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WHY THE DOUBLE STANDARD?
A CRITICAL REVIEW OF RUSSIAN WORK ON THE HAZARDS OF MICROWAVE RADIATION

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Summary

Continued interest in the determination of appropriate national levels of exposure to microwave fields has directed attention to Soviet work in this field. The vastly different standards adopted in the two countries have aroused much speculation as to the reasons. In this paper the Russian work is reviewed, and the major individuals identified. An explanation for the different exposure limits is offered, based partly on the difference in national organization.

Introduction to the Double Standard

Increasing interest in the possible biological hazard of exposure to microwave fields has focussed attention in recent months on the large body of Russian work in this area. It has surprised many observers to learn that the exposure limits established in the USSR for microwaves are a hundred to a thousand times lower than those established in the U. S. The historic parallel of the lowering of exposure limits for the various kinds of ionizing radiation, as more information was gained over the years, naturally invites comparison. Government scientists have recently suggested early adoption of lower limits for microwave ovens[1]. The question therefore arises as to the reason for this remarkable difference; in short, why the double standard?

To put the matter in perspective, some general similarities and some differences are readily apparent in appraising the literature from both countries.

Some differences are:

1. In the U. S. there is relatively little familiarity with, or acknowledgement of, Russian work, although in fairness it may be said that this suitation is changing. In the USSR, there is general awareness of U. S. work, and general inclusion of references in bibliographies.

2. In the U. S., there is a straightforward correlation of conclusions with reported laboratory work. In the USSR, one finds more fanciful conclusions, which at times are not apparently supported by the work reported.

3. In the U. S., the thermal effects are generally believed to be the only ones of significance; other contentions are usually dismissed as lacking a provable basis. In the USSR, non-thermal effects are considered the most significant and are overwhelmingly the ones most studied.

Some similarities are:

1. There is a constant stress in both countries on the need for more research, and free admission of the lack of sufficient fine-grain knowledge.

2. There is a fairly monolithic viewpoint in each country, although not the same one.

Various reasons have been suggested for the Russian insistence on lower exposure limits. These limits are given very little credence in this country and apparently are even resented by many agencies. Some of these reasons are:

1. They are trying to limit our operational effectiveness by placing an unnecessary barrier to our utilization of microwave devices, especially weapons.

2. The people directing the Russian efforts are really more interested in parapsychic phenomena and therefore their scientific objectivity is clouded.

3. The Russian technical reports are so poorly documented and the basis for their conclusions so obscurely presented that the work itself is likely of little value.

4. They have done so much work in the field and set their limits so low with respect to ours that there must be some sound reason for it, and we should probably move to some compromise position.

None of these statements in itself is a powerful argument, but each deserves some consideration and the material presented later may throw some light on each of the reasons listed.

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Who are the Russians?

The Russian community concerned with the entire subject of biological effects of microwaves is quite large and of diverse backgrounds. Russian medical practitioners have long maintained a lively interest and continuing research effort in the entire relationship between electricity and living organisms. This includes studies of electro-sleep, electro-anasthesia, shock therapy, magnetic medicine and similar subjects. Their pre-occupation with microwave hazards is a natural extension of their long involvement in the study of the electrical-biological relationship.

A number of organizations are active in a wide ranging and systematic study of microwave effects[2]. The two dominant groups are the Central Scientific Research Institute of Health Resort Science and Physiotherapy in Moscow and the Institute of Industrial Hygiene and Occupational Diseases of the Academy of Medical Sciences, USSR, also in Moscow. These institutional names may seem strange to an American eye, but the activities of the workers go far beyond what would appear to us to be the bounds of interest of these groups. A. S. Presman is the leading figure at the Central Scientific Research Institute. He worked at the Institute of Industrial Hygiene from about 1955 to 1959 on industrial protection against microwaves and about 1960, even as you or I might, he shifted institutes and has since been working on low intensity microwave effects, especially on the central nervous system. Members of his team include Y. I. Kamenskiy, N. A. Levitina, S. M. Rappaport, and L. A. Bymunfeld.

A somewhat larger group at the Institute of Industrial Hygiene is probably led by Z. V. Gordon, and includes Y. A. Lobanova, M. S. Tolgskaya, S. F. Belova, A. A. Letarvet, B. M. Belitskiy and others. They have done considerable work since 1955, especially on the irradiation of animals.

There are other groups besides these two. An active team at the Institute of Higher Nervous Activity and Neurophysiology of the Academy of Sciences in Moscow is headed by Y. A. Kholodov, and includes Z. A. Yanson and A. L. Eldarev. They have done a great deal of work on the effect of microwaves on the central nervous system of animals. Kholodov is also interested in the study of magnetic fields on the central nervous system, but that's another whole story.

Other active groups include a number of local institutes of industrial hygiene and occupational disease, not organizationally a part of the Academy of Medical Sciences, but under the individual republic ministries of health. The Leningrad (also Georgian, Ukrainian, and Gor'kiy) Institutes of Industrial Hygiene have all published papers since 1955 on the problem of industrial protection against microwaves. A team at the Bogomolets Institute of Physiology of the Ukrainian Academy of Sciences in Kiev has also been active in recent years. Some major contributors are S. F. Gorodetskaya, N. I. Kerova, and M. I. Yatsenko. A large numbers of papers by authors not mentioned above, and of other institutional affiliations, have also appeared in the last decade.

This diversity of individuals and organizations is certainly a measure of the deep and widespread interest throughout Soviet scientific circles in all aspects of the biological effects of microwaves. Some conferences on this subject were held in the Soviet Union between 1957 and 1962, as they were also in this country, but no proceedings are, to my knowledge, available.

What Do They Say? - A Look at Their Work

As evidenced by the exposure limits which have prevailed since about 1960, the Soviets believe that microwave fields generally considered low level are indeed hazardous to human beings. The general view is that such fields affect the structure and chemical reactivity of neural cells. They may affect the molecular arrangement of neural structures directly by resonant or other absorption. Such interferences with the normal functioning of the central nervous system lead to a wide variety of symptons of various degrees of severity. The best way to avoid the symptoms is to limit the exposure any individual is likely to receive. Upon recognition of the early symptoms, it is logical to assign an affected individual other duties or place him on vacation status.

Kamenskiy has described work in which frogs were chosen for irradiation[3]. Working from his colleague Presman's hypothesis that microwaves basically alter the functional condition of excitatory structures, he measured the nerve currents generated in the frogs during irradiation. Since such changes in nerve excitability occur as a result of heating from any source, be first measured the increase in excitability with a continuous microwave field (wave length 10 cms) and found that its effect corresponded closely with that attributable to ordinary beating, i.e., about 5 to 10% for each 1°C increase in temperature. He then measured the effect on the nerves at pulse repetition rates of 100, 200, and 700 per second. At 700 per second, the increase in excitability was approximately 1½ times that due to ordinary heating, continuous waves, or 100 and 200 pulses per second. In his opinion, this verifies the existence of a non-thermal effect, at least for frog nerves.

This work helps support the generally held Soviet view that pulse microwaves are more biologically active than continuous waves. Kamenskiy's explanation is that the effect somehow becomes accumulative at 700 pulses per second (1.4 msec intervals). At lower pulse rates, the recovery interval is great enough so that this cumulative effect does not occur.

Z. V. Gordon has written a chapter in a large handbook[4] dealing with various occupationally related hazards. The volume includes lengthy sections on vibration, noise, toxic chemicals, ionizing radiation and other hazards, as well as Gordon's contribution on microwaves. He relates the results of tests-to-the-death on laboratory rats by exposure to strong fields of various frequencies. The results are somewhat startling.

Wavelength	Energy Intensity (ergs/cm^3)	Mean Time to Death
Medium Waves	2830×10^{-6}	Non-lethal
Short Waves	1100×10^{-6}	100 Minutes
Ultra-Short Waves	1100×10^{-6}	5 "
Decimeter Waves	33×10^{-6}	60 "
Centimeter Waves	33×10^{-6}	15 "
Millimeter Waves	33×10^{-6}	180 "

They have also studied it the other way around; i.e., several months exposure to fields of low enough intensity (<10 mw/cm^2) that no thermal effects were observed. Gordon notes that after two months, they observed severe functional changes in the central nervous system, in particular a change in the reactivity to stimuli such as light, a loss of conditioned reflexes, and even the appearance in some animals of a predisposition to some of the symptoms of elipepsy. He concludes that the action of radio waves upon the central nervous system is achieved both directly on the nerve cells of the brain as well as reflexly, by the transmission of impulses from receptors.

The findings of the laboratory study generally confirm the concept that the biological effects of radio waves are reduced with an increase in wave length. However, Gordon argues that although this is usually true when comparing different regions of the spectrum (i.e. medium waves are less biologically active than UHF, and UHF less so than microwaves), yet within an individual band (for example, the microwave band) this general regularity may not exist. There are different discrete regions of wave length which have a more marked effect on certain function of the body than would be anticipated from the general rule. He remarks that this idea is fundamental to their studies of the mechanism of the biologic effect of radio waves.

In a recent book[5], Y. A. Kholodov describes a great many laboratory studies on such animals as rabbits, mice, fish, simians, and pigeons. These tests were performed at field strengths both high and low, and at wavelengths mostly from 1 cm to 10 cm. Studies were made of the effect not only of electromagnetic fields, but of electrostatic and magnetic fields as well, since Kholodov is also interested in space biology and in methods of reducing the effects of ionizing radiation on space crews.

A principal investigatory tool used was the electroencephalograph, largely because of its great sensitivity and also because of its direct indication of brain activity. Many interesting results are presented. For example, in irradiation of rabbits for three minutes to a moderately strong field, no temperature changes were noted nor heartbeat or respiration changes, and no vocal or motor reaction. Yet a definite change in the EEG of the animals was observed, generally in the form of high amplitude, low frequency potentials. Usually the changes occurred more than 10 seconds after the irradiation was started, and persisted for 10 or 15 minutes after the irradiation had ended. It was necessary to treat these data by statistical techniques, since not all rabbits demonstrated the same reaction at any given time, nor did a particular rabbit react the same on successive radiations, clearly showing the dependence of the reaction on the initial functional state of the nervous system.

Other interesting observations are presented in this book. A SHF field of thermal intensity reduced the resistance of mice to strychnine poisoning, but a field of nonthermal intensity increased it. In a study of anteaters, it was observed that they lost their ability to "inform" other anteaters about a food source during SHF irradiation, and furthermore they oriented their snouts along a particular axis during the irradiation. In studying the behavior of rats in which an epileptoid reaction had been induced by sound stimulation, it was observed that an SHF field reduced the excitability of the animals and decreased the severity of the convulsions.

An article by F. A. Drogochina and M. N. Sadchikova in a Russian journal[6] describes investigations over a period of many years at the Institute of Labor Hygiene and Occupational Diseases, on individuals who had been exposed to irradiation in the course of their work. These investigations enable them to trace the development of various symptoms resulting from exposure to various ranges of radio frequencies, especially in the centimeter wavelengths.

Their experience suggests a course of development falling into three general stages: (a) the initial, (b) the moderately pronounced, and (c) the strongly pronounced stages.

(a) The initial stage symptoms usually appear within three to five years of exposure. Most characteristic is the asthenic syndrome which develops because of the exhausting action of the radio frequencies on the central nervous system, and results in increased fatigue, headaches, and sleepiness during work hours. Among the biological effects which occur are bradycardia, changes in heart conduction on the electrocardiograph, weak development of dermagraphia, and hyperhydrosis of the wrists. Often there is a slight enlargement of the thyroid gland,

and a tendency towards increase in the leukocyte count and histamine content of the blood. All these changes are unstable and can be eliminated by a brief interruption of the work involving exposure.

(b) The second stage develops if exposure continues. Patients suffer prolonged headaches, pain in the region of the heart, bradycardia, increased blood pressure, pronounced changes in the appearance of the electrocardiogram, a lowered olfactory response, and often such trophic disturbances as loss of hair and brittleness of the nails, and a decrease in sexual potency. Some medical treatment is required and temporary transfer to other work is mandatory.

(c) The third stage is rather poorly described in the article and only by reference to individual case histories. Symptoms include strong and recurring headaches, vertigo and fainting, heart pains, shivering and trembling, gastrointestinal disturbances, pronounced dermographia and hyperhydrosis. In the few cases reported, many of the symptoms remained even a year later after the individuals had changed jobs, although at a reduced level.

It is difficult to evaluate this report in view of the extremely low exposure limits observed in the USSR. A likely explanation is that although the article appeared in January 1965, it had been submitted to the journal in 1963 and probably reported on exposures which had occurred prior to the adoption of the more stringent standards.

A. S. Presman is a leading spokesman of the non-thermal or specific effect school (in fact, he originated the term "specific" in this sense). He believes that if exposure to a microwave field does not sensibly vary the temperature of an organism under study, then any changes in its behavior or its functioning can properly be assigned to the "specific" mechanism of the microwave field. He has suggested[7] a number of ways in which the specific effects of microwaves might be explained, although it must be noted that the precise mechanism remains the subject of intensive research. His suggestions include:

1. The irradiation of such preparations as blood, tissue cultures, and microorganisms which possess a higher coefficient of microwave absorption than other media may result in selective "micro-heating" when "macro-heating" of the medium is not noticeable. Such a differential process of micro-heating could lead to changes in metabolic processes.

2. There is a possibility of resonant absorption of microwaves by complex protein molecules, particularly enzyme modecules. The result of such absorption could be changes in molecular structure.

3. Ion and dipole molecule oscillation due to the action of microwaves might exert an influence on the processes of ion and protein hydration, the state of boundary electric layers, and the concentration dynamics of ions and their activity. All of this might lead to changes in the functional characteristics of cell excitability, and these changes could be the basic explanation of the observed specific effects of microwaves on the nervous system.

4. Since some investigators have detected changes in nerve cell characteristics, there is a basis for considering the effect of pulsed and modulated microwaves as intermittent stimuli of the nervous system.

A word should be said about the participation of some of these scientists in the study of parapsychic phenomena. A Special Bioinformation Section, under the Moscow Board of the Scientific-Technical Society of Radiotechnology was established in 1965[8] to study such phenomena. The Section is composed of an inter-disciplinary group of radio engineers, medical doctors, biologists, physiologists, and hypnotists and includes three of the most prominent Soviets in microwave studies, Presman, Kamenskiy and Kholodov. The Section intends to analyze the world literature on parapsychic phenomena and to conduct experiments in various types of telepathic communication, especially "spontaneous" telepathy. "There is no need to dispute its existence", stated the Chairman, "but rather a need to investigate its nature."

Discussion

In this paper, only a few examples of the large Russian output on this subject have been presented, and only briefly. There have been very few instances in American writing of attempts to correlate findings with the Soviet conclusions. It is almost as though it should be ignored or politely dismissed since, after all, it is Russian. In interesting testimony before a Senate Committee[9] conducting hearings on the "Radiation Control for Health and Safety Act" in 1968, Dr. Charles Susskind of the University of California at Berkeley did discuss the Russian work and stated that much basic research at lower power densities should be performed before "we can decide whether we should adopt the much stricter safety level of the Soviet Union." He also suggested that non-ionizing radiation might ultimately prove to be a greater problem than ionizing radiation. If that prophecy should prove correct, I am sure the Russian literature will one day be weighed more carefully than it is at present.

Finally, to answer the question, "Why the double standard?", I believe that the reason probably is that the scientific concern with athermal effects in the USSR expresses itself through much shorter communication lines into lowered exposure limits, whereas the largly prevalent view in this country that thermal manifestations only are of consequence results in a present day standard which is quite acceptable on that basis.

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