INTERACTION BETWEEN CORTICOFUGAL AND PERIPHERAL EFFECTS ON SINGLE UNITS OF THE MESENCEPHALIC RETICULAR FORMATION

V. G. Zilov

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Central and peripheral influence of the same modality can converge on the same mesencephalic reticular neurons. When effects from the first sensomotor cortical area on mesencephalic reticular neurons are combined with effects from the sciatic nerve, the peripheral effects predominate in 39% of cases. The high proportion of reticular neurons showing predominance of effects from the first sensomotor cortical area (21%) or giving a "resultant" response to combined central and peripheral action (40%) indicates that the cortex plays an active role in unit responses of the mesencephalic reticular formation to peripheral stimulation.

Microelectrode studies of unit activity in the mesencephalic reticular formation have shown that these neurons can effect the convergence of different types of excitation [5, 6, 11-13]. These investigations have confirmed the basic assumptions underlying the concept of a functional system [2], according to which reticular structures play an important role in the integrative activity of the whole brain [3]. However, the conditions under which this primary integration of excitation takes place at the subcortical level have received inadequate study, despite the undoubted importance of this process in afferent synthesis. In particular, little is known about the scope of cortical interference in the integrative activity of reticular neurons and their responses to different stimuli.

A study of corticofugal influences on functions of the mesencephalic reticular formation by various electrophysiological methods have shown that, while subjected to effects from reticular structures, the cortex at the same time can participate actively in the activity of these subcortical structures [1, 4, 5, 7-10].

The present investigation was undertaken to obtain further information regarding the cortical control over the activity of single units of the mesencephalic reticular formation and over their responses to stimulation.

TABLE 1. Unit Responses of Mesencephalic Reticular Formation (MIS) to Stimulation of 1 SM and of the Sciatic Nerve and to Combined Central and Peripheral Stimulation

Region stimulated	Number of neurons	Character of response of MIS neurons		
		excitation (+)	inhibition (–)	no response
1 SM	159	52(32,70%)	38(23,97%)	69(43,33%)
Sciatic nerve	159	48(30,19%)	56(35,22%)	55(34,59%)
1 SM and sciatic nerve	159	50(31,46%)	52(32,70%)	57(35,84%)

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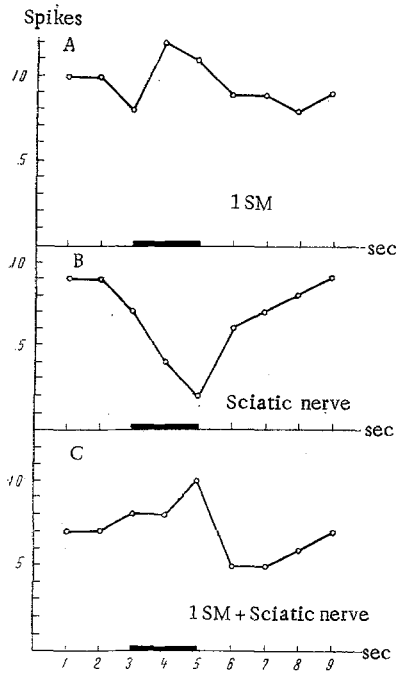

Fig. 1. Response of mesencephalic reticular neuron to stimulation of 1 SM (A), of sciatic nerve (B), and to combined central and peripheral effects (C). Here and in Fig. 2, parameters of stimulation: 1 SM 5 V, 10/sec, 1 msec; sciatic nerve 3 V, 10/sec, 1 msec. Abscissa, time (in sec); ordinate, number of spikes generated by neuron.

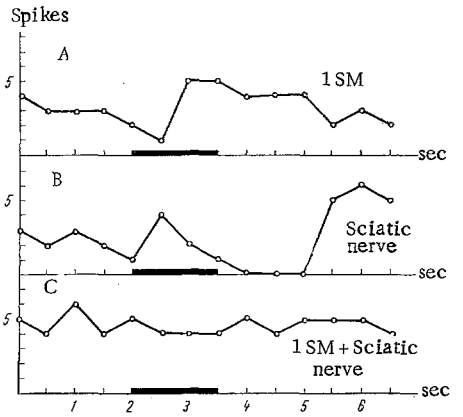

Fig. 2. "Resultant" response of mesencephalic reticular neuron to stimulation of 1 SM (A), of sciatic nerve (B), and to combined central and peripheral stimulation (C). Legend as in Fig. 1.

EXPERIMENTAL METHOD

Experiments were carried out on cats anesthetized with chloralose (60 mg/kg) and nembutal (10 mg/kg body weight). The animal was fixed in a stereotaxic apparatus and the cortex exposed. Throughout the experiment the cortex was irrigated with warm physiological saline and the animal was heated.

Unit activity in the mesencephalic reticular formation was recorded extracellularly by means of glass electrodes, with tip 1-5 μ in diameter, filled with 3 M NaCl solution and inserted stereotaxically in accordance with coordinates taken from the atlas of Jasper and Ajmone-Marsan.

For peripheral stimulation, square pulses (1 msec, 10/sec, 3 V) were applied to the sciatic nerve contralateral relative to the recorded region of the reticular formation. Corticofugal effects were evoked by electrical stimulation of the first sensomotor area of the cortex (1 SM) ipsilateral relative to the recorded reticular neurons. The interpolar distance of the cortical electrode was 2 mm. Parameters of stimulation of 1 SM: 5 V, 10/sec, 1 msec.

The projection of the microelectrode in the mesencephalic reticular formation was determined by the use of histological sections. Statistical analysis of the results was carried out by the χ^2 method.

EXPERIMENTAL RESULTS

Studies of 159 mesencephalic reticular neurons revealed their ability to respond to both corticofugal and ascending peripheral influences. However, the central and peripheral influences differed in the magnitude of their effects on the reticular neurons: ascending influences from the periphery were more effective than corticofugal effects from 1 SM (Table 1).

The character of the effects also differed. In responding reticular cells, stimulation of 1 SM evoked predominantly excitation (32.70%), while the effects of stimulation of the sciatic nerve were predominantly inhibitory (35.22%).

Studies of corticofugal effects on reticular neurons during stimulation of 1 SM confirmed previous observations [14] that the same cortical structures can exert both facilitatory and inhibitory descending influences, and that the effect of 1 SM on reticular neurons is predominantly excitatory [15].

However, the object of the investigation was to determine which effect was predominant in the case of combined central and peripheral effects on mesencephalic reticular neurons; to demonstrate how actively

corticofugal effects can interfere in the activity of reticular neurons and in their responses to peripheral stimulation.

From the 159 mesencephalic reticular neurons studied in order to discover whether the central or the peripheral effect was predominant, neurons giving responses of the same sign to isolated stimulation of 1 SM and of the sciatic nerve as well as to their combined stimulation were excluded. Of the 110 mesencephalic reticular neurons, 23 gave a response to combined central and peripheral stimulation which coincided with the response to isolated stimulation of 1 SM. The response of 43 neurons (39%) to combined central and peripheral stimulation coincided with the response to isolated stimulation of the sciatic nerve. The response of 44 neurons (40%) to the combined effects from 1 SM and the sciatic nerve were described as "resultant." This means that the response of the neurons to combined central and peripheral stimulation differed from their response to isolated stimulation of both 1 SM and of the sciatic nerve.

Analysis of the results using the χ^2 criterion also demonstrated the predominance of peripheral ($P = 0.75$) over corticofugal ($P = 0.014$) effects.

Examples of combined central and peripheral influences on reticular neurons are shown in Fig. 1 and 2. It is clear from Fig. 1 that the response of the reticular neuron to combined stimulation of 1 SM and of the sciatic nerve was very similar in character to the response to isolated stimulation of 1 SM.

An example of a "resultant" response of a reticular neuron is shown in Fig. 2. After a short period of inhibition, isolated stimulation of 1 SM causes prolonged excitation of the reticular neuron. The response of the same reticular neuron to isolated stimulation of the sciatic nerve after a short period of excitation is followed by prolonged inhibition. Combined central and peripheral stimulation generally speaking caused no changes in the activity of the reticular neuron.

It can be concluded from these results that effects from the periphery are predominant in the case of combined central and peripheral stimulation of reticular neurons. However, the cortex may interfere in the activity of the reticular formation not so much by its dominance in combined central and peripheral stimulation, which is relatively weak, as by the creation of a new, "resultant" response of the reticular neurons to combined stimulation.

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