DYNAMICS OF SPATIOTEMPORAL ORGANIZATION OF CORTICAL POTENTIALS DURING EXTINCTION OF AN ELECTRODEFENSIVE CONDITIONED REFLEX IN RABBITS

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Conditioned reflex formation causes considerable changes in global cerebral cortical electrical activity in rabbits both during interstimulus periods and during the action of conditioned stimuli [20, 6, 3, 4, 22]. A stable conditioned response arises at a time of high coherence of waves of potential between the regions involved [5]. Conversely, during the formation of differentiation and extinctive inhibition, discoordination of electrical potentials with respect to phase and frequency arises in the cortical areas of representation of the conditioned and unconditioned stimuli [21]. The spatiotemporal organization of potentials (STOP), due to which the passage of excitation from one analyzer system to another is facilitated, is disturbed. However, it is not clear whether a definite system of spatial relations of cortical potentials is formed during inhibition of the motor response.

Since in most investigations electrical activity of the visual and motor cortex was recorded by means of a few electrodes (not more than four), the analysis of the dynamics of spatial organization of electrical activity was insufficiently complete. With only a few derivations it is impossible to assess the contribution of potentials in different regions of the cortex to the formation of a system of spatiotemporal relations essential for behavioral reactions to take place. Knipst et al. [2, 9], who used a large number of derivations, described a special type of cortical STOP: periodic inversion of the sagittal potential gradient (PIPG). The formation of PIPG has been observed in various experimental situations in animals in the absence of motor activity [25, 17, 10, 16]. Extinction of an electrodefensive conditioned reflex is linked with active inhibition of the motor response. The object of the present investigation was to discover whether PIPG is formed at this time, and if it is, to investigate the topographic characteristics of the cortical potentials.

METHOD

Formation and Extinction of the Conditioned Reflex. Experiments were carried out on 10 unrestrained rabbits in a cage with a floor measuring 40 cm × 60 cm. The conditioned stimulus consisted of 20 flashes with a frequency of 4 Hz, applied from an FS-02 photostimulator. At the end of the 5th second the conditioned stimulus was joined by unconditioned reinforcement — electrical stimulation of the skin of the ear (the stimulating electrodes, consisting of a light clip, were located on the rabbit's ear nearer to its base). Intervals between combinations measured 2–3 min, and from six to ten combinations were presented during an experiment.

The reflex was extinguished after the conditioned-reflex responses of a given rabbit had reached the characteristic stable level, for which usually from 12 to 40 combinations were needed (three to six experiments). During the extinction procedure unreinforced conditioned stimuli were presented at the same intervals as during conditioning. Extinction was considered to have been produced if at least three successive isolated photic stimulations evoked no conditioned responses.

The conditioned reflex was 2–5 days after extinction, and as a rule this required fewer combinations; the whole extinction procedure was then repeated once again. In six of ten rabbits this procedure was thus carried out more than once. This paper gives data obtained in 22 extinction experiments.

Fig. 1. Diagram of arrangement of recording electrodes on surface of rabbit's skull, diagram of basic "initial" ET (A), and dynamics of STOP parameters during extinction of conditioned reflex (B). Above — actogram. Shaded areas of time scale correspond to periods of motor activity of the rabbit. Direction of small arrows corresponds to change in animal's posture toward greater (downward) or less (upward) muscular relaxation. Time of day shown below scale. Arrows above indicate unreinforced conditioned stimuli. (+) Conditioned response present, (−) absent. Arrows with numbers beneath indicate times of leading banks of data on cortical electrical activity into computer; 1–9) parameters of STOP corresponding to these banks. Top traces show dynamics of KET, bottom traces — dynamics of \( x_{ET} \). Ordinate, values of parameters; abscissa, time. Horizontal marker above traces corresponds to 16 values of ET (0.32 sec).