CORTICOFUGAL EFFECTS ON THE FORMATION OF FEEDING MOTIVATION

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UDC 612.391.3:612.825

Influences from various parts of the cortex on the development of feeding motivation giving rise to goal-directed behavior were established in chronic experiments on rabbits. Electrical stimulation of the frontal and anterior parietal regions of the cortex inhibited the formation of feeding responses evoked by stimulation of the hypothalimic "food center." Inhibitory influences of the frontal region were stronger. Stimulation of the posterior parietal and occipital regions was accompanied by lowering of the threshold of the evoked feeding response or even by its appearance in satiated animals.

KEY WORDS: feeding behavior; corticofugal effects.

Recent investigations have confirmed the important role, postulated by P. K. Anokhin's theory of the functional system, of biological motivations in the formation of various (including feeding) goal-directed responses [1]. The mechanisms and character of ascending motivational influences of the hypothalamic food centers on the cortex have been sufficiently well investigated [3, 4, 7]. Corticofugal influences on the feeding motivation centers have received less study.

Comparatively few investigations have shown that changes in the state of cortical function may disturb goal-directed feeding behavior of animals at various stages of its progress [2, 6, 12, 13]. Cortical influences have also been noted in the formation of certain biological motivations [8-10].

In the experiments described below the character of effects of different cortical areas on the formation of hunger motivation, determining the subsequent goal-directed feeding behavior of animals, was studied.

EXPERIMENTAL METHOD

Chronic experiments were carried out on 20 rabbits weighing 2.5-3 kg. Nichrome electrodes 0.09 mm in diameter were implanted into the frontal, parietal (the regions of sensory and motor representation), and occipital regions of the cortex and also into the dorsal hippocampus, the lateral region of the hypothalamus, and the mesencephalic reticular formation. The reference electrode was placed above the frontal sinus. Previously fed animals, in which stimulation of the lateral hypothalamus evoked a clear feeding response, were used in the experiments. The neocortical areas were stimulated electrically by pulses of 5 V, 1 msec in duration, at a frequency of 50 Hz. Cortical and subcortical electrical activity was recorded on a 16-channel Alvar electronic electroencephalograph. The location of the subcortical electrodes was determined histologically.

EXPERIMENTAL RESULTS AND DISCUSSION

In these experiments a goal-directed feeding response was evoked by stimulation of the region of the lateral hypothalamus, as a result of which the satiated animals developed a hunger motivation. Electrical stimulation of the frontal and anterior parietal cortical regions was accompanied by an increase in the threshold of the feeding response evoked by stimulation of the hypothalamic "feeding center." Stimulation

Department of Normal Physiology, I. M. Sechenov First Moscow Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR A.M. Chernukh.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 79, No. 6, pp. 3-6, June, 1975. Original article submitted July 9, 1974.

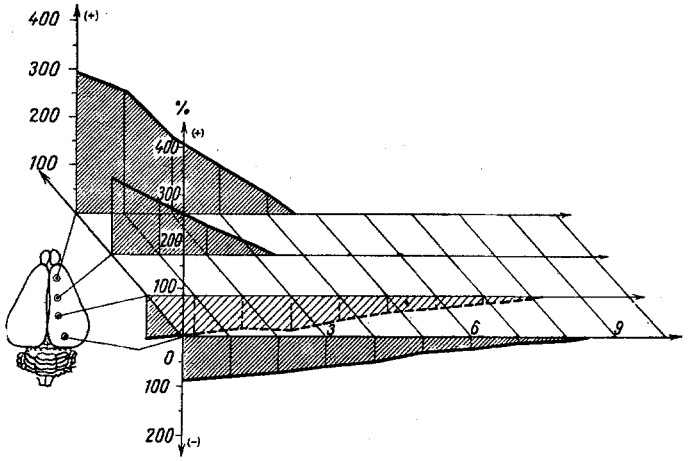

Fig. 1. Changes in threshold of feeding response during stimulation of different parts of the cortex. Ordinate, changes in threshold (in %); abscissa, time (in min).

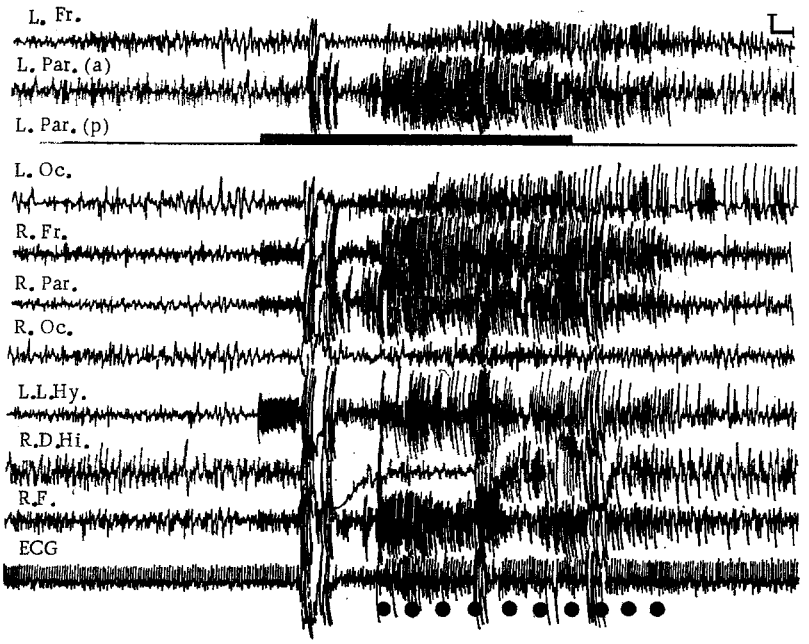

Fig. 2. Changes in EEG and ECG during feeding response evoked in satiated rabbits by electrical stimulation of posterior parietal cortex. Regions of cortex: L. Fr. – left frontal, L. Par. (a) – left anterior parietal, L. Par. (p) – left posterior parietal, L. Oc. – left occipital, R. Fr. – right frontal, R. Par. – right parietal, R. Oc. – right occipital, L. L. Hy. – left lateral hypothalamus, R. D. Hi. – right dorsal hippocampus, R. F. – mesencephalic reticular formation on left side. Black band is marker of stimulation (5 V, 50 Hz, 3 msec); black circles denote feeding response. Calibration > 2 sec, 50 μV.

of these neocortical regions during food consumption by the animals abolished the feeding response during the period of stimulation. Descending inhibitory effects of the frontal region of the neocortex were stronger than the effects of similar character from the anterior parietal region (Fig. 1). This was expressed both as a higher degree of elevation of the threshold of the evoked feeding response (to 300% in the case of frontal and 150% in the case of anterior parietal stimulation) and an increase in the time taken for it to return

to normal. Abolition of the feeding response in the animals also required weaker stimulation of the frontal than of the anterior parietal region of the cortex.

Stimulation of the posterior parietal and occipital regions of the cortex facilitated the onset of the feeding response to lateral hypothalamic stimulation in the satiated animals. Analysis of changes in the threshold of the evoked feeding response revealed the virtually complete identity of the facilitatory influences of the above-mentioned cortical regions. It is important to note that under these experimental conditions isolated stimulation of the posterior parietal or occipital region frequently evoked an orienting-investigative response in the satiated animals as a search for and consumption of food (Fig. 2).

The experiments showed that the cortex can exert an influence in the initial stage of formation of a feeding response through its action on the level of motivational excitation. In some cases the behavioral effects observed were accompanied by changes in electrical activity in subcortical structures. However, because of the simultaneous appearance of similar changes on the EEG in the limbico-mesencephalic structures it was impossible under these experimental conditions to detect the concrete physiological mechanisms of the inhibitory and facilitative effects of the neocortical regions on the feeding response.

The results of experiments with spreading cortical depression [9] or removal of various regions of the neocortex [11], and also experiments with electrical stimulation of various cortical regions [8], have shown that the cortex can modify the level of feeding motivation. The frontal region of the cortex has the strongest effect on the level of feeding motivation.

In all probability the functions of the frontal cortex in feeding behavior cannot be reduced purely to estimation of the animal's requirement of food, and hence, to the formation of a hoarding response [12, 13].

The results showing the ability of the frontal zones of the cortex to inhibit feeding motivation extend our ideas of the role of these areas in decision making and in the mechanism of goal-directed feeding behavior to correspond to the concrete conditions of the current situation [2-5], taking place at the stage of afferent synthesis.

The inhibitory and facilitative effects of certain neocortical regions on the development of feeding motivation revealed by this investigation leave unanswered, however, the question of the concrete mechanisms of these effects: do they include changes in the excitability of the hypothalamic "food center" itself or are they limited to a change in the excitability of other structures involved in the functional system of feeding behavior?

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