# FORMATION OF SPONTANEOUS SLOW ACTIVITY IN THE VISUAL SYSTEM AFTER HEMISECTION OF THE TEGMENTUM MESENCEPHALI

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Well-marked rhythmic activity, both fast and slow, can be recorded in all parts of the central visual system [1, 3, 6, 9, 12]. Genesis of the α-rhythm is of particular interest to investigators studying the formation of slow activity [4, 9, 12], whereas the genesis of the other components of the EEG in both cortical and subcortical visual structures as a rule has been neglected, with the exception of a few studies [4, 5]. The reason probably is that the most conspicuous rhythm on the EEG of the human visual cortex (VC) is the α-rhythm [4, 7], whose pacemaker, as several workers have suggested [11, 12], lies in the thalamus and, in particular, in the lateral geniculate body (LGB) [12]. Meanwhile there is evidence to suggest that the thalamus contains pacemakers for other EEG rhythms [4]. It has also been shown that a change in the functional state of the mesencephalic visual center (the superior colliculus – SC) is distinctly reflected in the functional state of VC [3], and this naturally must affect the formation of its electrical activity [5, 7]. The mesencephalic reticular formation (MRF) was shown previously [2, 9, 14] to exert a considerable influence on the functional state of SC, LGB, and VC [7]. It is natural to suggest that blocking the inputs of MRF into these structures would be clearly reflected in their functional state, and in turn this should lead to changes in the formation of their electrical activity.

The aim of this investigation was to study the influence of MRF on the functional state of the above-mentioned visual centers.

## EXPERIMENTAL METHOD

Experiments were carried out on 12 cats anesthetized with pentobarbital (35 mg/kg). Electrical activity of LGB, of SC, and of VC was recorded by means of nichrome wire electrodes 0.3 mm in diameter, which were introduced into the test structures, taking coordinates from a stereotaxic atlas [14]. Activity was recorded with a UBP-1-02 amplifier and Nihon Kohden (Japan) tape recorder. Hemisection of the tegmentum mesencephali (TM) was carried out by the method in [8]. The data were subjected to statistical and spectral analysis on the M-6000 computer. Cuts of 8 sec were analyzed, 25 cuts for each case. The significance of the experimental data was determined by the Student—Fisher test ($p < 0.05$).

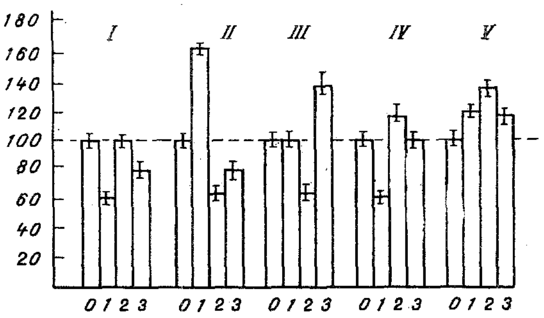

Fig. 1. Basic rhythms of electrical activity on LGB, SC, and VC before (0) and after (1, 2, 3) hemosection of TM. Ordinate, power level of rhythms (in % of control). I) δ-Rhythm; II) ν-rhythm; III) α-rhythm; IV) β-rhythm; V) $\beta_1$-rhythm. 0) Control for all structures; 1) LGB; 2) SC; 3) VC.

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TABLE 1. Power Levels of Rhythms of Electrical Activity of LGB, SC, and VC after Hemisection of TM (in % of control)

| Structure | Rhythm of electrical activity | | | | |
|---|---|---|---|---|---|
| | δ | ϑ | α | β | $\beta_1$ |
| LGB | 60±4<br>(—) | 160±4<br>(+) | 100±3<br>(0) | 60±4<br>(—) | 120±5<br>(+) |
| SC | 100±4<br>(0) | 60±5<br>(—) | 60±5<br>(—) | 120±7<br>(+) | 130±6<br>(+) |
| VC | 80±5<br>(—) | 80±5<br>(—) | 140±6<br>(+) | 100±5<br>(0) | 120±5<br>(+) |

Legend. —) Power spectrum reduced; +) increased; 0) unchanged.

## EXPERIMENTAL RESULTS

Blocking the inputs of MRF into LGB by hemisection of TM led to marked changes in the rhythms of electrical activity generated by that structure (Fig. 1). For instance, the power spectra of the δ- and β-rhythms was reduced. The opposite picture was observed with respect to ν- and $\beta_1$-rhythms: their power spectra increased. The power spectrum of the α-rhythm remained virtually unchanged.

Definite changes also were observed in rhythms generated by SC after hemisection of TM. However, they were quite different in character from the changes in electrical activity of LGB. For instance, the power spectra of the ν- and α-rhythms were reduced whereas the power spectrum of the β- and $\beta_1$-rhythms were increased. The power spectra of the δ-rhythm remained unchanged.

As regards electrical activity of VC, considerable changes also were observed in this case. The power spectrum of the α-rhythm showed a particularly marked increase. The power spectrum of the $\beta_1$-rhythm showed a smaller increase. The power spectra of the δ- and ν-rhythms were reduced a little, and the power spectrum of the β-rhythm remained unchanged.

Comparison of the results (Table 1) shows that electrical activity of the test structures varies considerably as regards rhythm generation. In the δ-rhythm, for instance, the changes were consistently downward, with a decrease in the power spectrum of electrical activity of LGB and VC, and no change in this rhythm in SC. For the ν-rhythm changes also were consistently downward for electrical activity of SC and VC, whereas for LGB there was a tendency for the power spectrum to increase. Changes in the region of the α-rhythm were opposite in character in SC and VC; the power spectrum decreased in the first case and increased in the second. The α-rhythm was unchanged in LGB. Changes in the β-rhythm differed in character in SC and LGB: in the former its power increased, thereas in the latter it decreased. Changes in all three structures were similar in direction only for the $\beta_1$-rhythm, whose power spectrum increased.

Since stimulation of RF is known to inhibit activity of LGB interneutrons [9], it can be postulated that removal of its influence should be accompanied by the opposite effect, namely an increase in their activity. The strongest effect of this type was observed with the ν-rhythm of LGB. This suggests that its interneurons participate in the genesis of this component of LGB electrical activity. The decrease in the power spectrum of the β-rhythm of LGB is evidence that LGB neurons, whose activity is inhibited when the discharge of reticular neurons is limited, may perhaps participate in its formation. These neurons could be relay neurons, receiving inhibitory impulses from interneurons whose activity is enhanced after abolition of inputs from MRF [9]. The results of recent investigations [3, 13] suggest that SC also has an inhibitory effect on certain LGB neurons. It can accordingly be postulated that those neurons participate in the generation of the $\beta_1$-rhythm, whose power spectrum is greatly enhanced after division of colliculo-geniculate inputs by hemisection of TM. The stability of the α-rhythm of LGB under these conditions can be explained by the fact that α-activity always arises in the thalamus during pentobarbital anesthesia [9, 11].

Changes in the formation of rhythms of electrical activity of SC cannot be explained in such a simple way as those of LGB. The reason is that the hemisection which was used led to the virtually complete isolation of SC: nearly all inputs to that structure were divided [8]. However, there is evidence [2, 10] to suggest that the decrease in power spectra of the ν- and α-rhythms of SC is connected with termination of the inflow of impulses for VC or from other parts of the visual system. The increase in power spectra of the fast rhythms of SC probably signifies that SC neurons, receiving inhibitory inputs from MRF, participate in their genesis [2, 15].

The increase in the power spectrum of the α-rhythm in VC is probably associated with enhanced activity of the pacemaker of this rhythm, which is located in LGB [12]. Changes in the generation of other rhythms of VC after mesencephalic hemisection are difficult to explain at present. It can be tentatively suggested that the increase in the power spectrum of the $\beta_1$-rhythm is evidently connected with abolition of inhibitory collicular inputs into LGB, the presence of which has been described [3, 13]. The absence of change in power of the β-rhythm can probably be explained on the grounds that the reticular formation may perhaps be involved in its generation [7], and under the experimental conditions used its activity was initially depressed by general anesthesia. Removal of reticular inputs into the cortex was therefore not reflected in the generation of this rhythm.

The main rhythms of electrical activity of VC are thus the resultant of complex thalamo- and tectocortical [3, 11-13] relations. The existence of no less complex reticulo- and corticocortical relations likewise cannot be ruled out [5, 7]. Meanwhile it follows from analysis of the data that inputs from MRF and SC into LGB, and also inputs from VC, MRF, and LGB into SC are of great importance for the formation of rhythms of electrical activity of both LGB and SC, and any changes in their generation are reflected in the formation of electrical activity of VC.

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