ROLE OF THE THALAMIC RETICULAR NUCLEUS IN RELATIONS BETWEEN THE MESENCEPHALIC RETICULAR FORMATION AND LATERAL GENICULATE BODY

L. É. Kul'gavin, N. N. Lyubimov,
N. A. Gadzhiev, and B. Kh. Baziyan

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The mesencephalic reticular formation (MRF) has a marked effect on function of the lateral geniculate body (LGB) [2, 3, 5, 6, 8, 11, 15]. This effect is mediated through the presence of direct connections of MRF with LGB [4, 8]. However, it has recently been suggested that influences of MRF on LGB may be transmitted also through the thalamic reticular nucleus (TRN) [14, 15]. In previous investigations into the problem of reticular control of LBG function it was shown that these influences are tonic and modulating in character [2, 6, 8, 15]. We have shown that this effect may also be physical in nature [3].

In the investigation described below the role of TRN in the mechanism of these two types of reticular control of LGB function was studied.

EXPERIMENTAL METHOD

Experiments were carried out on 15 conscious rabbits and 18 cats anesthetized with pentobarbital (35 mg/kg). Electrodes were implanted into the test structures in accordance with coordinates from stereotaxic atlases [12, 13]. Evoked potentials (EP) were recorded by the use of UBP1-02 and UBP2-03 amplifiers, a Nihon Kohden (Japan) magnetic recorder, and S1-18 cathode-ray oscilloscope, and an ÉSU-2 electrostimulator and Disa (Denmark) apparatus were used for electrical stimulation of RF. Single square pulses of current (150-200 μA, 0.1 msec) were applied. The functional state of RF was changed by injection of chlorpromazine (7 mg/kg) [1], the functional state of LGB was modified by division of the optic tract (OT) by the method in [5], and the functional state of TRN was altered by anodal polarization of its optic area [15] or by destruction of LGB by electrocoagulation.

EXPERIMENTAL RESULTS

Stimulation of MRF by a single pulse of current led to the formation of short-latency (4-5 msec) biphasic (positive—negative) potentials in LGB of the conscious rabbit and anesthetized cat (Figs. 1 and 2), which we called reticulo-genicular responses (RGR). This response developed quite quickly: the duration of the positive phase was 15 ± 2 msec and of the negative phase 30 ± 3 msec. The amplitude of the positive phase was 280 ± 7 μV and of the negative phase 76 ± 9 μV. RGR formation is evidence that RF can exert not only modulating tonic influences, as described by other workers previously [2, 6, 8, 15], but also fast phasic influences. Incidentally, both components of RGR have weak resistance to repetition. This is more especially the case with the negative component. On presentation of repetitive stimulation of RF a gradual decrease was observed in the amplitude of this component, virtually to zero.

To obtain more complete characteristics of the functional properties of the neuronal apparatus of LGB, responsible for forming RGR, its recovery cycles were studied. Experiments showed that the response to a testing stimulus, in the form of a small positive wave, began to appear when the interval between stimuli was 20-70 msec, and complete recovery of the response took place when the interval was 1000 msec (Fig. 1A).

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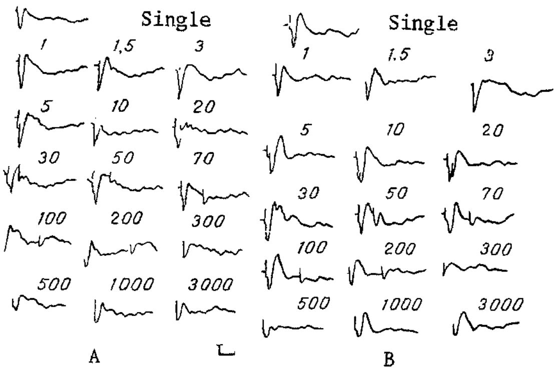

Fig. 1. Formation of recovery cycles of reticulo-genicular response under normal conditions (A) and under the influence of chlorpromazine (B). Calibration: 50 μV, 40 msec.

It was shown previously [2, 8, 11] that LGB has inputs from MRF, which are adrenergic in nature. It was therefore interesting to discover whether these inputs are related to realization of the fast phasic influence of RF on function of LGB. For this purpose the formation of RHR was studied during the action of chlorpromazine, which inhibits the adrenergic substrate of RF [1]. The investigation showed that under these conditions there was a marked increase in amplitude of the negative component of RGR by almost 25 ± 3%. The amplitude of the positive component remained unchanged (Fig. 1B). Against the background of the action of chlorpromazine the general pattern and trend of the recovery cycles of RGR were completely preserved (Fig. 1B), although the amplitude parameters of RGR to the testing stimulus were somewhat altered. This fact is evidence that the adrenergic apparatus of RF responds with comparatively long changes of tonic character, which lie at the basis of the modulating effect of RF on LGB function and it does not play a decisive role in the formation of RGR.

It was postulated previously [8, 14, 15] that TRN, which has direct connections with both RF and LGB [6, 14], plays an important role in the formation of reticulo-genicular relations. It can accordingly be suggested that this nonspecific thalamic nucleus can play a definite part in RGR generation. To test this hypothesis, RGR was recorded under conditions of excitation or destruction of the optic zone of TRN. The experiment showed that when this nucleus was excited, by anodal polarization, there was a marked increase in amplitude of the negative component of RGR (Fig. 2B, I). However, after destruction of the optic zone of TRN, where, as several workers have suggested, the bodies of the perigeniculate inhibitory interneurons of TRN lie [6, 8, 14], a completely opposite picture was observed: complete disappearance of the negative component (Fig. 2B, II). The results suggest that perigeniculate interneurons of LGB participate in generation of the negative component of RGR. We know that these neurons receive direct inputs from relay neurons of LGB [6, 7, 14]. Consequently, if their suggested role in generation of RGR is validated, it can be expected that changes in the functional state of LGB due to its excitation or deafferentation will be reflected in the formation of the negative component of RGR. To shed light on this problem two types of experiments were carried out: in the first type the effect of a photic stimulus on RGR formation was studied, in the second type the role of deafferentation of LGB due to division of OT on the formation of this same response was determined.

On presentation of paired stimuli (the 1st, photic; the 2nd, reticular) the response to the 2nd stimulus was considerably inhibited in amplitude if the intervals between the stimuli were short, from 0 to 50 msec (Fig. 3). If the interval was 70 msec, RGR was restored to the control values. It must be emphasized that inhibition of RGR took place for the period of development of the postsynaptic component of the response of LGB to photic stimulation, in whose genesis, it has been suggested [2], not only relay neurons, but also interneurons participate. Since our data provide a basis for assuming that interneurons participate in the generation not only of the visual EP of LGB, but also of RGR, the effect of inhibition of the amplitude of this response can probably be explained by the refractory state of these LGB neuroms, evoked by the flash. The results are thus evidence that excitation of LGB neurons caused by photic stimulation is definitely reflected in RGR formation. It is natural to suggest that exclusion of retinal influences on LGB can have the opposite effect. This is shown by data in the literature [9, 10], indicating a considerable change in synaptic transmission in LGB when the sensory volley from the retina is limited. This effect is linked with a change in function

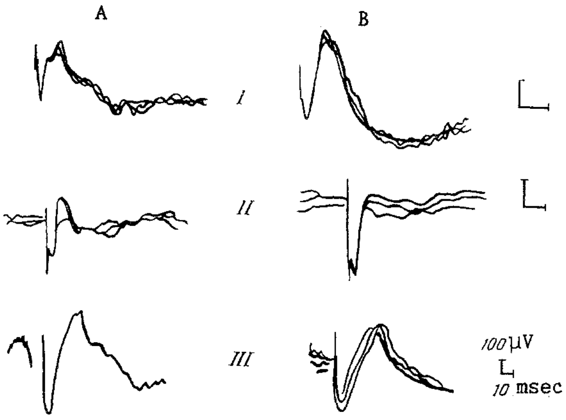

Fig. 2. Formation of reticulo-genicular response under normal conditions (A, I, II, III), under the influence of chlorpromazine on TRN (B, I) and destruction of TRN (B, II), after division of OT (B, III). B, I) During anodal polarization; B, II) after destruction of optic zone of thalamic reticular nucleus. Calibration: 50 µV and 20 msec for I, II; 100 µV and 10 msec for III.

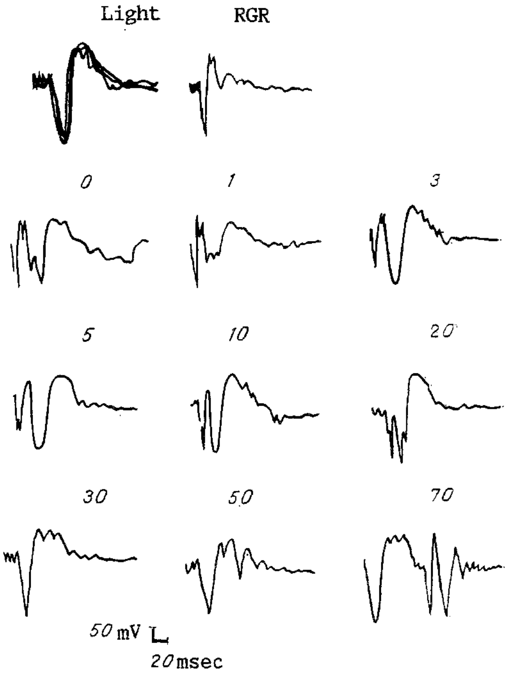

Fig. 3. Interaction between visual response of lateral geniculate body and reticulo-genicular response. Numbers above traces show intervals between stimuli (in msec). Calibration: 50 µV, 20 msec.

of the interneurons [10]. It can accordingly be expected that exclusion of the sensory volley from the retina will lead to marked changes in RGR generation. However, this does not happen (Fig. 2B, III). Neither the temporal nor the amplitude parameters of this response showed any change whatsoever after division of OT. Consequently, the perigeniculate interneurons of LGB, which participate in generation of the negative component of RGR in darkness do not experience any appreciable influences from the retina. This fact is confirmed by data obtained by other workers [7] and by our own data published previously [5]. It can thus be concluded that TRN plays an important role in the formation of relations between MRF and LGB.

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COMPARATIVE ANALYSIS OF EFFECTIVENESS OF SYNAPTIC INFLUENCES ON RESISTIVE VESSELS OF SPONTANEOUSLY HYPERTENSIVE AND NORMOTENSIVE RATS DURING CONSTANT-FLOW, CONSTANT-PRESSURE PERFUSION

I. M. Rodionov, T. P. Vakulina,
O. S. Tarasova, V. B. Koshelev,
V. G. Pinelis, and Kh. M. Markov

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The development of all forms of arterial hypertension is linked with a change in the structure and function of the vascular system [1, 3, 10, 12]. One of the mechanisms of the structural changes in the vascular bed in hypertension is reduction of the internal diameter of the arteries, as a result of thickening of their wall [8]. Changes of this kind lead to an increase in the ratio of the thickness of the wall to the radius of the vessel and they are the main cause of the increase in reactivity to vasoconstrictor influences [10]. It was shown previously that during perfusion of vessels of the posterior part of the body of spontaneously hypertensive and normotensive rats, during constant-flow perfusion, injection of noradrenalin into the blood stream [8, 9] or stimulation of the sympathetic chains [1] induces a greater increase of resistance in hypertensive animals. However, when investigating vasomotor responses of hypertensive and normotensive animals, we discovered an interesting fact: The results obtained during constant-flow perfusion sometimes differed even qualitatively from those obtained under constant pressure conditions [15]. There is evidence that vasomotor responses in normotensive animals may differ qualitatively if different methods of perfusion are used [4], evidently on account of different conditions of contraction of the vascular smooth muscles [5]. The aim of this investigation was a comparative analysis of the reactivity of spontaneously hypertensive and normotensive rats perfused under the two different conditions.

Department of Physiology of Man and Animals, Moscow State University. Laboratory of Pathophysiology, Research Institute of Pediatrics, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR I. P. Ashmarin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 106, No. 12, pp. 645-648, December, 1988. Original article submitted January 22, 1988.

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