CHANGES IN EVOKED POTENTIALS OF THE RETICULAR FORMATION FOLLOWING HYPOTHALAMIC STIMULATION BY SINGLE PULSES

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UDC 612.826.4:612.826

Excitation cycles of responses of the ponto-mesencephalic reticular formation to sciatic nerve stimulation were studied in acute experiments on rabbits anesthetized with Nembutal. A long recovery period after paired stimulation of the sciatic nerve and a facilitatory effect of stimulation of the posterior hypothalamus on responses in the reticular formation were discovered.

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Analysis of ascending influences on the cortex is an important part of the study of integrative activity of the brain. The specific character of ascending activating influences of the bulbar reticular system on the biological quality of a response has been demonstrated in Anokhin's laboratory [1, 4, 6, 9]. Some workers [12, 13, 16] also include the hypothalamus in this system, and they regard ascending hypothalamic influences as a part of the influences of this system as a whole.

However, remembering the special place of the hypothalamus as an important neuroregulatory center, the location of higher autonomic and neurohumoral integrations, and also its undoubted connection with emotions and motivation states, it may be considered that it is the hypothalamus which gives generalized influences on the cortex their "biological tint" by integrating its own excitation with that of the reticular activating system of the brain stem. The study of hypothalamic influences on the reticular formation is thus particularly interesting.

The writer's investigations [7, 8] have shown that tetanic stimulation of the posterior hypothalamus inhibits potentials in the reticular formation evoked by stimulation of the sciatic nerve. These results were confirmed by Zilov's experiments [5] at the neuronal level. However, under moderately deep Nembutal anesthesia, signs of activation were observed in response to identical stimulation of the posterior hypothalamus in recordings made from the reticular formation.

To determine in more detail the effects of the hypothalamus on the reticular formation, experiments were carried out to study the effect of hypothalamic stimulation by single square pulses on the excitability of the reticular formation.

EXPERIMENTAL METHOD

Acute experiments were carried out on rabbits anesthetized with Nembutal. Evoked activity was recorded by a monopolar method using nichrome electrodes (0.18 mm) insulated except at their tip, in response to stimulation of the sciatic nerve with single square pulses (2-5 V, 0.1 msec). Stimuli were applied to the sciatic nerve through buried stimulating electrodes from a "Fizlovar" stimulator. Electrodes to stimulate the hypothalamus consisted of two twisted nichrome wires (0.18 mm), and the posterior hypothalamus was stimulated by a current of 3-5 V for a period of 0.05-0.1 msec. Activity of the ponto-mesencephalic reticular formation was recorded on a "Biofaz-4" CRO fitted with a "Cathomatic" camera. Electrodes were inserted stereotactically into the hypothalamus and reticular formation in accordance with

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Translated from Byulleten' Éksperimental' noi Biologii i Meditsiny, Vol. 68, No. 11, pp. 3-6, November, 1969. Original article submitted March 17, 1969.

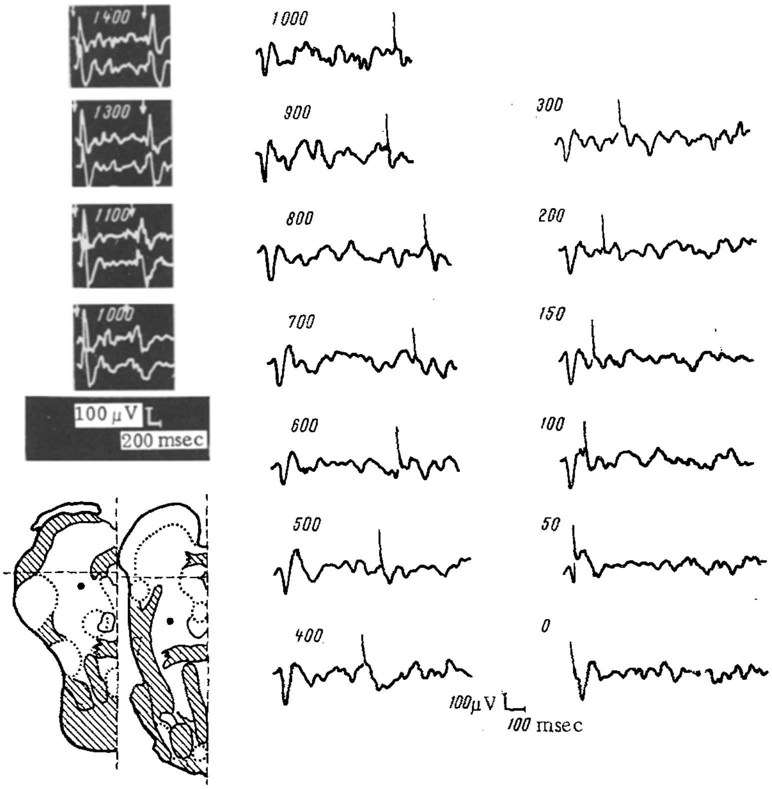

Fig. 1. Changes in test response in reticular formation to paired stimulation of the sciatic nerve. First stimulation of sciatic nerve coincides with beginning of beam, second marked by arrow (on tracings on left side) or by artefact of stimulation (on the right). Numbers denote interval between two stimuli applied to sciatic nerve (in msec). Below on left: dots denote localization of electrode in reticular formation (P8-P10 in Sawyer's atlas).

the coordinates of Sawyer's atlas [15]. The localization of the electrodes was marked by coagulation (each electrode was connected to the anode of a dc circuit giving 0.5 mA for 10-15 sec). After fixation of the brain in formalin, the localization of the electrode tip was determined by a projection method [14].

Two forms of excitation were applied to the reticular formation at different time intervals: from hypothalamic stimulation (facilitating) and stimulation of the sciatic nerve (testing). For control purposes, changes in excitability of the reticular formation in response to paired stimulation of the sciatic nerve were studied. Analysis of the evoked response in the reticular formation to sciatic nerve stimulation under Nembutal anesthesia was described by the writer in an earlier paper [8], and it will not therefore be considered here.

EXPERIMENTAL RESULTS

With a gradual decrease in the interval between successive stimuli applied to the sciatic nerve, the response in the reticular formation to the second stimulus began to diminish when the interval between stimuli fell below 1400 msec. When the interval was 1400 msec, the second response was still unchanged, but shortening the interval to 1300-1200 msec reduced its amplitude by 30%, to 1100 msec by 50-60%, and to 1000 msec by 70%. If the interval between stimuli was less than 1000 msec, no response whatever appeared to the second stimulus (Fig. 1).

The results obtained, indicating a long period of recovery of activity in the reticular formation, are in agreement with data in the literature. Adey and Lindsley [10], for instance, did not observe recovery of the test response in the reticular formation when peripheral stimuli were applied at an interval of 300 msec (they did not use longer intervals), while Feldman [11], using an interval of 1000 msec, likewise did not observe recovery of the testing response.

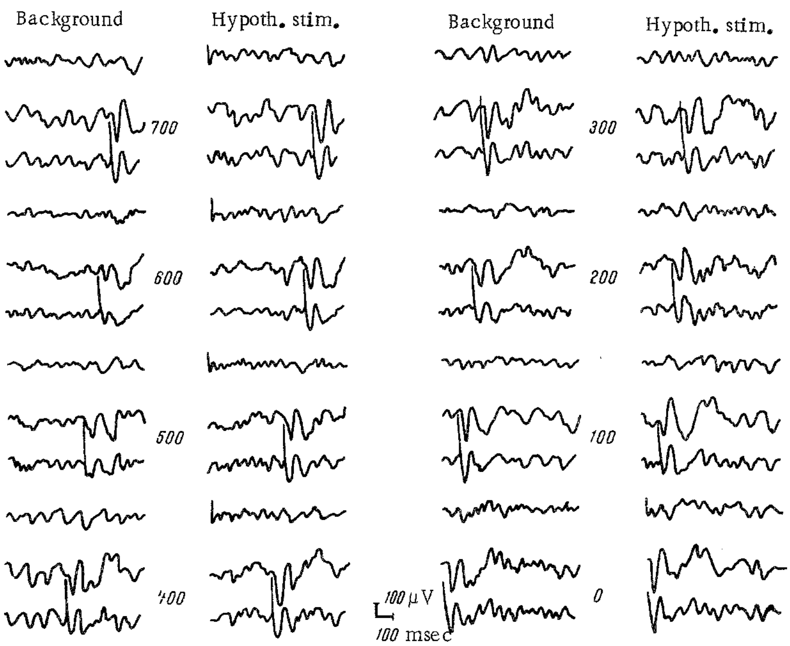

Fig. 2. Changes in testing response in reticular formation during facilitatory hypothalamic stimulation. First and third columns show response in reticular formation to stimulation of sciatic nerve (background), and second and fourth columns show same response after preliminary hypothalamic stimulation. In each recording the top curve (three curves per recording) in the second and fourth columns shows an artefact from hypothalamic stimulation coinciding with the beginning of the curve.

To study the effect of the hypothalamus on function of the reticular formation, the first stimulation of the sciatic nerve was replaced by hypothalamic stimulation. In that case, the subsequent response in the reticular formation to stimulation of the sciatic nerve was considerably modified. Complete recovery of this response was observed if the interval was 100 msec. With a gradual increase in the interval between stimulation of the hypothalamus and sciatic nerve, the amplitude of the testing response began to increase above its initial level. This increase was particularly clear at intervals of 400-600 msec (Fig. 2). These results can evidently be regarded as evidence of the temporary facilitatory effect of the hypothalamus on the reticular formation. This facilitatory effect was manifested only in response to weak hypothalamic stimuli (3-5 V), not themselves capable of producing recordable responses in the reticular formation. With an increase in the strength of hypothalamic stimulation, the facilitatory effect on the testing response in the reticular formation disappeared.

Comparison of these results with those obtained previously suggests that the hypothalamus gives rise to polymorphic effects on the mesencephalic reticular formation during Nembutal anesthesia: hypothalamic stimuli of relatively low intensity (single) have a transient facilitatory effect on the reticular formation, while tetanic stimulation of the hypothalamus produces prolonged activation of single units in the reticular formation, but the predominant feature is a shorter (up to 100 msec) inhibitory effect. Under natural conditions the character of the hypothalamic influences on the reticular formation is evidently determined by the degree of hypothalamic excitation present, which in turn depends on the general physiological state of the organism.

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