ROLE OF THE ACTIVATION OF THE INTRALAMINAR NUCLEI OF THE THALAMUS IN REGULATING THE PARTICIPATION OF THE NEOSTRIATAL CHOLINERGIC SYSTEM IN THE DIFFERENTIATION OF ACOUSTIC SIGNALS IN DOGS*

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We had previously demonstrated [1] in chronic experiments in dogs that the activation of the cholinergic system of the neostriatum (with microinjections of small doses of carbacholine) induces a significant improvement in the differentiation of acoustic signals in a defense situation. It seemed of interest to elucidate how this striatal mechanism might be triggered in the norm. Preliminary investigations showed that bilateral stimulations of the intralaminar nuclei of the thalamus with high-frequency electrical stimuli of low amplitude (200 Hz, 15 mA, 0.5 msec), accompanied by an arousal behavioral reaction, leads to a significant increase in the level of acetylcholine and choline in a dialysate of the neostriatum of freely-moving rats.

A great deal of attention has been devoted in recent years to the study of the role of the ascending cholinergic system, which begins in the pedunculopontine and the tegmental laterodorsal nuclei and which then switches in the CM-Pf complex of the thalamus and terminates in the cortex [5]. The activation of this system influences such important processes as the wakefulness-sleep arousal cycle, attention, and orienting activity [5]. It is known that the nuclei of the CM-Pf complex send direct projections to all zones of the caudate nucleus [2]. A conclusion was reached, on the basis of experiments in dogs using histochemical and electron microscopic methods, regarding the possibility of direct influences of brainstem cholinergic nuclei on the activity of thalamostriatal neurons [3]. These data make it possible to regard the neostriatum as another important target of modulatory influences ascending from tegmental cholinergic neurons. The study of these influences on the accomplishment of the functions of the neostriatum and its cholinergic system is of undoubted significance.

The investigation was carried out in 3 mongrel dogs (Ferri, Chizhik, and Dik), using the methods of Petropavlovskii [1]. The animals were trained to avoid the action of an electric shock applied to the left hind paw by raising this paw to the height of 8 cm, and by maintaining this position through entire action of the conditional signal (10 sec). The current was turned on at the fifth second of the conditional signal, and acted together with it for an additional 5 sec. A 130 beats/min (M130) metronome was used as the defense conditional signal, and M60, M60, and M90 metronomes were used as the differential signals. The differential signals were introduced into the experiment after the instrumental reaction to the M130 was consolidated. The stimuli were used in random order. The following operations were carried out on the trained animals stereotactically under sterile conditions [4]: the implantation of stimulating electrodes (Nichrome, glass insulation, 200 μm, 20-40 kΩ) into the CM-Pf complex of the thalamus (the stimulation was applied 10 sec before the conditional signal was turned on (15-20 μA, 0.5 msec, 200 Hz); the implantation of guide cannulae into the head of the caudate nucleus and the CM-Pf complex in accordance with stereotaxic coordinates. A polyethylene microinjector, calibrated and filled with the agent, was introduced into the guide cannula in order to carry out the microinjections. The acetylcholine agonist carbacholine in doses of 0.05-0.1 μg was injected in 1.5 μl of bidistilled water over the course of 25-30 sec. The solvent in the same volume was used as the control. Thus, the

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Fig. 1. Influence of the activation of the cholinergic system of the striatum, the CM-Pf complex, and their combined activation on the latent periods of the reaction to the differential signals in the dogs. A) Chizhik; B) Ferri; and C) Dik; 1) baseline; 2) activation of the cholinoreactive structures of the CM-Pf complex; in A: microinjections of carbacholine into the ipsilateral thalamus; in B and C: its ipsilateral electrical stimulation; 3) microinjections of carbacholine into the ipsilateral caudate nucleus; 4) the effect of combined activation of the cholinergic structures of the caudate nucleus ipsilaterally and of the CM-Pf complex. Along the vertical: latent periods of the solution of the instrumental task, sec.

Fig. 2. Absence of the effects of the activation of the cholinoreactive structures of the CM-Pf complex of the thalamus and of the effects of the combined striatothalamic activation of the cholinoreactive systems with the use of these influences against the background of developed differentiation. A) Chizhik; B) Ferri. Remaining designations as in Fig. 1.

activation of the CM-Pf complex of the thalamus was carried out twice, using the injection of small doses of the cholinomimetic, carbacholine, or by means of electrical stimulation. The activation of the cholinergic system of the head of the caudate nucleus was accomplished through microinjections of small doses of carbacholine. In Dik, the guide cannulae were implanted bilaterally into the head of the caudate nucleus and the stimulating electrodes ipsilaterally into the CM-Pf complex; in Ferri, the chemotrodes were implanted bilaterally into the caudate nucleus, stimulating electrodes into the right CM-Pf complex, and a chemotrode into the left CM-Pf complex; in Chizhik, the guide cannulae were implanted bilaterally into the head of the caudate nucleus and into the CM-Pf complex. In all, 67 microinjections of carbacholine into the head of the caudate nucleus and CM-Pf complex of the thalamus and 101 electrical stimulations of the CM-Pf complex were accomplished in the three dogs. The experiments involving the injections were carried out no more than once a week, and alternated with the controls. The injections were made after the use of 10 defense and two to three differential signals (the baseline, about 10 min). The experiment was resumed 10 min after the agent was injected; the results were analyzed statistically every 10 min for 40-50 min after the microinjections. During this period, 30-50 M\textsubscript{30} conditional defense signals and six to nine differential stimuli were presented in random order.

The latent periods of the components of the postural rearrangement, the electromyograms of the muscles of the working and the support hind limbs, the movement mechanograms, the amplitude of the movement, and the time of the maintenance of the limb in the flexed position were recorded on the tape of an electromagnetic oscillograph and analyzed. The time of the accomplishment of the instrumental task (L6), i.e., the time needed for the limb to enter the "safety zone," was recorded. The results of the analysis of this indicator in particular, analyzed statistically on a Wang (USA) computer, are presented in this paper.