EFFECT OF PARAMETERS OF ACOUSTIC STIMULUS ON AUDITORY CORTICAL EVOKED POTENTIALS

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The dependence of amplitude and latent period of auditory evoked potentials on the intensity, duration, build-up, frequency, and rhythm of acoustic stimuli was investigated in 40 rabbits. Stimulus intensity and build-up and intertrial interval were shown to affect the parameters of the evoked potentials.

KEY WORDS: hearing; objective audiometry; evoked potentials.

The intensive study of auditory cortical evoked potentials (EP) in recent years has necessitated a solution to certain theoretical and practical problems, particularly those connected with the development of methods of objective audiometry and clinical audiological practice. It is of the utmost importance to discover the relationship between the amplitude and temporal characteristics of the potentials on parameters of the acoustic stimuli such as duration, intensity, steepness of build-up, frequency, and rhythm.

Although these problems have been discussed to some degree in the experimental literature [1, 6, 7, 9], certain contradictions exist and, in particular, the results are difficult to compare because of differences in the methods to record the electrical responses and to shape and calibrate the stimuli in investigations by different workers. These were the circumstances which led to the investigation described below.

EXPERIMENTAL METHOD

Experiments were carried out on 40 chinchilla rabbits weighing 1.8-2 kg. Under chloralose–pentobarbital anesthesia (15 and 30 mg/kg respectively) steel needle electrodes were inserted into the rabbits: the active electrode into the cranial bones in the projection region of the auditory cortex, the reference electrode into the nasal bones, and the grounding electrode into the soft tissues of the thigh. To amplify the derived potentials units of the "Galileo" electroencephalograph were used, after which the EP were recorded on a specially designed system described by the writers previously [4], with low-frequency modulator for recording on magnetic tape. The system envisaged combined recording of the potential and the synchronizing pulse. The stimulating pulse and EP were led in parallel to the input of an S1-18 dual-beam oscilloscope for visual control and photographic recording. EP recorded on magnetic tape were then led to an ART-1000 computer for averaging. Usually 25 successive EP were averaged with an epoch of analysis of 250 msec.

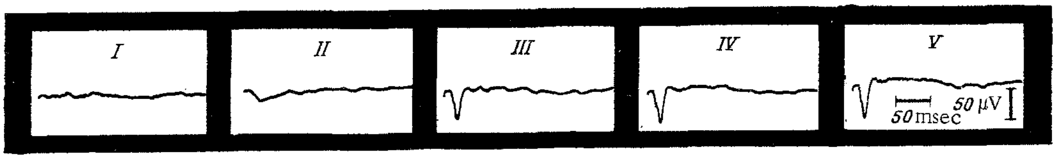

Fig. 1. Averaged EP of rabbit in response to acoustic stimuli of different intensities. Computer averaging of 50 successive potentials to clicks 5 msec in duration with intertrial interval of 1 sec. Stimulus intensity (in dB) above threshold for response production: I) 0, II) 12, III) 28, IV) 50, V) 60.

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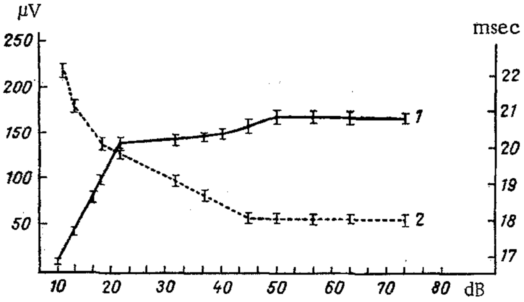

Fig. 2. EP amplitude as a function of intensity of acoustic stimulus (M ± m): 1) amplitude of EP; 2) spike latency of positive phase of EP.

Clicks 0.5, 1, and 5 msec in duration and tonal volleys 20, 30, and 50 msec in duration were used as acoustic stimuli. The filling frequencies of the tonal volleys were 500, 1000, 2000, 4000, and 8000 Hz. The build-up of each tonal volley varied from 2.5 to 15 msec and the intensity of the stimuli varied from 0 to 100 dB above the $2 \cdot 10^{-5}$ P level when the emitting telephone was calibrated with the "artificial ear" instrument (Bruel and Kjaer). The sound generator was a DN-69 low-ohmic electrodynamic telephone, which was applied directly to the pinna of the animal. Acoustic stimuli were applied at intervals of 1, 2, and 3 sec. All the parameters of the stimuli listed above were formed by means of a specially designed attachment for the AUG-69 audiometer. Experiments were carried out in a soundproofed and electrically screened chamber.

EXPERIMENTAL RESULTS

The recorded EP consisted of a positive–negative complex, developing within 40-50 msec after the beginning of acoustic stimulation with a peak–trough amplitude of up to 200 μV.

The amplitude and temporal characteristics of the potential had identical parameters for stimuli with different filling frequencies, provided that the intensity of the stimulus for each frequency corresponded to its threshold level. This is a very important factor for it is the basis for the use of EP recording to develop methods of objective audiometry.

The study of the role of stimulus intensity showed a marked dependence of amplitude and latency of the EP on intensity. In particular, if stimulus intensity was increased to 20-25 dB above the threshold for appearance of a response there was a linear increase in amplitude of the EP and a decrease in the spike latency. With a further increase in intensity, the linear relationship was disturbed: The EP amplitude continued to rise very slightly up to a certain level, after which a further increase in intensity of the acoustic stimulus caused no further change in EP amplitude, i.e., a phenomenon of "saturation" was observed (Fig. 1).

Shortening of the EP latency took place in a relatively linear fashion approximately to the same level of acoustic stimulation to which the amplitude of the EP rose. With a further increase in the strength of stimulation the latent period became stabilized, i.e., a phenomenon of "saturation" also occurred. The curves of amplitude and latency on the graph came out on a plateau at an intensity of 45-50 dB above the threshold for EP production (Fig. 2).

This dependence of the character of the EP on stimulus intensity was observed when both tonal volleys and clicks were used as acoustic stimuli. These facts agreed with observations in the literature [1, 3, 5, 10], but they do not confirm observations by some workers who found a decrease in EP amplitude during the maximal increase in stimulus intensity [8].

A no less clear relationship was discovered when the effect of the build-up in intensity of the acoustic stimuli on EP was studied. With a decrease in the duration of stimulus build-up from 8 to 5 and to 2.5 msec the amplitude rose from 96 ± 6.1 to 108 ± 5.1 and 128 ± 5.0 μV respectively; however, under these circumstances the latent period was unchanged. Meanwhile a change in the duration of the stimulus had no effect on either amplitude or latency of the EP. These findings agree with the views of Gershuni [2] on the primary role of transition processes in the stimulus compared with steady-state processes for the formation of integral cortical responses.

An essential factor for the practical use of auditory EP recording in audiology is the establishment of their dependence on the rhythm of acoustic stimulation. The experiments showed that with an increase in the interval between successive stimuli from 1 to 2 and 3 sec the amplitude of EP increased regularly from 102 ± 5.0 to 132 ± 5.0 and 152 ± 6.6 μV respectively. No such relationship could be found for the latent period.

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EFFECT OF A MODULATED ELECTROMAGNETIC FIELD ON SELF-STIMULATION RESPONSE IN RATS

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The effect of an electromagnetic field (EMF) with different frequencies of modulation (2, 7, and 50 Hz) on the self-stimulation response was studied in rats. Exposure to an EMF of 2 Hz caused a primary increase in frequency of the self-stimulation response, followed by depression. Exposure to an EMF of 7 Hz initially did not change the intensity of self-stimulation, but later led to a gradual decrease in its frequency. EMF with modulation of 50 Hz suppressed the self-stimulation response virtually immediately. The changes observed in the self-stimulation response were independent of the location of the stimulating electrodes and were determined by the frequency of modulation of the EMF.

KEY WORDS: electromagnetic field; modulation frequency; self-stimulation response; limbic system.

Previous investigations in the writer's laboratory showed that exposure to a modulated electromagnetic field (MEMF) leads to selective excitation of the limbic structures of the brain, which are known to participate in the formation of emotional responses [1, 4]. Changes in the emotional sphere are one of the most characteristic manifestations of illness developing in persons exposed at work to the action of MEMF [2, 5].

One of the most objective phenomena with which to study emotional responses is Olds' self-stimulation response (SSR). Accordingly, in the investigation described below, changes in the SSR in rats during exposure to an MEMF were studied. Special attention was paid to the study of differences in the SSR during exposure to EMD with different modulation frequency, for according to many investigators this is a very promising method of obtaining controlled changes in the activity of the CNS [3, 6].

EXPERIMENTAL METHOD

Experiments were carried out on 30 rats of both sexes with chronically implanted bipolar electrodes located in various subcortical formations (anterior and posterior hypothalamus, septum). The SSR was studied in a special Plexiglas chamber in which an EMF was generated between capacitor plates fixed along the walls

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