ELECTRICAL REACTIONS IN POSTERIOR CORPORA QUADRIGEMINA OF RATS DURING ACTION OF SHORT ACOUSTIC SIGNALS (CLICKS)

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An earlier investigation [2] furnished evidence on certain peculiarities of electrical reactions in the peripheral part of the auditory system in the rat. This suggested that there were certain special features in the functioning of the auditory system in these animals. In order to prove this, it is essential that electrical reactions in other parts of the auditory system should be examined. As investigations already published provide evidence of considerable complexity of structure in the inferior corpora quadrigemina of mammals [4,5,6,9,10] and of great variety in the responses from their individual elements [11-14-17], it might be expected that definite functional differences would be found in this part of the auditory system more particularly in different animals. Important structural and functional differences in the inferior corpora quadrigemina are extremely probable in rats, which are lissencephalic animals.

METHOD

The experimental animals were 30 albino rats under barbiturate anesthesia. The tip diameter of the recording electrode did not exceed 100 μ. The indifferent electrode was placed in the animal's mouth or on the skull in the region of the frontal sinuses. The recording electrode was inserted by steps of 0.25 mm (until a distinct response to sound developed). The position of the electrode was established by subsequent morphological examination. The auditory stimuli were short acoustic signals (clicks) 0.2 msec in length. The source was a moving-coil loud speaker with uniform frequency between 200 and 7000 c/s. It was placed 10 cm in front of the animal.

Thresholds for development of the reaction under examination, latent periods, amplitude and length were measured in every experiment. Average values for the individual parameters of the reaction were established by measurement of 10 successive recordings. Other features examined, in addition to the main parameters of reactions in the inferior corpora quadrigemina, were the relationship between changes in the intensity of the acoustic signals and changes in amplitude and the course of recovery as revealed by the delivery of paired acoustic signals with different intervals between. The intensities of the two signals were the same, and were not more than 50 dB above the threshold for development of the particular reaction.

RESULTS

The electrical reactions in the inferior corpora quadrigemina of the rat were of the same form as responses from the same part of the auditory system in the cat, as described by several authors [3,7,8,15,16]. The typical reaction began with a fast positive wave, followed by a slower negative wave. Two positive waves with a succeeding negative wave were recorded in some cases. A similar form of response has been described in one of the papers dealing with rats [18]. The amplitude of the reaction in our animals ranged from 70 to 400 μV. Maximum response amplitudes were recorded in the experiments in which the electrode was in the center of the nucleus. Reaction thresholds averaged a little above audibility thresholds for man, measured under the same conditions. The subsequent morphological examinations revealed that the electrode was either in a superficial or medial position in a great majority of the animals in which high reaction thresholds had been found. Thresholds were, however, high in some cases, even though the electrode was in the central part of the nucleus.

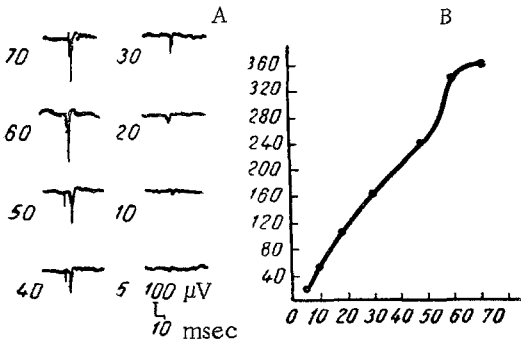

Fig. 1. Changes in amplitudes of responses in inferior colliculi of rat with change in acoustic signal intensity (A) and response amplitude/signal intensity (B). Numbers at side – intensity (dB) above reaction threshold. Ordinate – amplitude (μV). Abscissa – intensity (dB) above reaction threshold.

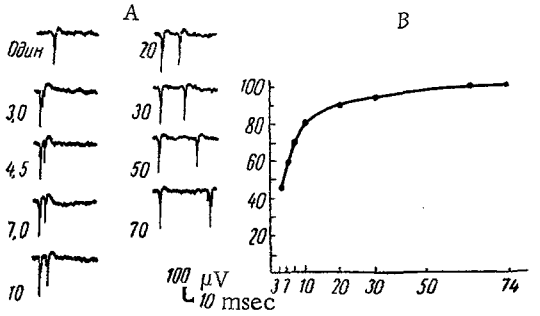

Fig. 2. Responses in inferior colliculi to paired acoustic stimuli (A) and degree of recovery in relation to interval between signals (B). Numbers at side – intervals between signals (msec). Ordinate – percentage recovery. Abscissa – intervals between signals (msec).

As it has been stated in the literature that inflammatory phenomena are frequently found in the middle ear of albino rats [19], some control experiments, in which thresholds for cochlear responses as well as for reactions in the inferior corpora quadrigemina were measured, were carried out.

Distinct changes in the mucous membrane lining the cavity of the bulla ossea were found in several animals with high thresholds for both reactions.

The average threshold for animals in which the middle ears were normal was very slightly higher than the reaction threshold in the corresponding part of the auditory system in the cat (the difference did not exceed 5 dB). The average latent time of the reaction was 3.1 msec when stimulation intensity was 45-50 dB above threshold strength. As signal strength was increased from 5 to 80 dB above threshold for development of reaction, the latent period changed from 5 to 2.8 msec. The length of the positive wave varied from 2 to 4 msec, depending on the form of the reaction. The relationship between acoustic signal intensity and changes in response amplitude are shown in Fig. 1, A and B.

The general character of the reaction curve did not differ essentially from that of the corresponding curve for the same part of the auditory system in the cat [1].

The process of recovery in the inferior colliculi of the rat was examined in 20 experiments (Fig. 2). Paired signals with intervals of 3, 4, 6, 7, 10, 14, 20, 30, 50, 60, 74, 90, and 100 msec were used. It was found that the amplitude of the response to the second signal reached 50 percent of the amplitude of the first response when the interval was 3-4.6 msec. A 75 percent recovery required 7 msec. Thereafter, response recovery slowed down quite sharply. Paired responses of equal amplitude was only achieved when the interval was 60-70 msec. Recovery was, however, seen to be complete after 50 msec in occasional experiments.

Comparison of the results generally with those obtained in experiments on cats [1] revealed certain differences. The amplitude of the electrical reactions in the inferior colliculi, evoked by acoustic signals of identical supraliminal intensities, was considerably less in rats than in cats. The curves for the relationship between signal intensity and reaction amplitude differed for the two species.

Some interesting features were revealed in the examination of the restoration of electrical reactions in the inferior corpora quadrigemina of the rat. An 80 percent restoration was reached earlier in rats than in cats, but complete restoration required a longer period in the former than in the latter. The curve for restoration of response amplitude in the inferior colliculi practically reproduced the curve for response restoration in the peripheral part of the rat's auditory system (Fig. 3). In the cat, the degree of restoration of reaction amplitude was less in the inferior colliculi than in the cochlea, whatever the interval between the paired stimuli. More rapid recovery in the inferior colliculi than in the cochlea has been described in the auditory system of bats [13]. Although the functional significance of this is not yet clear, it is undoubtedly evidence of special functional qualities in this part of the auditory system in lissencephalic animals.

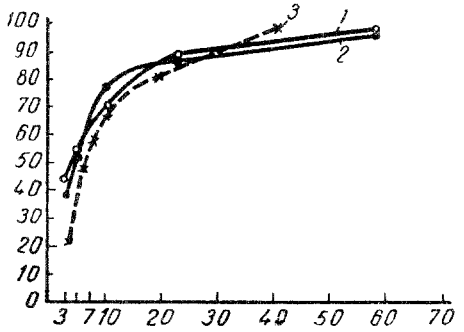

Fig. 3. Curves for recovery of response in cochlea (1), inferior colliculus (2) of rat and inferior colliculus of cat (3). Ordinate – percentage recovery. Abscissa – intervals between signals (msec).

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