LITERATURE CITED

1. Ya. A. Al'tman and A. M. Maruseva, Zh. Vyssh. Nerv. Deyat., No. 3, 539 (1965).
2. G. V. Gershuni, in: Physiology of Sensory Systems [in Russian], Vol. 2, Leningrad, pp. 286-308.
3. O. F. Dembnovetskii, Zh. Vyssh. Nerv. Deyat., No. 1, 164 (1967).
4. B. M. Sagalovich and G. G. Melkumova, in: Combined Collection of Inventions and Efficiency Suggestions of Medical Colleges and Research Institutes of the RSFSR [in Russian], Ivanovo (1974), pp. 181-184.
5. G. Hofmann, Mschr. Ohrenheilk., 107, 537 (1973).
6. W. D. Keidel, Acta Oto-Laryng. (Stockholm), 71, 242 (1971).
7. E. B. Kern, D. T. Cody, and R. G. Bickford, Arch. Otolaryng., 90, 315 (1969).
8. C. D. Teas and N. J. Kiang, Exp. Neurol., 10, 91 (1964).
9. A. R. Tuntury, Am. J. Physiol., 213, 597 (1967).
10. F. G. Worden, J. T. March, F. D. Abraham, et al., Electroenceph. Clin. Neurophysiol., 17, 524 (1964).

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

G. D. Antimonii, V. I. Badikov, A. A. Kel',
E. A. Krasnov, and S. K. Sudakov

UDC 612.821.014.426

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

P. K. Anokhin Institute of Normal Physiology, Academy of Medical Sciences of the USSR, Moscow.

(Presented by Academician of the Academy of Medical Sciences of the USSR N. A. Fedorov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 82, No. 10, pp. 1163-1165, October, 1976. Original article submitted February 11, 1976.

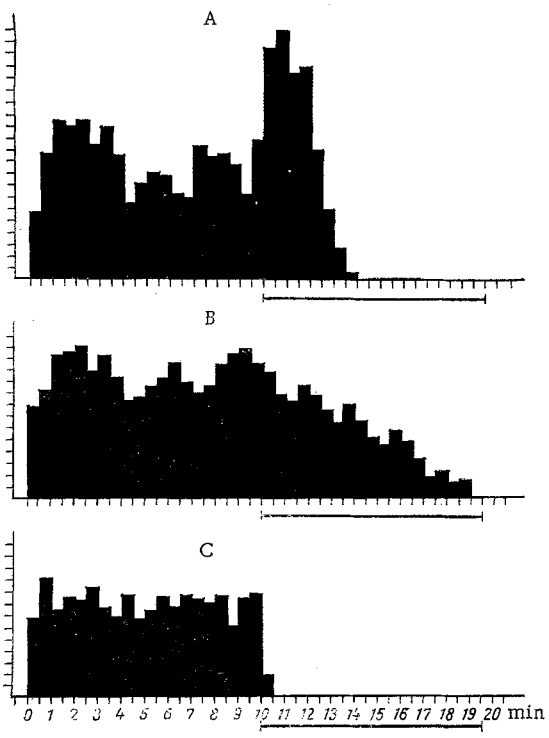

Fig. 1. Dynamics of changes in frequency of SSR during exposure to EMF with different modulation frequencies: A-C) changes in frequency of SSR during exposure to EMF with modulation frequencies of 2, 7, and 50 Hz respectively. Abscissa, time (in min); ordinate, number of times animal pressed on pedal. Marker of action of EMF generator shown below abscissa.

and connected to an EMF generator. The parameters of the EMF were: frequency 39 mHz, field intensity 100-120 W/m, depth of modulation 80%, modulating frequencies 2, 7, and 50 Hz. Depending on the modulation frequency of the EMF used the experimental rats were divided into three groups with 10 animals in each group. The results were subjected to dispersion analysis. The investigation was carried out by the method of least squares, by counting the number of times the animal pressed on a pedal in 30 sec initially and during exposure to a modulated EMF.

EXPERIMENTAL RESULTS AND DISCUSSION

The experimental results showed that a modulated EMF with a frequency of 39 mHz caused characteristic changes in the SSR of the rats. The dynamics of these changes largely depended on the modulation frequency used. During exposure to an EMF with modulation frequency of 2 Hz, an increase of 93% in the frequency of the SSR was observed in the first 2 min. During the next 1-1.5 min of exposure the frequency of the SSR fell to its original level and it disappeared completely by the fifth minute (Fig. 1).

During exposure to an EMF with a modulation frequency of 7 Hz the frequency of the SSR during the first 4 min was virtually the same as initially, but during the next 5 min the frequency of the SSR fell gradually and it disappeared completely after exposure for 10 min (Fig. 1).

An EMF with a modulation frequency of 50 Hz blocked the SSR of the experimental animals virtually immediately (Fig. 1). Characteristically exposure of rats in which the SSR was completely suppressed by an EMF with a modulation of 50 Hz to an EMF with a modulation frequency of 2 Hz led to a temporary stimulation of the SSR which lasted 2-3 min.

These experiments thus showed that EMF with different modulation frequencies but of the same intensity differ in their effects on the SSR: A lower modulation frequency (2 Hz) has an initial activating effect, but later exhibits the SSR; with a modulation frequency of 7 Hz the stimulating effect is absent, but the SSR of the animals

continues for a long time; an increase in the modulation frequency to 50 Hz leads to complete abolition of the SSR at the beginning.

Histological analysis showed that the changes described above in the SSR during exposure to an MEMF are practically independent of the location of the electrodes in the corresponding subcortical centers but are determined by the modulation frequency of the EMF used. In particular, the changes in SSR were identical in character during exposure of rats with electrodes located in the anterior hypothalamus (six animals), septum (two animals), and posterior hypothalamus (two animals) to an EMF with modulation frequency of 7 Hz; during exposure of rats with electrodes located in the anterior hypothalamus (seven animals), septum (two animals), and posterior hypothalamus (one animal) to an EMF with a modulation frequency of 7 Hz.

During exposure to an EMF with a modulation frequency of 50 Hz identical responses were observed in rats with electrodes located in the anterior hypothalamus (four animals), septum (one animal), and posterior hypothalamus (two animals). The results of these experiments indicate the selective character of the effect of EMF with different modulation frequencies on emotional responses of animals irrespective of the subcortical center in which the electrodes are situated.

LITERATURE CITED

1. P. K. Anokhin, K. V. Sudakov, and G. D. Antimonii, Abstracts of Sectional Proceedings of the Fourth International Biophysical Congress [in Russian], Vol. 4, Moscow (1972), pp. 118-119.
2. T. N. Orlova, in: Cerebral Mechanisms of Mental Diseases [in Russian], Kazan' (1971), pp. 16-18.
3. A. S. Presman, Electromagnetic Fields and Living Nature [in Russian], Moscow (1968).
4. K. V. Sudakov and G. D. Antimonii, Usp. Fiziol. Nauk, No. 2, 101 (1973).
5. N. V. Tyagin, Clinical Aspects of Irradiation in the shf Range [in Russian], Leningrad (1971).
6. H. Jehlička and V. Vrána, in: Third International Symposium on Electrosleep and Electroanaesthesia, Summaries, Varna (1972), pp. 35-36.