. It was considered that autostimulation can be obtained by reinforcement with single pulses of current [6].

The investigation described below was carried out to test this hypothesis.

EXPERIMENTAL METHOD

Albino rats weighing 200-250 g were anesthetized with pentobarbital and two bipolar electrodes were inserted into the region of the lateral hypothalamus, symmetrically relative to the midline of the skull using stereotaxic coordinates [4]. Each electrode consisted of two nichrome wires, 80 μ in length, glued together.

A pedal measuring 30 × 50 mm was situated in the middle of one wall of a chamber (35 × 40 × 35 cm) 2 cm above the floor. Stimulation began if the pedal was pressed with a force of about 5 g and it continued during pressure. Square pulses 1 msec in duration were used. The frequency of the pulses (of stimulation) varied from test to test in the following order: 20, 10, 5, and 30 Hz. Each test lasted 10 min except the last (30 Hz), which lasted 3-5 min. The duration of each pressure on the pedal under each interval was recorded. The strength of the current was unchanged (200-400 μA). Three experiments were carried out on each of 2 rats, 2 on one rat, and 1 experiment on 1 animal, using each electrode.

EXPERIMENTAL RESULTS AND DISCUSSION

In all experiments on all rats (except the experiment on one rat) the mean frequency of pressure on the pedal with frequencies of stimulation of 30, 20, 10, and 5 Hz lay within the range of 24, 30, 9, 12, 5.8, and 2.3 min respectively, and the mean duration of the series of pulses was 0.5-1.5, 1.5, 4.7, 3.7, 11, and 15-47 sec.

The frequency of pressures on the pedal was reduced with a decrease in the frequency of stimulation, while the duration of the series of pulses increased (Fig. 1). The length of the interval increase with a change in the frequency of stimulation from 30 to 20 Hz, but fell with a further decrease in the frequency (Fig. 1). With a frequency of 5 Hz the total duration of all intervals formed was about 0.36 sec in the course of a 10-min test. In this case the intervals were so short that they evidently did not cause stimulation of the brain to cease. They were most probably formed accidentally by some movement of the animal, some change

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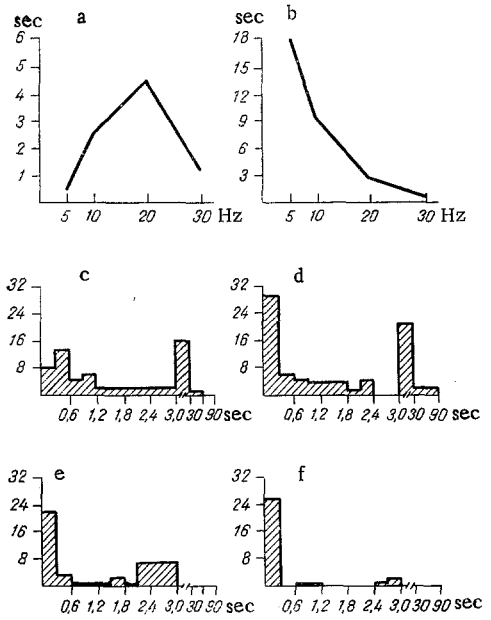

Fig. 1

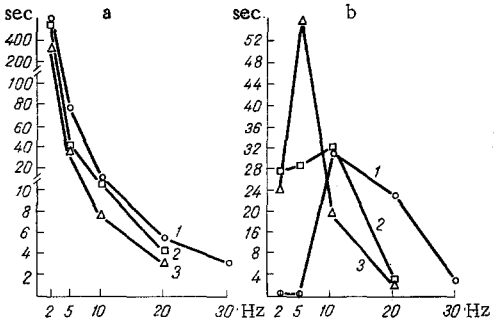

Fig. 2

Fig. 1. Mean duration of interval (a), series of pulses (b), and histogram of distribution of interval durations for frequencies of stimulation of 30 (c), 20 (d), 10 (e), and 5 (f) Hz in one experiment.

Fig. 2. Mean duration of a series of pulses (a) and intervals (b) for different current strengths and different frequencies of stimulation in one experiment: 1) 100 μA; 2) 150 μA; 3) 200 μA.

in its position, and so on. For practical purposes the rats ceased to interrupt the stimulation. It is natural to suppose that at a low frequency of stimulation the influence of successive pulses is weak. The duration of the after-effect of hypothalamic stimulation, according to the writer's observations, is close to that obtained by the use of a different technique [1]. Rats in a T-shaped maze were presented with two sequences of 10 standard series of pulses 0.2 sec in duration and at a frequency of 60 Hz, which differed in the duration of the interval between the series of pulses. The animals always chose sequences with shorter intervals between series if these intervals were less than 0.5 sec. The rats did not distinguish between intervals of 0.5 and 1 sec.

The longest mean duration of the interval in the present experiments was observed at 20 Hz (Fig. 1). In one rat with one electrode, however, the longest interval occurred at a frequency of 10 Hz. The frequency of pressures on the pedal in this rat, when stimulated at 20 Hz with this electrode, reached 20-25 min by contrast with all other rats and with stimulation of this same rat with the other electrode. It was therefore decided to test the hypothesis that the frequency of stimulation at which the interval duration was maximal can vary with the strength of the current. A series of analogous experiments at different strengths of current was carried out on two rats.

These showed that with a decrease in the frequency of stimulation the mean duration of the interval increased if the current was weaker than a certain critical value. However, with higher values of the current strength there was a range of frequencies within which the mean duration of the interval fell with a decrease in the frequency of stimulation (Fig. 2). With a further increase in the current strength this range was shifted toward lower frequencies (Fig. 2).

If current of a certain strength and stimuli of low frequency are used, hypothalamic autostimulation thus becomes virtually continuous.

LITERATURE CITED

1. J. A. Deutsch and C. J. Howath, Psychol. Rev., 70, 444 (1963).
2. W. Hodos, J. Comp. Physiol. Psychol., 59, 219 (1965).

3. R. E. Kusey, J. Comp. Physiol. Psychol., 58, 206 (1965).
4. J. F. R. König and R. A. Klippel, The Rat Brain: A Stereotaxic Atlas of the Forebrain and Lower Parts of the Brain Stem, Baltimore (1963).
5. J. Madlafausek, K. Freund, and J. Grofova, J. Comp. Physiol. Psychol., 72, 28 (1970).
6. J. Olds, Psychol. Rev., 42, 554 (1962).
7. L. Stein, J. Comp. Physiol. Psychol., 55, 405 (1962).