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ANALYSIS OF FOOD-MOTIVATED EXCITATION AT THE THALAMIC NEURONAL LEVEL IN RABBITS

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Activity of 34 neurons in the ventral posteromedial thalamic nucleus – a relay in the central pathway for taste – was investigated in fed rabbits before and after elicitation of a food response from them to stimulation of the lateral hypothalamus. The appearance of volley activity in 26.4% of neurons in response to lateral hypothalamic stimulation is particularly interesting, for it evidently may reflect recruiting of neurons of this thalamic nucleus into food-motivated excitation.

KEY WORDS: rabbit thalamus; motivated excitation.

Food-motivated excitation, arising in pacemaker points of the hypothalamic structure of the brain has been shown [6-8, 10, 11] to spread to neurons at both subcortical and cortical levels of the brain, to create a widely branched system that acts as the structural and functional basis for goal-directed behavior. The neuronal correlates of the participation of structures such as the hypothalamus and neocortex in this case are not so much changes in general activity of the neurons as changes in the configuration of their discharge activity [1, 2, 4, 5, 9].

It was therefore decided to investigate unit activity in another brain structure which could become involved in food-motivated excitation, namely the ventral posteromedial nucleus of the thalamus. Food-motivated excitation in the rabbit was created by electrical stimulation of the lateral hypothalamus, giving rise to an additional demand for food in satiated rabbits.

EXPERIMENTAL METHOD

Experiments were carried out on 27 male rabbits, weighing 3-3.5 kg. As a preliminary measure, before unit activity was recorded, the fed rabbits were tested for the presence of a food response to stimulation of the lateral hypothalamus, causing an additional demand for food. The lateral hypothalamus was stimulated electrically through a bipolar nichrome wire electrode with factory insulation, inserted by the "wandering electrode" method, so that the region of the lateral hypothalamus could be accurately identified with coordinates taken from Sawyer's atlas (P 1.5, I 1.5, H 12-15 mm) and a marked food response could be obtained in the satiated rabbit. The parameters of the stimulating current were: frequency 50 Hz, pulse duration, 3 msec, voltage from 2 to 5 V.

Activity of neurons of the thalamic nucleus which coordinates P 4, I 3, H 10-12 mm was recorded extracellularly by glass microelectrodes (unanesthetized rabbit, stereotaxic fixation), amplified on the MZ-4 apparatus (Nihon Kohden), and recorded on magnetic tape.

Statistical analysis of unit activity recorded 200 sec before and 200 sec after stimulation of the lateral hypothalamus was carried out with respect to the mean frequency (in spikes/sec) and the degree of regularity of discharge activity, determined as the coefficient of variation of the mean frequency or the mean value of interspike intervals, by means of the NTA-1024 analyzer and Iskra-122 calculator.

The location of the macro- and microelectrode was determined in laminar brain sections processed by the photo-express method.

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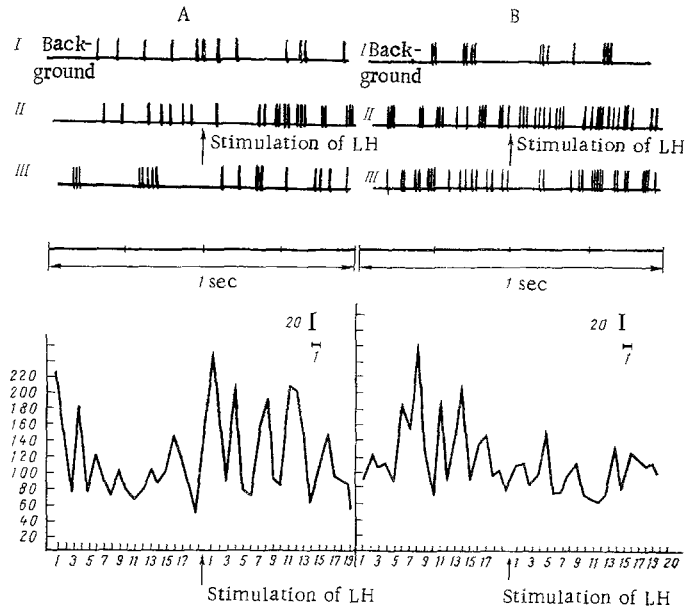

Fig. 1. Plain recording of unit activity on automatic writer and changes in coefficient of variation (CV) of mean frequency after stimulation of lateral hypothalamus (LH). Abscissa, time (in sec); ordinate, CV (in %); A) changes toward volley activity; B) toward regularity.

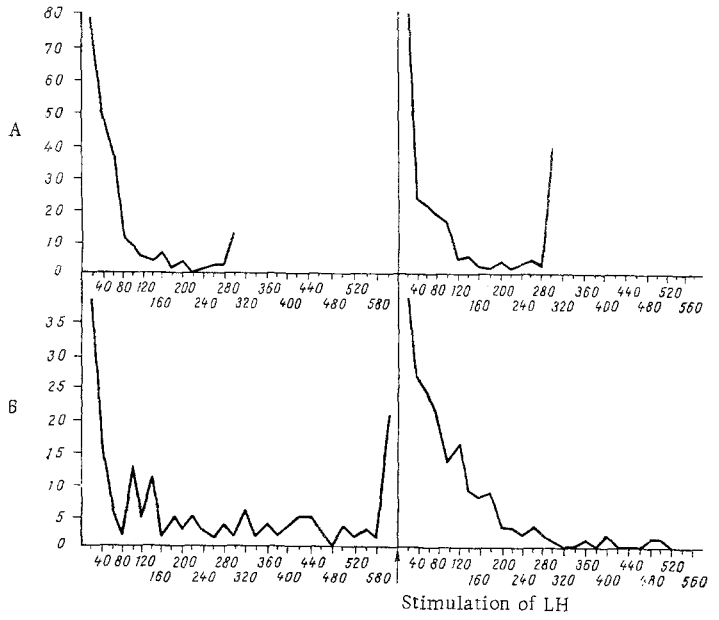

Fig. 2. Interval histogram of neurons of ventral posteromedial thalamic nucleus. Abscissa, interval (in msec); ordinate, number of intervals. A) Appearance of bimodal curve after stimulation of lateral hypothalamus for neurons responding with volley activity; B) appearance of monomodal curve for neurons changing their activity toward regularity.

EXPERIMENTAL RESULTS

Activity of 34 neurons of the ventral posteromedial thalamic nucleus was recorded. Unit activity in this nucleus was subjected to statistical analysis before and after stimulation of the lateral hypothalamus with the following results.

The initial activity of the thalamic neurons had an overall mean frequency of 15.2 spikes/sec. The coefficient of variation, reflecting the degree of regularity of the mean frequency was 42.86% for all neurons, and the limits of its variations were from 13 to 107%. The limits of variations of the mean frequency were from 1 to 84 spikes/sec. After stimulation of the lateral hypothalamus the overall mean frequency of spontaneous activity rose to 17 spikes/sec, with limits of variation from 0 to 83 spikes/sec. Meanwhile the coefficient of variation of the mean frequency rose to 54.6% and the limits of variations of the coefficient of variation widened from 6.7 to 136.8%. Characteristically, in 9 of 34 neurons (26.4%) activity after stimulation of the lateral hypothalamus had a distinct appearance of "volleys," whereas in 8 neurons (23.5%) it changed to a more regular rhythm (Fig. 1).

Previous investigations showed [1, 2, 4, 5, 9] that food-motivated excitation also is characterized by volley activity with relatively rigid characteristics between spikes at the hypothalamic [1, 2] and cortical [4, 5] unit level. Analysis of interval histograms (200 intervals before and after stimulation of the lateral hypothalamus) of neurons of the ventral posteromedial thalamic nucleus responding with volley activity to stimulation of the lateral hypothalamus gave a bimodal curve with peaks under 10 msec and about 300 msec. A monomodal curve with a peak at about 40 msec was found on the interval histogram of neurons changing their activity toward greater regularity (Fig. 2).

Stimulation of the lateral hypothalamus, leading to the formation of a food response, thus changes unit activity of the thalamic relay nucleus. Analysis of interval histograms showed that in some cases (in 26.4% of neurons) these changes in unit activity were similar to those found by other workers [1, 2, 4, 5] who investigated food motivation. It can therefore be suggested that neurons of the thalamic relay nucleus which have activity of volley type can be involved in food motivated excitation. This volley-like activity of the thalamic neurons, which is also observed in other brain structures such as the hypothalamus [1, 2] and neocortex [4, 5], may evidently reflect synchronization or coherence [3] in unit activity in different parts of the brain, thus ensuring the goal-directedness of all the animal's behavior.

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