CHANGES IN THE CORTICAL ELECTRICAL ACTIVITY OF THE RABBIT DURING EXPOSURE TO AN UHF ELECTROMAGNETIC FIELD. REPORT 2. THE DIRECT ACTION OF THE UHF FIELD ON THE CENTRAL NERVOUS SYSTEM

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In contrast to other stimuli (light, sound), the uhf field has a considerable penetrating action. This gave reason to suppose that the uhf field may exert both reflex and a direct effect on the central nervous system. The present investigation was undertaken to verify this suggestion experimentally. It was previously shown [2] that during the local application of an uhf field with an intensity of 1000 W/m to the head, chest, abdomen, or hind limbs of a rabbit, changes in the EEG were observed only when the action was directed towards the head. Consequently, the analysis of the reflex and central pathways of the effect of the uhf field may be limited to the head region.

The object of the present investigation was to study the reaction of the EEG to the uhf field in rabbits after injury to the telereceptors and section at the level of the mesencephalon.

EXPERIMENTAL METHOD

Vision was excluded by division of the optic nerve on both sides. The auditory analyzer was destroyed by injecting 1-3 ml of 96% alcohol into the middle ear by means of a syringe, carrying a needle the tip of which was sharpened and bent at a right angle [3]. The olfactory analyzer was destroyed by making a vertical incision through the anterior division of the rhinencephalon. Section of the mesencephalon was carried out in the unanesthetized rabbit after preliminary trephining of the skull in the occipital region. An incision was made in the dura posteriorly, the occipital lobes of the brain were brought out into the woud, and the mesencephalon was divided with a scalpel at the level of the anterior colluculi. The results of each operation were verified histologically after sacrifice of the animals.

The EEG was recorded as described previously [2]. The head was exposed to the action of the uhf field for 3 min. The field was brought to act on the animal several times before operation and 5-20 times thereafter. The experiments began 10-40 min after the operation and finished after 3-6 h in the case of the isolated brain preparation and after 20-30 days in the case of the deafferented rabbits.

EXPERIMENTAL RESULTS

The animals subjected to the operation reacted to the uhf field in just the same way as the normal rabbits, i.e., by an increase in the amplitude and a decrease in the frequency of the potentials on the EEG (Fig. 1). The reactions of each group of rabbits subjected to the same operation were qualified by their mean stability (the ratio between the number of reactions and the number of actions, in percent) and their mean latent period.

It will be seen from Table 1 that the rabbits continued to react to the uhf field after destruction of any of their distant analyzers and also in the isolated brain preparation. Admittedly, the reactions were slightly less stable than in normal rabbits after deafferentation, and especially after destruction of the olfactory analyzer (26% compared with 45%), and the mean latent period of the reaction was increased especially after destruction of the auditory analyzer (74 sec compared with 53 sec). However, the fact that the reactions continued to occur, and were actually better in the isolated brain preparation, demonstrates clearly that the telereceptors are not primarily concerned with the perception of the uhf field.

TABLE 1. Comparative Characteristics of the Reactions of the EEG to the UHF Field in Normal Animals, in Rabbits after Destruction of the Optic, Auditory, or Olfactory Analyzers, and in Isolated Brain Preparations

Experimental conditions	No. of rabbits	No. of exposures	No. of reactions	Mean stability (in %)	Mean latent period (in sec)
Normal rabbits	12	67	30	45	53
Destruction of optic analyzer	3	38	22	38	61
Destruction of auditory analyzer	3	48	17	35	74
Destruction of olfactory analyzer	4	76	16	21	57
Isolated brain preparation	10	43	34	80	33
The same + division of rhinencephalon	8	57	26	45	34

Section at the mesencephalic level led to a sharp increase in the stability of the reactions (from 45 to 80%) and considerably shortened their latent period (from 53 to 33 sec). The reactions of the isolated brain to the uhf field were unchanged after additional division of both optic nerves. When, however, the rhinencephalon was also divided, the stability of the reaction fell to 45%, although there was no change in the mean latent period (34 sec compared with 33 sec). Injury to the rhinencephalon thus leads to a decrease in the stability of the reaction to the uhf field of approximately half, irrespective of whether the section is carried out on the intact or the isolated brain. It is important to verify whether the observed effect is dependent on destruction of the olfactory analyzer or on injury to the anterior division of the brain. However, whatever the results of the future testing of this hypothesis, it can be concluded even now that the isolated brain, deprived of all its afferent neural pathways, reacts to the uhf field.

Our experiments demonstrate that the divisions of the brain situated above the level of section i.e., the diencephalon and telencephalon, are capable of reacting directly to the uhf field. The problem of whether such a reaction can take place in the lower divisions of the brain remains for the moment unsolved.

It has previously been shown [2] that the curve of distribution of the latent periods of the reactions to the uhf field in normal rabbits has two maxima: at 40 and 90 sec. We attempted to discover whether these maxima were still present in the distribution curves of the latent periods of the reactions of the operated rabbits (Fig. 2). The animals with destroyed optic, auditory, or olfactory analyzers were grouped together in a single group of deafferented rabbits, because the distribution of the latent periods of their reactions was identical.

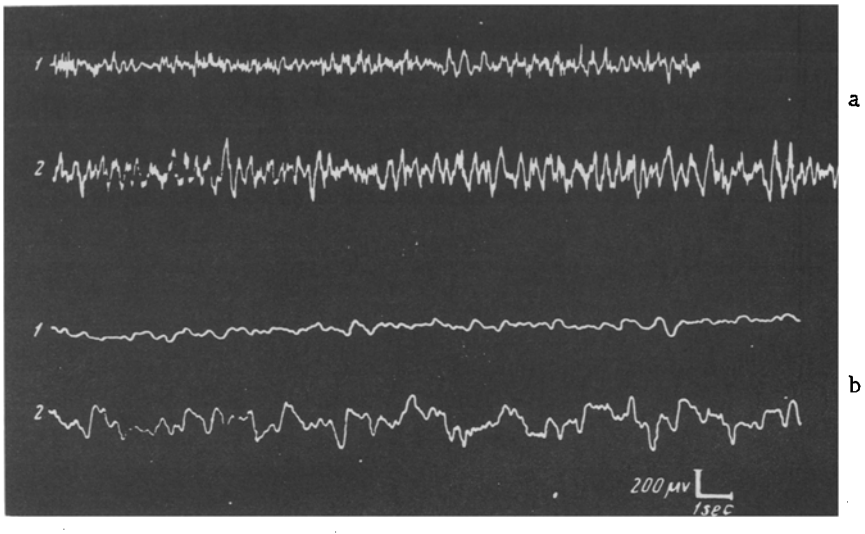

Fig. 1. EEG of the occipital region before (1) and after (2) the action of an uhf field on the head of a rabbit with its auditory analyzer destroyed (A) and of an isolated brain preparation (B).

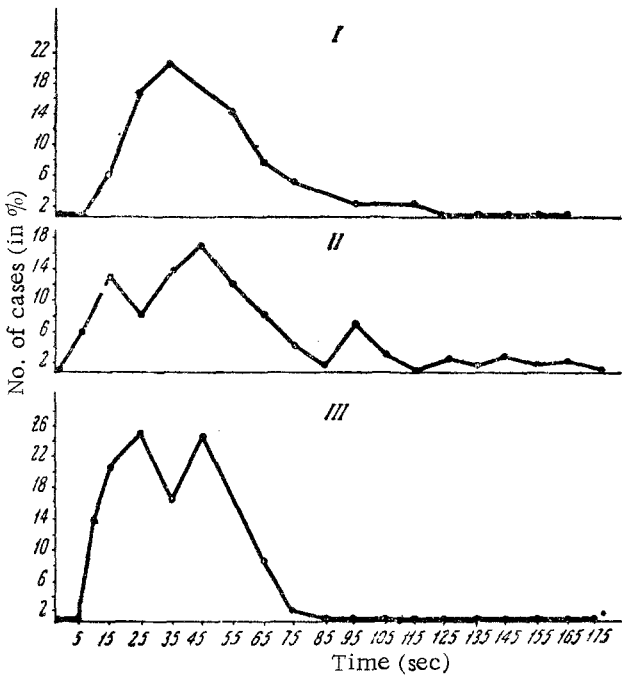

Fig. 2. Curves of the distribution of the latent periods of the reactions of the EEG to the action of the uhf field on the head of normal (I) or deafferented rabbits (II) and on the isolated brain (cerveau isole) preparation (III).

The mean latent period of the reaction was increased after deafferentation (see Table 1). However, according to the distribution curve of the latent periods, the animals of this group had very long latent periods and also showed a maximum at 15 sec. This example shows that the mean latent period is insufficient by itself to qualify the reactions. In order, therefore, to compare the reactions of the operated and normal animals, we divided the time of action of the stimulus into four periods, in each of which we included the group of reactions with that particular latent period. In the first group (latent period from 1 to 25 sec, with a maximum at 15 sec) went the reactions not encountered in normal rabbits; in the second (latent period from 25 to 65 sec with a maximum at 40-45 sec)—reactions most commonly found in normal rabbits; in the third (latent period from 65 to 115 sec, with a maximum at 90-100 sec)—reactions found relatively rarely in normal rabbits; in the fourth group (latent period from 115 to 180 sec, with no definite maximum) reactions also not found typically in normal rabbits. Table 2 is compiled on the basis of this subdivision, and the relative proportion of the different groups of reactions in normal and operated animals is expressed as a percentage.

It is most convenient to begin the examination of Table 2 on the right. The fourth group of reactions was encountered only in the deafferented rabbits, and it accounted for 12% of all cases. The third group of reactions was

TABLE 2. Relative Proportion of Groups of Reactions to UHF Field in Normal and Operated Rabbits

Experimental conditions	No. of reactions (in %)			
	first group	second group	third group	fourth group
Normal rabbits	0	82	18	0
Deafferented rabbits	14	54	20	12
Isolated brain preparation	38	53	9	0
The same + division of the rhinencephalon	34	66	0	0
Mean	21	64	12	3

absent only in the isolated brain preparation with division of the rhinencephalon. On the average for all the animals this accounted for 12% of the reactions, decreasing as the brain was progressively isolated. The second group of reactions not only was present in all the animals, but was predominant, constituting on the average 64% of all the reactions. It should be noted that the reactions of this type were predominant in the normal rabbits (82%) and also in the isolated brain preparation after division of the rhinencephalon (66%).

The first group of reactions was totally absent from normal rabbits and was found only rarely in the deafferented animals (in 14% of cases). In some measure this group of reactions may be regarded as pathological, for they developed after extensive operations on the brain.

Our results do not yet provide an adequate morphological explanation for the two formally defined groups of reactions of rabbits to the uhf field, qualified by the length of their latent period. Nevertheless, the most marked histological changes were recorded in two regions: the cortex and the hypothalamus [1]. If we assume that these two regions are, in fact, responsible for the reactions of the brain to the uhf field, it seems probable that the hypothalamus, as the more inert system, is related to the second group of reactions while the cortex is related to the first group. Further investigations are needed in order to verify this hypothesis experimentally.

LITERATURE CITED

1. M. S. Tolgskaya, Z. V. Gordon, and E. A. Lobanova, in the book: the Biological Action of Super-High Frequencies [in Russian], Moscow (1960), p. 90.
2. A. B. Tsypin and Yu. G. Grigor'ev, Byull. éksper. biol., 2, 114 (1961).
