INFLUENCE OF DIFFERENT CORTICAL AREAS ON UNIT ACTIVITY IN LATERAL DIVISIONS OF THE POSTERIOR HYPOTHALAMUS

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Acute experiments on cats under chloralose anesthesia showed that neurons of lateral divisions of the posterior hypothalamus have a low level of spontaneous activity and high ability to carry out convergence of different influences.

Corticofugal influences of sensorimotor areas I and II, of auditory projection areas I and II, and of visual projection area I on unit activity in the lateral division of the posterior hypothalamus were ineffective in 40-50% of cases.

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Cyclic interaction between cortical and subcortical structures is being increasingly revealed by experimental investigations in various manifestations of integrative brain activity.

An important role in this interaction is played by the functional state of the hypothalamus, one of the more important subcortical structures at the stage of afferent integration, exerting complex and varied influences on cortical electrical activity [1, 3, 5].

Nowadays the hypothalamus is regarded not merely as a level of integration of autonomic functions, but also as a link between limbic structures and other subcortical formations in the physiological mechanisms of behavioral reactions of widely different types [1, 2, 4].

Hypothalamic structures are connected principally to the frontal lobes [8], and if the functional state of the cortex is modified locally, changes can be observed in electrical activity in the hypothalamus [6, 13]. However, despite sporadic investigations [9, 10], corticofugal influences on hypothalamic unit activity remains inadequately studied.

The object of the present investigation was to study not only the properties of neurons in the lateral portions of the posterior hypothalamus connected with the formation of certain motivational states, but also to discover to what degree their unit activity is under the influence of different parts of the cortex.

EXPERIMENTAL METHOD

Experiments were carried out on cats under chloralose anesthesia (60 mg/kg body weight, intraperitoneally). The skin, muscles, and cranial bones were removed layer by layer from the stereotaxically fixed animal, and the dura was detached. During the experiment the exposed cortex was irrigated with warm physiological saline and the animal was heated.

Unit activity was recorded extracellularly by means of glass microelectrodes with a tip 1-5 μ in diameter, introduced stereotaxically into the hypothalamus in accordance with coordinates of the atlas of Jasper and Ajmono-Marsan. Cortical areas were stimulated by means of a bipolar electrode, with interelectrode distance 2 mm. The parameters of stimulation were always strictly constant: 5 V, 10/sec, 0.5 msec. The influence of sensorimotor areas I and II, auditory projection zones I and II, and visual projection zone I was investigated. In some experiments, to study the ability of hypothalamic neurons to carry out convergence of different types of excitation, parts of the mesencephalic reticular formation and sciatic nerve were stimulated and photic and acoustic stimuli were applied.

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TABLE 1. Influence of Different Cortical Areas on Unit Activity of the Lateral Hypothalamus

Area of cortex stimulated	Number of neurons of lateral hypothalamus	Character of unit response of lateral hypothalamus		
		excitation (+)	inhibition (-)	no reaction
I sensorimotor	135	37 (27.4%)	44 (32.6%)	54 (40.0%)
II sensorimotor	138	38 (27.4%)	44 (31.9%)	56 (40.7%)
I auditory projection	128	32 (25.0%)	40 (31.3%)	56 (43.7%)
II auditory projection	122	36 (29.5%)	25 (20.5%)	61 (50.0%)
I visual	124	35 (28.8%)	30 (24.1%)	59 (47.1%)

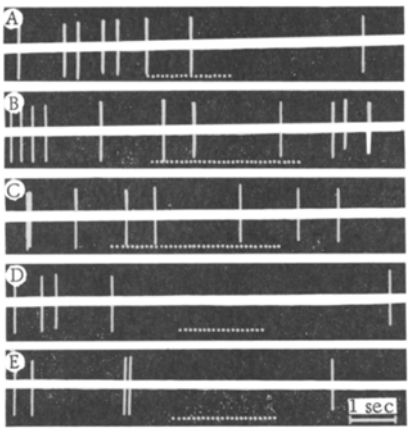

Fig. 1. Example of response of lateral hypothalamic neuron to corticofugal influences. A) Sensorimotor area I; B) sensorimotor area II; C) auditory area I; D) auditory area II; E) visual area I of cortex.

EXPERIMENTAL RESULTS

Investigation of spontaneous unit activity in lateral divisions of the posterior hypothalamus revealed the low frequency of cell discharges. Of the total number of neutrons 38.6% had activity not exceeding 1/sec. Together with a group of neurons whose spontaneous activity was within the range 1-5/sec, cells of the lateral divisions of the hypothalamus with low activity accounted for about 75% of the total number of neurons investigated in this structure. Only 25% of hypothalamic neurons discharged at frequencies exceeding 5/sec. These results in general confirm those of previous investigations [7, 11], in which attention was drawn to the relatively low level of unit activity in lateral divisions of the posterior hypothalamus.

Participation of the hypothalamus in different functional systems [1, 2] presupposes convergence of influences from a wide variety of sources on its neutrons. In the present investigations only 10% of hypothalamic neutrons tested for their ability to carry out convergence did not respond to any of the stimuli used. High ability of the hypothalamic cells to respond to stimuli of different modalities is evidently responsible for the wide participation of this structure in various integrative reactions on the whole brain [7, 12].

The study of central influences on activity of hypothalamic neurons from sensorimotor areas I and II, auditory projection zones I and II, and visual area I gave results which are summarized in Table 1.

Many hypothalamic neurons do not respond to stimulation of these cortical areas. The effectiveness of corticofugal influences on unit activity of the lateral hypothalamus varied. Auditory area II was least active in this sense: 50% of hypothalamic neurons did not respond to stimulation of this area. Descending influences from sensorimotor areas I and II were more effective, but in these cases also the percentage of hypothalamic neurons which failed to respond was high—40 and 40.7 respectively.

Neurons of the lateral hypothalamus responding to corticofugal influences were mainly inhibited by stimulation of sensorimotor areas I and II and auditory area I: 32.6, 31.9, and 31.1% respectively (Table 1).

Corticofugal effects of auditory area II and visual area I were predominantly excitatory: 29.5 and 28.8% respectively.

It can also be considered that cortical projection areas II may have influences on hypothalamic neurons which coincide in sign with the response from projection areas I, as in the case of sensorimotor areas I and II, or which do not coincide, as in the case of the corticofugal effects of auditory areas I and II.

The response of one hypothalamic neuron to influences from these cortical projection areas is shown in Fig. 1.

Despite the fact that neurons of the lateral hypothalamus are less sensitive to corticofugal influences than to stimuli from other sources, the possible influences of cortical levels on the hypothalamus must always be taken into account when the integrative activity of the whole brain is studied.

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