EXPERIMENTAL MODEL OF A SECONDARY PACEMAKER CENTER OF FEEDING MOTIVATION

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The possibility of simulating the functions of the feeding motivation pacemaker by various structures of the limbico-reticular complex was studied in chronic experiments on rabbits. In response to combined stimulation of the feeding center of the lateral hypopthalamus and various formations of the limbico-reticular complex, a secondary pacemaker of feeding motivation excitation was shown to be formed only in the mesencephalic reticular formation.

KEY WORDS: *feeding response; pacemaker; limbico-reticular complex.*

Motivational excitation arises primarily in the specific centers of the hypothalamus and then spreads widely over the CNS secondarily, on account of selective ascending activating influences, as far as the cerebral cortex inclusive [1, 8].

Hypothalamic structures have been shown to play an initiating "pacemaker" role in the formation of the whole widely ramifying system of motivational excitation [1, 8, 9].

The question naturally arises: To what extent do other structures involved in motivational excitation possess a pacemaker function and can such a function be imposed on them artificially?

Investigations by Bekhtereva and co-workers [4, 7] have shown that during combined electrical stimulation of two structures of the human brain artificial connections are created between them and are potentiated by administration of ethimizole. Experimental data, which showed that during learning specific "connectors" capable of fixing information in neurons and storing it for a long time are formed in the brain [2, 11, 12], served as the theoretical basis for these observations.

Taking these facts into consideration, it was decided to study the manifestations of feeding motivational responses to stimulation of various limbico-reticular structures of the brain, and also, after combined stimulation of these structures and the pacemaker of feeding motivation — the lateral hypothalamus.

EXPERIMENTAL METHOD

Experiments were carried out on 26 adult rabbits of both sexes. Stimulating bipolar nichrome electrodes with interelectrode distance of 0.3-0.5 mm were inserted by the "wandering" method [3] into various structures of the animals' limbico-reticular complex (lateral hypothalamus, septum, thalamus, hippocampus, mesencephalic reticular formation). The electrodes were implanted under the control of the appearance of feeding responses consisting of the search for and consumption of food of the sort used to feed the animals before the experiment. The parameters of the stimulating current were: frequency 50 Hz, pulse duration 3 msec, voltage chosen individually and, as a rule, not over 5 V, total duration of stimulation not more than 10 sec. Ten successive combined stimulations of the lateral hypothalamus with one of the structures of the limbico-reticular complex to be investigated were used in each experiment. Each structure of this complex was stimulated at the end of the feeding re-

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TABLE 1. Character of Behavioral Responses Observed to Electrical Stimulation of Structures of the Limbico-Reticular Complex

Structure tested	No. of animals	Character of response to testing stimulation		
		feeding	avoidance	individual fragment responses
Lateral hypothalamus	24	24	—	—
Septum	5	—	1	4
Mesencephalic reticular formation	14	1	10	3
Dorsal hippocampus	3	—	—	3

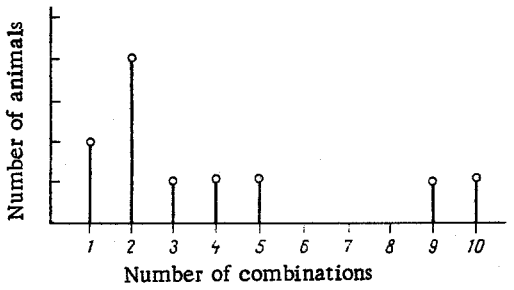

Fig. 1. Distribution of experimental animals depending on number of combined stimulations of lateral hypothalamus and mesencephalic reticular formation required to obtain feeding response. Abscissa, number of combined stimulations; ordinate, number of animals.

sponse evoked by stimulation of the lateral hypothalamus. To destroy the lateral hypothalamus a direct current of 0.5 μA was applied from the anode for a duration of 20 sec. The location of the electrode and size of the focus of destruction were identified in histological brain sections stained by Nissl's method. In some experiments ethimizole was injected intramuscularly in a dose of 1 mg/kg body weight in a 1.5% solution.

EXPERIMENTAL RESULTS AND DISCUSSION

Various behavioral responses were observed in fed rabbits in response to stimulation of the different structures of the limbico-reticular complex. They were divided conventionally into feeding and nonfeeding (Table 1). Motivational feeding responses assumed the following form: The fed animals, which before stimulation refused food, 3.2 ± 0.7 sec after stimulation actively searched for food and ate it. Responses of this sort were observed only to stimulation of the lateral hypothalamus and, in one case, to stimulation of the mesencephalic reticular formation. In response to stimulation of the septum, thalamus, and hippocampus avoidance reactions were observed, accompanied by a characteristic group of autonomic changes: respiration rate, pulse rate, diameter of the pupil, and so on, and also with various motor responses such as turning the head to one side or the other, thrusting the head forward, and tonic convulsions. In response to combined stimulation of the hypothalamus, septum, and hippocampus with stimulation of the lateral hypothalamus, the character of the nonfeeding responses observed previously to isolated stimulation of these structures remained unchanged.

A different picture was observed to combined stimulation of the hypothalamus and reticular nuclei of the tegmentum mesencephali. Such stimulation in 76% of cases led to replacement of nonfeeding responses by feeding. However, under these circumstances different numbers of combined stimulation of the reticular tegmental nuclei and stimulation of the lateral hypothalamus were required to obtain a stable feeding response (Fig. 1). A response was regarded as stable only if it was observed in not less than five cases of iso-

lated successive stimulation of the reticular formation. The time during which formed feeding motivational responses were observed to isolated stimulation of the lateral hypothalamus varied within wide limits — from 30-40 min to three days. After electrolytic destruction of the primary pacemaker point of the lateral hypothalamus in these animals by the anodal dc subsequent stimulation of the reticular formation led to the appearance of the defensive and locomotor behavioral responses as observed previously during testing, in 100% of cases.

Administration of ethimizole in the above-mentioned doses to the animals had no marked effect on the results obtained previously.

The data show that despite involvement of such limbic structures as the septum, thalamus, and hippocampus in the complex of feeding motivational excitation [1, 8, 9], stimulation of these structures by itself did not lead to normally developed feeding motivation. Feeding motivation in satiated animals was induced only by stimulation of the lateral hypothalamus. These data are further confirmation of the view that the lateral hypothalamus plays a pacemaker role in feeding motivational excitation. In response to combined stimulation of the lateral hypothalamus and various formations of the limbico-reticular complex artificial connections are formed only with the mesencephalic reticular formation. A secondary pacemaker of feeding motivational excitation can thus be formed artificially in that structure. The reason why this pacemaker can be formed only in the mesencephalic reticular formation is evidently because of the existence of closer bilateral morphological and functional connections between the mesencephalic reticular formation and the lateral hypothalamus [5, 10] and also the ability to mobilize adrenergic structures of the reticular formation into the mechanism of long-term hunger [6].

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