INTERACTION BETWEEN ZONES OF THE SENSOMOTOR CORTEX AND HYPOTHALAMUS DURING THE FORMATION OF PAIN STRESS

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Cross-correlation analysis of the tension rhythm in various zones of the sensomotor cortex relative to the posterior hypothalamus showed that during pain stress there is an increase in the phase shifts accompanied by a decrease in the cross-correlation coefficients. These changes varied within the sensomotor cortex. At the focus of maximal activity for pain projections (posteriorly to the bregma) they were less marked than outside it, especially in the more anterior zones of the cortex (anteriorly to the bregma).
KEY WORDS: cerebral cortex; hypothalamus; stress.

According to Anokhin's concept [1] of the functional system as a unit of integrated activity of the organism, the initial stage of any behavioral act is the afferent synthesis of qualitatively different actions. A leading role in decision taking and assessing the result obtained is played by the hypothalamic motivational excitations which spread as ascending activations to the various zones of the cortex.

On this basis it was decided to study interaction between the posterior hypothalamus and various zones of the sensomotor cortex, namely: at the focus of maximal activity (SMC_p) and in more anterior zones (SMC_a). Various parameters of the tension rhythm of 4-7 Hz were used as the indicator of this interaction.

The object of this investigation was to carry out cross-correlation analysis of the 4-7 Hz rhythm and to compare its slow waves by phase shifts and cross-correlation coefficients in the brain structures chosen during the formation of pain stress.

EXPERIMENTAL METHOD

Permanent electrodes were implanted into 12 unanesthetized rabbits. Electrical activity was recorded on an electroencephalograph and cross-correlation analysis carried out later on a computer. Nociceptive stimulation was applied irregularly at intervals of between 30 sec and 2 min by an electric current of 20-200 V, 120 Hz, for 10 sec in the region of the hind limb.

EXPERIMENTAL RESULTS

The data described are based on the results of analysis of 1760 cross correlograms. They showed that before application of nociceptive stimulation the slow waves of the tension rhythm of the hypothalamus and sensomotor cortex posteriorly to the bregma (SMC_p) were largely cophased (Fig. 1). The cross-correlation coefficients were 0.5-0.65. Meanwhile small phase shifts (2.5-16 msec) occurred between the slow waves of the tension rhythm of the hypothalamus and anterior (to the bregma) zone of the sensomotor cortex (SMC). The cross-correlation coefficients were 0.3-0.56. Nociceptive electrical stimulation of the skin in most cases evoked an increase in the phase shifts of the tension rhythm of both zones of the sensomotor cortex relative

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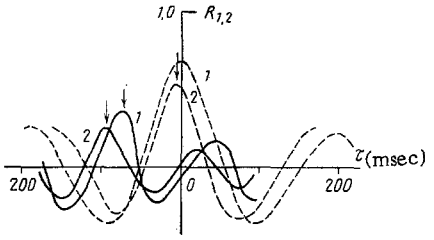

Fig. 1. Cross correlograms of tension rhythm of the posterior hypothalamus and various zones of the sensomotor cortex: 1) focus of maximal activity (posteriorly to the bregma); 2) more anterior zones (anteriorly to the bregma). Broken lines represent initial level before nociceptive stimulation; continuous lines level after 50th application of nociceptive stimulation.

to the hypothalamus. However, these shifts differed in magnitude: in SMC_a they reached 16-25 msec, compared with only 2.5-16 msec in SMC_p. With a low background level of correlation (0.3) in SMC_a the cross-correlation coefficients as a rule increased (0.45-0.5), but with their relatively high level (0.65) in SMC_p, on the other hand, they decreased (0.35-0.48). At the moment of generalization of activation, correlation between the anterior sensomotor zone (SMC_a) and the hypothalamus evidently increased.

After repeated exposures (from 15-30 to 200) to nociceptive stimulation (Fig. 1) the phase shifts increased (to 99-108 msec), the cross-correlation (0.1-0.2) and dispersion (0.4-1.5) coefficients decreased, and the tension rhythm of SMC_a relative to the hypothalamus fell. Meanwhile the changes in these parameters from SMC_p were somewhat smaller: the phase shifts 75-99 msec, cross-correlation coefficients 0.18-0.3, and dispersion 0.8-2.5.

In agreement with the results of previous investigations [2], the parameters given above showed that the repeated application of a nociceptive stimulus led to weakening of connections between the cortex and hypothalamus and a lowering of their energy level. These changes varied within the boundaries of the sensomotor cortex. They were more marked in SMC_a, possibly on account of the progressive development of the anterior zones and the increasing complexity of their functional characteristics, than in SMC_c, in which the focus of maximal activity for pain projections lies.

The lowering of the level of cortical function under these conditions fits in with Pavlov's view of the development of "protective inhibition" in the higher levels of the brain during the action of "extremal stimuli."

LITERATURE CITED

1. P. K. Anokhin, Fundamental Problems in the General Theory of Functional Systems [in Russian], Moscow, (1971).
2. P. K. Anokhin, A. I. Shumilina, and A. M. Mamedov, Dokl. Akad. Nauk SSSR, 209, No. 1, 249 (1973).