INTERACTION BETWEEN ASCENDING AND HYPOTHALAMIC INFLUENCES ON NEURONS OF THE MESENCEPHALIC RETICULAR FORMATION

V. G. Zilov

UDC 612.826.2

In cats anesthetized with chloralose and pentobarbital, responses of neurons of the mesencephalic reticular formation (MRF) to isolated and combined stimulation of the sciatic nerve and the lateral hypothalamic region were studied extracellularly. The stimuli applied were fairly effective: only 31% of reticular neurons did not change their spontaneous activity in response to it. Excitation of the hypothalamus can modify responses of MRF neurons considerably to ascending peripheral influences, thereby giving rise to a qualitatively new resultant response, i.e., a response differing from that observed to isolated stimulation both of the lateral hypothalamus and of the sciatic nerve.

Electrophysiological investigations of the functional properties of neurons of the reticular formation of the brain stem have confirmed the view [1] that this subcortical formation plays an important role in the integrative activity of the brain at the stage of afferent synthesis. The ability of reticular neurons to respond to various types of stimulation [3, 9, 17, 23] and the extensive connections of the reticular formation with other parts of the brain suggest that these structures play an essential role in behavioral reactions of widely different biological quality [2, 8, 10-13, 19, 20]. In particular, hypothalamoreticular connections are a component in the neurophysiological mechanisms of formation of food [5, 15, 18] and locomotor responses [4, 14, 21] and of the autostimulation response [16, 22].

The object of this investigation was to study responses of reticular neurons to ascending peripheral stimulation and the changes in those responses during excitation of hypothalamic structures participating in the formation of various motivational and emotional states.

EXPERIMENTAL METHOD

Cats were anesthetized by intraperitoneal injection of chloralose (60 mg/kg) and pentobarbital (15 mg/kg body weight). Unit activity was recorded extracellularly by a stereotaxic method in the region of the mesencephalic reticular formation (MRF). Responses of reticular neurons were studied during stimulation of the contralateral sciatic nerve and ipsilateral region of the lateral hypothalamus (coordinates Fr 10.0-10.5 on the atlas of Jasper and Ajmone-Marsan). The location of the electrodes was determined in histological sections 50 μ in thickness. The reliability of the results in each case of a change in unit response was determined from the mean error in the activity of the neuron before and after stimulation and the mean error of the differences. The confidence coefficient was then calculated: the ratio between the difference between the unit responses before and after stimulation and the mean error of the difference in the values. The ratio of the difference between the compared means and the error of the difference was regarded as significant if it exceeded 3. The comparison of the hypothalamic and ascending peripheral influences on neurons of MRF was based on the χ^2 criterion.

Department of Normal Physiology, I. M. Sechenov First Moscow Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR P. K. Anokhin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 76, No. 11, pp. 3-5, November, 1973. Original article submitted February 5, 1973.

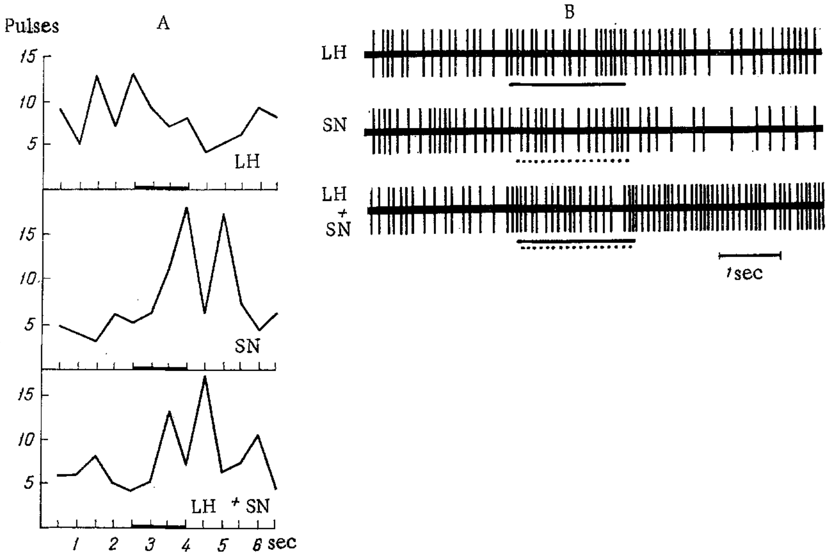

Fig. 1. Responses of MRF neurons to isolated and combined stimulation of lateral hypothalamic region and sciatic nerve. A) Resultant response absent; B) resultant response present (see text). Parameters of stimulation: lateral hypothalamus (LH) 5V, 100/sec, 1 msec; sciatic nerve (SN) 1.5 V, 10/sec, 1 msec.

EXPERIMENTAL RESULTS

Responses of 164 MRF neurons to isolated and combined stimulation of the lateral hypothalamic region and the sciatic nerve were studied. These stimuli proved to be fairly effective: only 31% of reticular neurons did not change their spontaneous activity. The slight preponderance of inhibitory influence during excitation of the lateral hypothalamic region will be noted, in agreement with results obtained by recording evoked potentials [6, 7]. The fact that the stimuli used in the present experiments evoked responses of most neurons of MRF confirms the high convergent ability of the reticular neurons with respect to stimuli of different modalities observed previously.

However, the problem at issue was the degree to which the influence of the hypothalamic region can modify responses of reticular neurons to ascending peripheral stimuli or, in other words, to what degree the MRF is subject to the modulating influence of the subcortical centers of motivations and emotions. For this purpose unit responses in MRF to combined stimulation of the hypothalamic region and sciatic nerve were combined with unit responses to isolated stimulation. Of 164 MRF neurons, 54 which responded equally to isolated and combined stimulation of the hypothalamus and sciatic nerve were excluded.

Analysis of the remaining 110 reticular neurons showed that the response of 27 of them (24.55%) to combined stimulation was identical with their response to isolated stimulation of the lateral hypothalamic region. Combined stimulation of the hypothalamus and sciatic nerve evoked the same response in 38 neurons (34.55%) as isolated stimulation of the sciatic nerve (Fig. 1A). It is important to note that during combined stimulation a "resultant" response was recorded in 45 neurons (40.9%) of MRF, i.e., a response which differed from that observed to isolated stimulation of the lateral hypothalamic region or sciatic nerve (Fig. 1B).

The use of Pearson's criterion (χ^2) failed to reveal any dominant effect during combined stimulation of hypothalamus and sciatic nerve (P was 0.78 and 0.95, respectively), mainly because of the high frequency of the resultant response.

It can be concluded from these experiments that excitation of the hypothalamic region can considerably modify responses of MRF neurons to ascending peripheral influences.

LITERATURE CITED

1. P. K. Anokhin, Internal Inhibition as a Physiological Problem [in Russian], Moscow (1958).

2. P. K. Anokhin and K. V. Sudakov, Dokl. Akad. Nauk SSSR, 187, 681 (1969).
3. V. G. Zilov, in: Problems in Higher Nervous Activity, Neurophysiology, and Neuromorphology [in Russian], Ryazan' (1967), p. 11.
4. T. K. Kipriyan, in: Electrophysiology of the CNS [in Russian], Tbilisi (1966), p. 147.
5. A. A. Panfilov and T. N. Loseva, Fiziol. Zh. SSSR, No. 5, 447 (1967).
6. D. G. Shevchenko, in: Electrophysiology of the CNS [in Russian], Tbilisi (1966).
7. D. G. Shevchenko, Byull. Éksperim. Biol. i Med., No. 11, 3 (1969).
8. V. C. Abrahams, S. M. Hilton, and J. L. Malcolm, J. Physiol. (London), 164, 1 (1962).
9. C. Bell, G. Sierra, N. Buendia, et al., J. Neurophysiol., 27, 961 (1964).
10. G. Carli, A. Malliani, and A. Lanchetti, Exp. Neurol., 7, 210 (1963).
11. L. V. Di Cara and G. Wolf, Exp. Neurol., 21, 231 (1962).
12. E. Endröczi, K. Lissak, L. Koranyi, et al., Acta Physiol. Acad. Sci. Hung., 33, 375 (1968).
13. M. Glusman, W. Won, E. I. Burdock, et al., Trans. Am. Neurol. Ass., 86, 216 (1961).
14. J. C. Hinsey, S. W. Ranson, and R. F. McNattin, Arch. Neurol. Psychiat. (Chicago), 23, 1 (1930).
15. P. J. Morgane, Ann. New York Acad. Sci., 157, 806 (1969).
16. M. E. Olds and J. Olds, Am. J. Physiol., 217, 1252 (1969).
17. M. Palestini, G. F. Rossi, and A. Lanchetti, Arch. Ital. Biol., 95, 97 (1957).
18. S. W. Parker and S. M. Feldman, Exp. Neurol., 17, 313 (1967).
19. F. M. Scultety and M. S. Chamberlain, Neurology, 15, 438 (1965).
20. M. H. Sheard and J. P. Flynn, Brain Res., 4, 324 (1967).
21. M. B. Sterman and M. D. Fairchild, Brain Res., 2, 205 (1966).
22. E. S. Valenstein and J. F. Campbell, Am. J. Physiol., 210, 270 (1966).
23. N. Yoshii and H. Ogura, Med. J. Osak Univ., 11, 1 (1960).