HYPOTHALAMIC ELECTRICAL ACTIVITY DURING STRESS

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UDC 616.45-001.1/.3-092.9-07:
616.831.41-073.97

Chronic experiments on rabbits showed that excitation of the pituitary-adrenocortical system during immobilization stress is accompanied by changes in multiple unit activity in the anterior, medial, and lateral hypothalamus. Activation of the medial and inhibition of the anterior and lateral hypothalamus are observed during stress.

KEY WORDS: *stress; hypothalamus; corticosteroids; multiple unit activity.*

The role of the hypothalamus in stressor activation of the pituitary-adrenocortical system is well known [1, 8]. Damage to the hypothalamus or changes in the affluent impulsation reaching it is accompanied by a disturbance of the response of this system to stressors [1, 7].

The object of this investigation was to obtain information characterizing the electrical activity of the anterior (AHA), medial (MHA), and lateral (LHA) hypothalamus during immobilization stress. The state of the pituitary-adrenocortical system was judged from the blood corticosteroid level.

EXPERIMENTAL METHOD

Multiple unit activity in AHA, MHA, and LHA was investigated in chronic experiments on male rabbits weighing 2.5-3 kg. Nichrome semimicroelectrodes [4] were implanted into the hypothalamus 10-14 days before the beginning of the experiments. The electrodes were inserted in accordance with coordinates of a stereotaxic atlas [9]. The discharge frequency of a neuron pool was recorded for 30 min before and 60 min after the beginning of immobilization. The firing rate was determined over a period of 15 sec at least once every 2 min. The potentials were led, first, to an amplifier, a standard pulse shaper with threshold device, and a pulse counter. In the course of the experiment, the activity of one or two neuron pools was recorded. Neuron pools for which the signal-to-noise ratio was not lower than 2:1 were used. For each neuron pool the significance (using Student's t test) of differences between the initial discharge frequency (for 30 min) and the frequency after stress (for 10-30 min) was determined. The neuron pools were divided into groups depending on the character of their response to stress. The conclusion that the number of neuron pools with a given type of response was the majority of the total number of pools in each part of the hypothalamus investigated was shown to be reliable by determination of the d criterion for a binomial distribution.

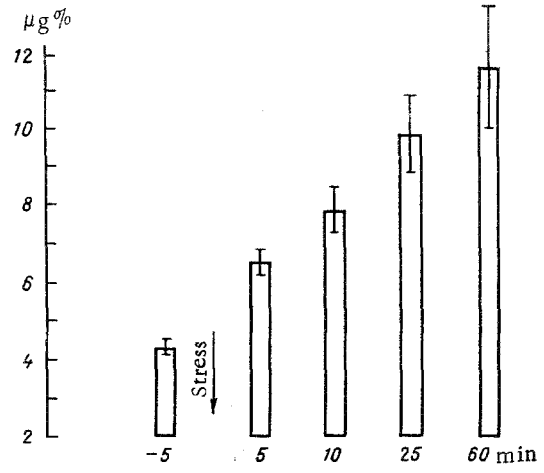

Fig. 1. Blood corticosteroid concentration (ordinate, μg %) during stress (time from beginning of immobilization shown).

Laboratory of Experimental Endocrinology, I. P. Pavlov Institute of Physiology, Academy of Sciences of the USSR, Moscow. (Presented by Academician V. N. Chernigovskii.) Translated from Byulleten' Eksperimental'noi Biologii i Meditsiny, Vol. 84, No. 7, pp. 3-5, July, 1977. Original article submitted January 25, 1977.

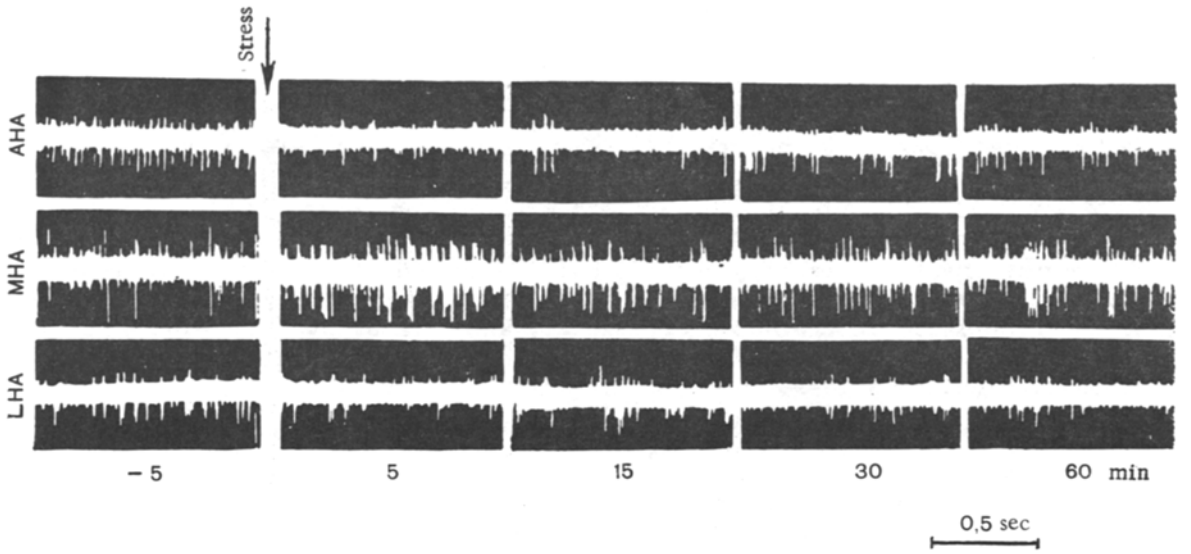

Fig. 2. Multiple unit activity in three parts of the hypothalamus during stress (time from beginning of immobilization shown).

To characterize the response of the pituitary-adrenocortical system to stress the blood corticosteroid concentration was determined spectrofluorometrically [10]. Blood was taken from a vein of the animal's ear. The significance of changes in the corticosteroid concentration was estimated by Student's t test.

At the end of the experiment the location of the electrodes was verified histologically.

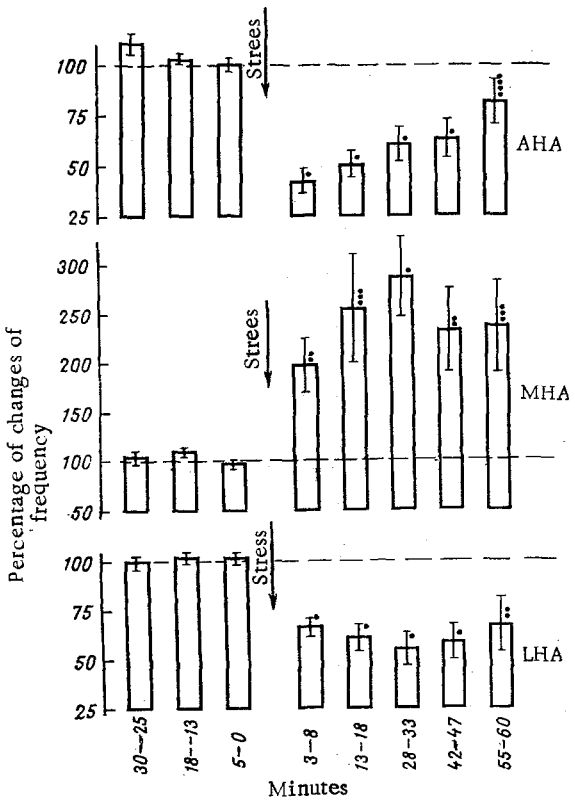

Fig. 3. Mean discharge frequencies (M ± m) of hypothalamic neuron pools during stress. Results shown were obtained for the period specified (duration of each period 6 min). Time elapsing after beginning of immobilization shown. Discharge frequency for that period expressed as percentage of mean initial frequency over whole period of recording of activity before beginning of stress (30 min), taken as 100%. Significance of differences calculated relative to background: 1 dot $P < 0.001$; 2 dots $P < 0.01$; 3 dots $P < 0.05$; 4 dots $P > 0.1$.

TABLE 1. Distribution of Hypothalamic Neuron Pools by Responses to Stress

Region of hypothalamus	Change in discharge frequency				Total
	increase	decrease	biphasic	no change	
AHA	8	18*	1	3	30
MHA	17*	10	1	5	33
LHA	9	13*	2	1	25
Total					88

Legend. Groups of pools marked by asterisk are significantly ($P < 0.002$) in the majority in each of the three parts of the hypothalamus (d criterion for a binomial distribution).

EXPERIMENTAL RESULTS

Immobilization led to activation of the pituitary-adrenocortical system, as shown by an increase in the blood corticosteroid concentration. This increase was observed as early as the 5th minute and it continued throughout the period of observation (Fig. 1).

During stressor activation of the pituitary-adrenocortical system the discharge frequency of the hypothalamic neuron pools changed (Fig. 2).

As Table 1 shows, the majority of pools in AHA showed a reduction in their discharge frequency. In MHA the discharge frequency of most pools increased. In LHA most of the pools responsed by a decrease in discharge frequency.

The mean changes in discharge frequency for groups of neuron pools forming the majority in AHA, MHA, and LHA are shown in Fig. 3.

No significant changes in discharge frequency were observed in the control experiments in which multiple unit activity was recorded for 90 min.

During immobilization stress MHA was thus activated and AHA and LHA inhibited. The redistribution of activity of the hypothalamic centers evidently reflects central relationships formed in the hypothalamus during stress and as a result of which changes take place in the autonomic and endocrine functions. The observed redistribution of activity is probably connected with activation of the pituitary-adrenocortical system. This is supported by evidence of the role of the medial hypothalamus in the regulation of this system [1] and also by our own observations [2, 3] relating to the role of AHA and MHA in activation and inhibition of the pituitary-adrenocortical system.

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