CONVERGENCE OF AFFERENT IMPULSES ON NEURONS OF THE MESENCEPHALIC RETICULAR FORMATION

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Neurons responding to stimulation of the dorsal roots, the peripheral nerves, and somatosensory areas 1 and 2 of the cortex were recorded in the mesencephalic reticular formation (RF) of cats. In some cases interaction between afferent stimuli reaching RF neurons by the lemniscal and spinothalamic systems may be inhibitory in character. The number of convergent neurons in the mesencephalic RF is 40% of the total number recorded.

One of the most characteristic features of the brain-stem reticular formation (RF) is the convergence of afferent stimuli of different sensory modalities on single neurons [2, 3, 9]. Anatomical and physiological studies have shown that somatic afferent impulses reach the brain-stem RF by direct spinoreticular fibers in the ventrolateral columns of the spinal cord and also by collaterals of the spinothalamic tracts [5, 6, 8, 9]. Some workers consider that neurons of the brain stem receive afferent impulses via the cortical loop [1, 4], belonging to the system of the medial lemnisci.

In the investigation described below convergence of the lemniscal and spinothalamic impulses on mesencephalic RF neurons was investigated and the character of interaction between these impulses studied.

EXPERIMENTAL METHOD

Acute experiments were performed on unanesthetized cats immobilized with listhenon and maintained on artificial respiration. The animal was fixed in a stereotaxic apparatus and the spinal cord was dissected at the level of the superior cervical segments. The dorsal and lateral columns of the spinal cord were then divided. The peripheral nerves of the forelimbs and the central ends of the dorsal columns were stimulated. Single unit activity of the mesencephalic RF was recorded extracellularly by glass microelectrodes (1-2 μ, 25-30 MΩ) on an oscilloscope of the Disa-Indicator type with cathode follower.

EXPERIMENTAL RESULTS

Activity of 73 neurons was recorded in 25 experiments. Forty of these neurons responded only to stimulation of the central end of the dorsal columns, with a latent period of 6-25 msec, while 29 neurons responded to stimulation of the central end of the dorsal columns and nerves of the forelimbs. Since the dorsal and lateral columns were divided in the cervical region, the afferent impulse during stimulation of the nerve to the forelimb could reach the mesencephalic RF neurons only by the system of the spinothalamic tract. The latent period of the unit response to stimulation of the limb as a rule exceeded the latent period of the response to stimulation of the dorsal columns. Four neurons responded to stimulation of the dorsal columns and two to stimulation of the somatosensory cortex. In earlier experiments, convergent

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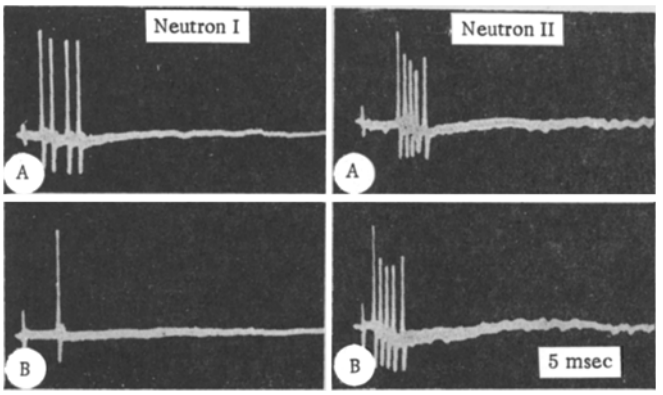

Fig. 1. Responses of two neurons of the mesencephalic RF to stimulation of the dorsal columns (A) and cortex (B).

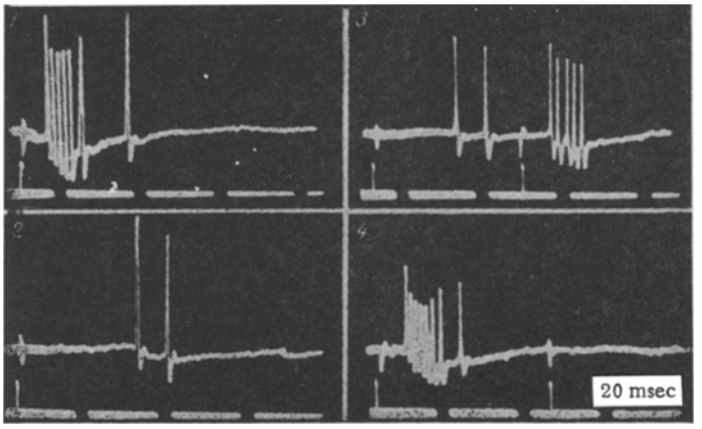

Fig. 2. Inhibitory effect of lemniscal impulses on unit response evoked by spinothalamic afferent impulses: 1) unit response to stimulation of dorsal columns; 2) unit response to stimulation of forelimb nerve; 3) unit response to stimulation of dorsal columns after stimulation of forelimb; 4) no unit response to stimulation of forelimb applied 45 msec after stimulation of dorsal columns.

neurons responding to stimulation of the dorsal columns were recorded in somatosensory areas 1 and 2 of the cortex. As a rule, the latent period of the response to cortical stimulation was much shorter than to stimulation of the dorsal columns. However, neurons responding to cortical stimulation with a longer latent period than to stimulation of the dorsal columns also were found (Fig. 1). The reason was evidently that in the latter case the afferent impulse reached the RF neuron after a considerable number of relays in the RF itself.

The ratio between the numbers of convergent and nonconvergent neurons (33 : 40) recorded in the present investigation in the mesencephalic RF corresponds closely to that obtained by Palestini [7], who found that the number of convergent neurons in the mesencephalic RF may reach 50%.

In 14 of the 29 convergent neurons which responded to stimulation of the central end of the dorsal columns and the nerve of the contralateral forelimb the character of interaction between the lemniscal and spinothalamic impulses could be determined. For instance, if the first of two consecutive stimuli was applied to the dorsal columns and the second to the forelimb, and under these circumstances the neuron responded to the second stimulus only after an interval much longer than the latent period of the response to stimulation of the forelimb, it could be concluded that stimuli reaching the neuron via the lemniscal system

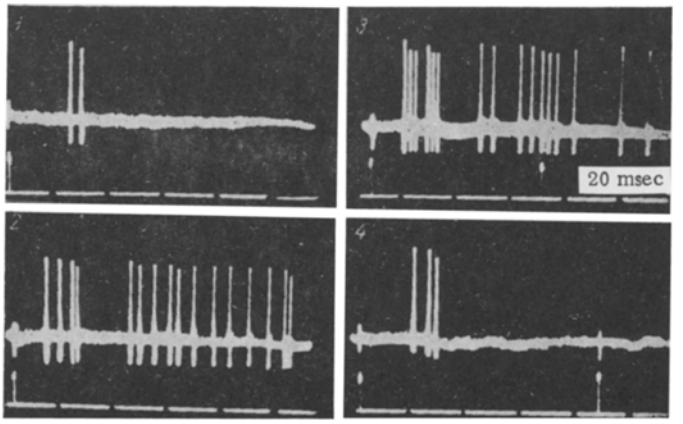

Fig. 3. Inhibitory effect of spinothalamic impulses on unit response evoked by lemniscal afferent impulses: 1) unit response to stimulation of forelimb nerve; 2) unit response to stimulation of dorsal columns; 3) inhibition of unit discharge evoked by stimulation of dorsal columns (1st stimulus) on stimulation of forelimb nerve (2nd stimulus); 4) no unit response to stimulation of dorsal columns applied 85 msec after stimulation of forelimb.

had an inhibitory action in that case on the spinothalamic impulses. Six convergent neurons with responses of a similar character to lemniscal and spinothalamic afferent impulses were recorded (Fig. 2).

If the neuron responded to stimulation of the dorsal columns when following stimulation of the forelimb at an interval much greater than the latent period of the response to stimulation of the dorsal columns only, it was concluded that the spinothalamic impulses had an inhibitory effect on the unit response to afferent impulses from the system of the medial lemnisci. Responses of this type were recorded from three neurons (Fig. 3). Five neurons responded to stimulation of the dorsal columns and nerves of the forelimbs virtually regardless of the interval between them.

Although the results given above suggest that the effect of afferent impulses reaching the brain-stem RF neurons via the system of the medial lemnisci is mainly inhibitory, final conclusions can be drawn only when sufficient convergent neurons have been found.

So far as the mechanism of the inhibitory interaction between the lemniscal and spinothalamic impulses on brain-stem RF neurons is concerned, it may evidently be both presynaptic and postsynaptic in character and its location may be in the RF itself or in the thalamic relay nuclei.

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