

**DOMINANT ROLE OF THE MESENCEPHALIC RETICULAR
FORMATION IN THE MECHANISM OF PREVENTIVE
EFFECTS OF A uhf ELECTROMAGNETIC FIELD ON
RESPONSES TO STIMULATION OF HYPOTHALAMIC
EMOTIOGENIC CENTERS**

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Several workers have demonstrated the physiotherapeutic effect of electromagnetic fields (EMF) in different ranges [1, 11]. However, the mechanisms of therapeutic action of EMF have not yet been explained. No final answer has yet been obtained to the question of whether the EMF has a selective action on different brain structures. Some workers state that the reticular formation is the most sensitive structure to the action of EMF [4, 14], and that the neurophysiological effects of EMF are due to disturbance of relations between the reticular formation and hypothalamus [12]. Other workers [5, 7, 10, 13] consider that the hypothalamus and cerebral cortex are the structures most sensitive to the action of EMF in the CNS. It has also been reported [2, 9] that exposure to EMF leads to selective excitation of limbic structures, especially the hippocampus.

In order to study the preventive action of the uhf electromagnetic field on the dynamics of acute emotional stress, discovered in the writers' laboratory [8], the investigation described below was carried out with the aim of elucidating the role of different structures of the limbico-reticular complex in the mechanism of the effects of a modulated uhf field on responses to electrical stimulation of emotiogenic centers of the ventromedial hypothalamus. It was shown previously that the uhf field blocks autonomic manifestations of the emotional response to stimulation of the ventromedial hypothalamus [3].

EXPERIMENTAL METHOD

Experiments were carried out on 42 male chinchilla rabbits weighing from 1.5 to 2.5 kg.

Bipolar nichrome electrodes were implanted in the rabbits at points in the ventromedial hypothalamic nuclei, electrical stimulation of which with square pulses (50 Hz, 1 msec, 3-8 V) evoked a passive defensive reaction.

The rabbits were fixed to a frame for the experiments. The arterial blood pressure, respiration, and ECG in standard lead II were recorded by means of piezoelectric transducers and strain gauges connected to a Mingograph-34 apparatus (from Siemens-Elema, Sweden). The blood pressure was recorded by means of a catheter introduced into the femoral artery. Electrical stimulation of the ventromedial hypothalamic nuclei three times, for 3 sec each time, was repeated at intervals of 2 min to obtain a stable pressor response.

A modified UVCh-66 apparatus, generating a modulated EMF with carrier frequency of 40 mHz on metal plates measuring 20 × 18 cm, between which the animal was fixed to a frame, was used in the experiments. The depth of modulation was about 100%, its frequency 7 Hz, and the intensity of the field varied from 30 to 300 V/m. The duration of exposure varied in different experiments from a few minutes to a few hours. The experiments were carried out in a special screened chamber.

In the first stages of the experiments changes in somatovisceral responses evoked by stimulation of the ventromedial hypothalamic nuclei and the effect of uhf fields, with the parameters given above, on them were studied. Certain brain structures (dorsal hippocampus, septum, and different parts of the reticular formation) were then coagulated for 1 min with a current of 2 mA. After bilateral, and also ipsilateral, destruction of the above-mentioned formations the effect of the uhf field on changes in blood pressure, respiration, and heart rate evoked by stimulation of the ventromedial hypothalamus were studied. The location of the electrodes in the brain and the region of coagulation were identified by a projection method followed by reconstruction of the volume of the brain lesions.

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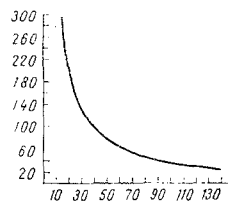


Fig. 1. Mean effective exposure doses to uhf field causing blocking of hypothalamic hypertensive reaction. Abscissa, exposure (in min) to uhf field; ordinate, intensity of uhf field (in V/m).

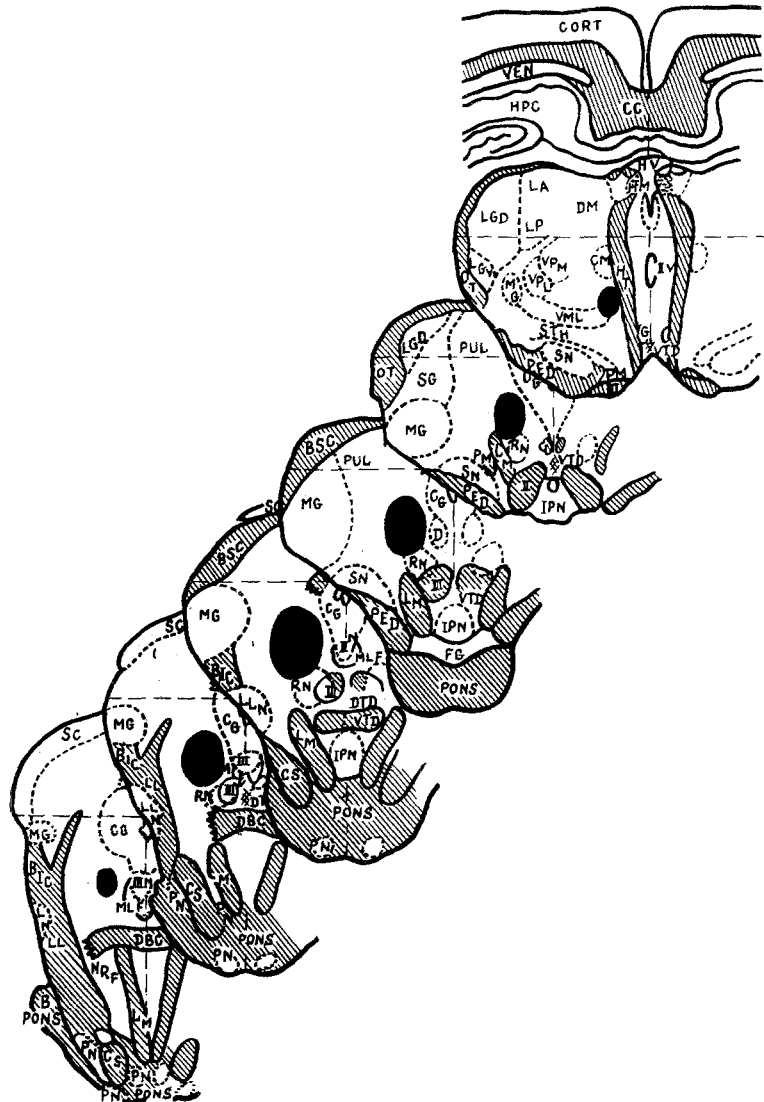


Fig. 2. Structures of mesencephalic reticular formation playing a key role in mechanism of preventive effect of uhf field on responses to stimulation of ventromedial hypothalamus (black ovals indicate zone of coagulation leading to absence of blocking action of uhf field on hypothalamic responses).

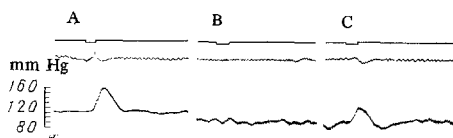


Fig. 3. Blocking of hypertensive response to stimulation of ventromedial hypothalamus by exposure to uhf field. From top to bottom: marker of stimulation, respiration, arterial pressure. A) Before, B) immediately after, and C) 90 min after exposure to uhf field.

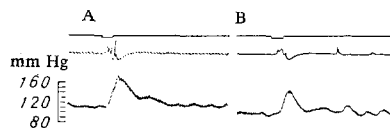


Fig. 4. Absence of blocking action of uhf field on hypothalamic response after coagulation of structures of mesencephalic reticular formation. A) Before exposure to uhf field, after coagulation of mesencephalic reticular formation, B) after exposure to uhf field.

EXPERIMENTAL RESULTS

Electrical stimulation of the ventromedial hypothalamus caused an increase in the arterial pressure by 24.3 ± 12.6 mm Hg, slowing of the heart rate by 26.1 ± 14.2 beats/min, and quickening of respiration by 19 ± 8 cycles/min. The effect of exposure to the uhf field on the response to electrical stimulation of the ventromedial hypothalamus was to produce blocking of the hypertensive reaction in 14 (33%) of the 42 rabbits. Depression of the automatic response was observed as a rule after a certain exposure to the action of the uhf field. Depression of the hypothalamic response was observed (Fig. 1) both after prolonged exposure (tens of minutes) to fields of low intensity (30 V/m) and after short exposures (minutes) to fields with high intensity (200-300 V/m). The effective uhf exposure dose was strictly individual and depended both on the experimental animal itself and on the parameters of hypothalamic stimulation needed to obtain a marked somatovisceral response. For instance, if the threshold of hypothalamic stimulation was below 5 V, a much smaller dose of uhf field was needed to block it than if the threshold of hypothalamic stimulation was higher. The effective dose of exposure to the uhf field was found to be directly dependent on the threshold of hypothalamic responses.

In 20 experimental animals (14 of which were sensitive and six insensitive to the action of the uhf field as shown by the criterion of inhibition of the hypertensive reaction) various zones of the mesencephalic reticular formation, dorsal hippocampus, and septum were coagulated in order to reveal their role in the mechanism of effects of the uhf field on hypothalamic responses.

In the six experimental animals sensitive to the action of a uhf field inhibition of the hypothalamic response as a result of exposure to the uhf field was not observed after bilateral and also after ipsilateral destruction of the mesencephalic reticular formation in a zone located laterally to the central gray matter and above the red nucleus (Figs. 2-4). After coagulation of these zones of the mesencephalic reticular formation the changes in blood pressure caused by stimulation of the ventromedial hypothalamus were more marked: The amplitude of the hypertensive reaction was increased by 8 ± 5 mm Hg and its duration by 6.4 ± 3.2 sec.

In two other animals sensitive to the action of the uhf field, weak inhibition of the hypothalamic response was observed when exposure to the uhf field followed destruction of the mesencephalic reticular formation. Subsequent morphological examination showed that zones lying laterally to those parts of the reticular formation indicated in Fig. 2 were destroyed in these animals.

In six animals insensitive to the action of the uhf field destruction of the mesencephalic reticular formation (Fig. 2) also caused an increase in the amplitude and duration of the hypertensive reaction but without any inhibition of that reaction by exposure to the uhf field.

In six animals sensitive to the action of the uhf field the dorsal hippocampus (in two animals) and the septum (the lateral region in two animals, the medial portion in two) were coagulated, causing a change in the character of the hypertensive reaction to stimulation of the ventromedial hypothalamus, but without changing the blocking action of the uhf field.

The experiments thus showed that structures of the mesencephalic reticular formation located laterally to the central gray matter and above the red nucleus performed key functions in the mechanism of the effects of the uhf field on hypothalamic emotiogenic reactions. Somatovisceral responses to stimulation of the ventromedial hypothalamus becomes resistant to the action of the uhf field after destruction of the above-mentioned structures of the mesencephalic reticular formation.

The mesencephalic reticular formation is known to exert ascending activating influences on other parts of the brain and the cerebral cortex [6]. It is the site of adrenergic neurons whose processes are widely distributed throughout the brain stem. The results of the present experiments suggest that effects of the uhf field on emotional responses are realized only if these ascending tonic influences of the adrenergic substrate of the reticular formation are present.

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