EFFECT OF COAGULATION OF THE DORSAL HIPPOCAMPUS AND MESENCEPHALIC RETICULAR FORMATION OF THE FOOD RESPONSE

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The effect of coagulation of the dorsal hippocampus and mesencephalic reticular formation of the food response evoked by electrical stimulation of the lateral hypothalamus was studied in experiments on satiated waking rabbits. Unilateral coagulation of the dorsal hippocampus ipsilaterally or contralaterally to the stimulated hypothalamic "food center" led to lowering of the threshold of the food response and, in some cases, was accompanied by spontaneous eating. Unilateral coagulation of the region of the mesencephalic reticular formation ipsilaterally or contralaterally to the stimulated "food center," on the other hand, was characterized by a marked increase in the threshold of the evoked food response. The mechanisms of the reciprocal effects of the dorsal hippocampus and mesencephalic reticular formation on the food response are discussed.

KEY WORDS: food behavior; hippocampus; reticular formation.

The results of the study of mechanisms of formation of natural or artificial food responses of animals provide convincing evidence of the participation of structures of the limbic system and mesencephalon in their neurophysiological make-up [1, 2, 7, 12]. However, the variety of methods used and the different experimental situations encountered frequently lead to contradictory results concerning the functional role of particular subcortical brain formations and also the character of their mutual relations. In particular, the role of the dorsal hippocampus and structures of the mesencephalon in the formation of food responses is not sufficiently clear.

In the experiments described below electrolytic destruction of the dorsal zones of the hippocampus and the region of the mesencephalic reticular formation was carried out as a logical sequel to earlier investigations [3] in which the effect of stimulation of these subcortical structures on the evoked food response was studied.

EXPERIMENTAL METHOD

Experiments were carried out on 22 unimmobilized, unanesthetized rabbits weighing 2.5-3 kg. The animals used in the experiments had previously been fed, and electrical stimulation of the lateral hypothalamus evoked a well-marked food response. Nichrome electrodes, 0.1 mm in diameter, were inserted into the structures of the dorsal hippocampus and mesencephalic reticular formation ipsilaterally or contralaterally relative to the hypothalamic "food center" stimulated. In the course of the experiment coagulation of either the dorsal hippocampus or a part of the mesencephalic reticular formation was carried out in each animal by means of implanted subcortical electrodes. A current of 10-20 mA was passed for 10 sec. The cortical electrical activity was recorded on a 15-channel Alvar-Electronic electroencephalograph. The location of the subcortical electrodes and the dimensions of the foci of coagulation were determined histologically.

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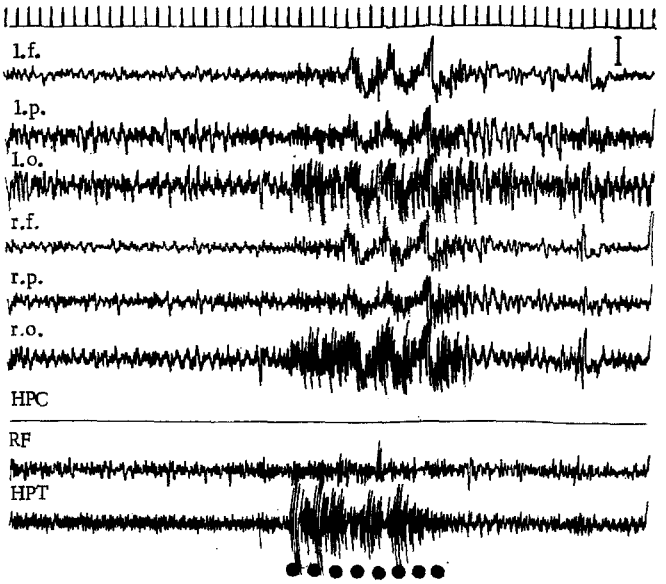

Fig. 1. Spontaneous food response of satiated rabbit after coagulation of the right dorsal hippocampus. From top to bottom: time marker, l.f.) left frontal, l.p.) left parietal, l.o.) left occipital, r.f.) right frontal, r.p.) right parietal, and r.o.) right occipital regions of the cortex. HPC) Hippocampus, RF) mesencephalic reticular formation on the right side; HPT) lateral hypothalamus on the left side. Black dots indicate food response. Calibration: 50 μV.

EXPERIMENTAL RESULTS AND DISCUSSION

Threshold electrical stimulation of the hypothalamic food center evoked a feeding response in the fed animals, usually preceded by a transient investigative response and a search for food. The records of the EEG showed that the investigative response was usually accompanied by the appearance of a theta-rhythm in the dorsal hippocampus and mesencephalic reticular formation and by desynchronization in the neocortex, whereas the food response itself, expressed as eating, was characterized by the appearance of high-amplitude activity, linked with chewing movements, in all leads of the EEG.

Unilateral coagulation of the dorsal hippocampus ipsilaterally or contralaterally relative to the stimulated hypothalamic food center was accompanied by asymmetry of the EEG. The spontaneous EEG on the side of coagulation consisted of low-amplitude waves, not exceeding 25 μV, with total disappearance of slow, high-amplitude waves of 50-100 μV. Under these conditions the animal's food response was evoked by a stimulating current of lower voltage. Often the actual presentation of food to the satiated animals with a destroyed dorsal hippocampus was accompanied by a normal food response (Fig. 1).

Unilateral destruction of zones of the mesencephalic reticular formation was accompanied by a marked decrease in the level of cortical electrical activity of both hemispheres, as reflected in the appearance of slow, low-amplitude waves, interrupted by 3-4 sec periods of spindle-shaped activity with an amplitude of not more than 100 μV. The general state of the animals also changed and they became apathetic and adynamic.

The food response of the animals, even after unilateral destruction of the mesencephalic reticular formation, occurred if the strength of the stimulating current was increased by several times or it was absent completely. An increase in the voltage of the current by 2.5 times after right-sided destruction of the mesencephalic reticular formation did not evoke a food response with all its behavioral and electrophysiological manifestations (Fig. 2).

Destruction of the dorsal hippocampus in the satiated rabbits in these experiments was accompanied by facilitation of the onset of the food response. These results, in agreement with the few observations reported by other workers [6], suggest that the intact dorsal hippocampus has an inhibitory effect on food responses.

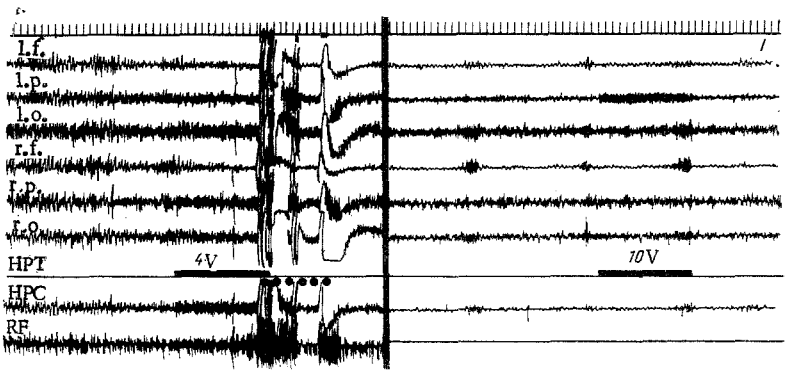

Fig. 2. Food response and its absence after coagulation of the mesencephalic reticular formation on the right side. From top to bottom: time marker, l.f.) left frontal, l.p.) left parietal, l.o.) left occipital, r.f.) right frontal, r.p.) right parietal, r.o.) right occipital cortex. HPT) Lateral hypothalamus on the left side, HPC) dorsal hippocampus on the right side, RF) mesencephalic reticular formation on the right. Thick line represents marker of stimulation of lateral hypothalamus. Black dots represent food response. Calibration: 50 μV.

The results of experiments with destructive lesions at the mesencephalic level, involving the reticular formation to some degree or other, are extremely contradictory. In particular, hyperphagia and increased body weight have been described after extensive bilateral divisions in the lateral zones of the mesencephalon in cats [17] and rats [14]. At the same time, there are reports of the development of aphagia in animals after destruction of the reticular formation ventro-laterally to the circumaqueductal gray matter [8, 11] and in the region of the red nucleus [10, 11, 13, 15]. The histological control to the present experiments showed that the foci of coagulation lay in the region of the mesecephalic reticular formation without affecting neighboring structures, especially the medial lemniscus. This fact is emphasized, because of the conclusions drawn from Skultely's recent observations [16] concerning the different roles of mesencephalic structures in food responses. According to these observations, destructive lesions confined to the region of the medial lemniscus were accompanied by hyperphagia in rats. Skultely postulates that hyperphagia in animals is the result of the interruption of information concerning the intake of food into the body from receptors of the oro-pharyngeal region and the proximal portion of the gastro-intestinal tract.

It can be concluded from the results of the present experiments and the analysis of those of previous investigations that limited coagulation at the mesencephalic level interferes with the formation of the food response. The greatest changes in the food response take place after destruction chiefly in the region of the reticular formation. This suggests that the mesencephalic reticular formation is an intermediate link in the chain of physiological mechanisms forming purposive food behavior. The contradictory results of experiments with coagulation in the region of the mesencephalic reticular formation and, in particular, the phenomena of hyperphagia, can be attributed to the fact that the extensive zone of coagulation included the region of the medial lemniscus responsible for the mechanism of "sensory satiation" [1] as well as the reticular formation. Evaluation of the role of the dorsal hippocampus and mesencephalic reticular formation in the development of the food response on the basis of the present experiments in which these structures were coagulated reveals the opposite character of their effects on the evoked food response. However, this conclusion does not rule out the possibility of synergistic effects of these structures in other physiological responses of the organism [4, 5].

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