Early experiments found extremely low frequency electric fields affect humans

A series of experiments in Germany (1953-1970) demonstrated that natural and man-made electrical fields below 20 hertz affect humans, especially their sleep.

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Introduction

Humans are exposed to extremely low frequency (ELF) radiation from both natural and artificial sources. Natural sources include:

- Variations in the earth's magnetic field
- Local thunderstorms
- Schumann resonance

The Schumann resonance is present anywhere on Earth at all times. It is created by thunderstorms somewhere on the globe, even thousands of miles away. It was discovered in 1954 by the German scientists Schumann and Konig.

Artificial sources include:

- Variations in household electrical feed
- Some types of electrical trains (including German ones)
- Some types of communication using power lines (PLC)
- Some industrial ovens

Humanity evolved with the constant presence of the natural radiation, while the artificial ones were new. The question was whether they affected humans, and in which way.

The first experiment

A traffic exhibition was held in Munich, Germany, in 1953. One of the exhibits allowed people to test their reaction time when a light changed. The data from more than 40,000 tests were recorded throughout the weeks the exhibition was open.

The ambient levels of natural extremely low frequency radiation were also recorded during the exhibition.

The researcher, R. Reiter, found that the levels of these natural frequencies affected people's reaction time. With increased 3 Hz signals, people were slower to react. With increased Schumann resonance waves (around 8 Hz) people's reaction time improved, i.e. they reacted faster.

Reproducing the traffic exhibition study in the laboratory

The researchers were able to demonstrate the same effects in the laboratory. They used the same equipment from the traffic exhibition, but in a setup where the electrical field could be controlled.

The test chamber had wire mesh on the floor and the ceiling 2.5 m (7.7 ft) apart. Frequencies of 10 Hz (sinus) or 3 Hz (with lots of harmonics, presumably square wave) were applied, with a voltage of 2 to 7 volts. The field strength was typically around 1 V/m.

Each test subject was kept in the test chamber for several hours, with the electrical field applied at various times and strengths. One sample shows a test lasting seven hours.

The test was single-blind, as the equipment was operated by a human monitor. The number of test subjects was too low to do a statistical analysis, though the results showed a clear correlation between the fields and the reaction time.

The test subjects were asked about any symptoms they experienced during these multi-hour tests. There were some complaints about headaches, tightness of the chest, sweating palms, etc., especially when exposed to the 3 hertz (plus harmonics) fields. Symptoms were reported as eventually disappearing, becoming random after several hours of exposure.

Symptoms were not recorded during the test, so it was not possible to correlate them with the exposures.

Galvanic skin response

A double-blind test was then done, measuring the galvanic skin response of humans. Each test consisted of 24 minutes of no radiation, then 20 minutes of radiation with a 3 hertz signal with higher harmonics, followed by 14 minutes of no radiation.

The first series used 12 test subjects in a field of 1 V/m. Only one test subject had a response.

The second series used a stronger 5 V/m electric field. Here five of the ten test subjects reacted to the electric field.

The report has a graph showing the response of each test subject. The galvanic skin responses clearly start to ramp up within a few minutes of the exposure to the electric field, and down again some minutes after the field was removed again. Only two of the test subjects returned to baseline within the 14-minute rest period. One test subject stayed at full response throughout the 14-minute rest period.

American reaction-time experiments

A decade later, the American scientist J. R. Hamer did similar reaction-time experiments. In these experiments, the test subjects were placed between two electrode plates that were 50 cm (20 inches) apart. Frequencies of 3, 8 or 12 hertz were applied, with a voltage of 2 volts (i.e. 4 V/m).

Hamer found the same effects as the Germans, i.e. a slowed reaction time with the 3 hertz electrical field and a faster reaction time at 8 and 12 hertz.

Testing the lower limits of the field

Hamer also attempted to find how low the electrical field could be and still affect humans. This was tried in the setup where the test subject sat between two electrode plates, which were spaced 50 cm (20 inches) apart.

Plate voltages of 0.2 V, 0.02 V and 0.002 V (i.e. 0.4 V/m, 0.04 V/m and 0.004 V/m) were used. Effects on the reaction times were found at all the voltages. This means that humans can be affected by fields naturally occurring in nature, such as the Schumann resonance.

The sleep experiments

Extensive sleep experiments were done in Germany during the 1960s and onwards. A research facility was built as an underground house with two small apartments and a monitoring room. The building had no windows and was heavily sound proofed, so no light or sound could enter the apartments and provide clues to the time of day.

One of the apartments was also heavily shielded against low-frequency electrical and magnetic fields. The earth's natural frequencies were reduced a hundred-fold in the apartment, while they were only reduced by 10% in the unshielded apartment.

The shielded apartment also reduced radio-frequency signals by at least 40 dB.

There is no mention of any shielded electrical system, so the test subjects in both apartments were continuously exposed to a 50 hertz electrical field.

The shielded room had built-in electrodes in the walls, ceiling and floor to produce electrical and magnetic fields when desired. The electrodes were hidden by plaster and the test subjects were not aware of their existence.

The test subjects stayed in one of the apartments for up to four weeks, during which they had no outside clues as to what the time was. There was no natural light and no sounds of traffic to give any clue when it was daytime. The temperature was constant around the clock. There was no contact with the staff managing the facility.

The body temperature was monitored continuously for each test subject. Their activities were also monitored, such as when they had their lights on and flushed the toilet.

The researchers found that without any cues as to the time of day, the "body clock" (circadian rhythm) started to follow a cycle of about 25 hours. This happened to all the test subjects.

When comparing the text subjects in the shielded apartment (n=50) to those staying in the unshielded apartment (n=34) some interesting differences were found.

The sleep/awake circadian rhythm was longer for people staying in the shielded apartment.

Thirty percent of the people in the shielded room became internally desynchronized, versus none in the unshielded room. When a person becomes desynchronized, the body temperature no longer follows the sleep/wake cycle.

Parameter	Unshielded room 34 subjects	Shielded room 50 subjects	Significance
Mean value of circadian cycle	24.87 hrs	25.26 hrs	$p < 0.01$
Standard deviation	0.44	0.85	$p < 0.01$
Internal desynchronisation	0 subjects	15 subjects	$p < 0.001$
Apparent desynchronisation	5 subjects	0 subjects	$p < 0.01$

The researchers then exposed test subjects in the shielded room to an artificial electric field, using the electrodes embedded in the walls, ceiling and floor.

The frequency was 10 hertz square wave (which means lots of higher harmonics). The field strength was 2.5 V/m (peak-to-peak).

Various tests were conducted with the electrical field on throughout the test subjects' stay, or only a part of it. The test subjects were never aware of when the field was on or off; in fact, they were not even told about that part of the experiments.

Ten experiments were done where the field was on for a part of the test period. It was either on continuously for several days at a time (typically a week) or off for several days.

In all ten cases, the field created a more normal circadian rhythm, compared to when the field was turned off. This was irrespective of the sequence of the on and off periods.

To be more specific, the presence of the field significantly reduced the circadian cycle ($p < 0.01$) and it also created less variability between the test subjects ($p < 0.01$).

The desynchronization between body temperature and the sleep/awake cycle never happened while the 10 hertz field was applied. Some test subjects became desynchronized while the field was not on, but they all resynchronized quickly when the field was applied.

The source material does not state how many such cases they had, though the data for two are presented.

Additional experiments were done where the 10 hertz electrical field was on for a part of each day and off at night. Sometimes the time of day the field was on was gradually varied. These experiments were an effort to see if the field could be used to control the circadian rhythm.

There seemed to be some such effect, but not strongly, and not sustainably over time. If there indeed is such an effect, it is weak.

Comments

These studies indicate that very weak electrical fields can effect humans. The studies all looked at extremely low frequencies, below 20 hertz, which is the same area the human brain operates in.

Some frequencies seem to slow people's reaction time; others increase the reaction time. So it appears that there can be stimulatory or depressive effects. The sleep studies indicate that the Schumann frequencies (around 8 hertz) help to steady the internal clocks in the human body.

The electrical fields used in the experiments were generally around 1 to 5 V/m, which are on the low end of what most people today are exposed to 24 hours a day. It is thus interesting that one study found human responses at field strengths as low as 0.004 V/m.

None of the studies were looking for health effects, and only one of the studies mentioned that some of the test persons complained of headaches and other subjective symptoms.

An important find is that humans apparently *do* have some ability to pick up very weak electrical fields. How that works is still not known today, but may be similar to how pigeons navigate, using microscopic magnetite as compasses.

It is still hotly contested today that humans can be affected by weak electrical fields. One reason may be the strong commercial interests which could be affected by such a finding.

The world has changed dramatically since these studies were done. There are now many more sources of electrical and magnetic frequencies, which makes it much more difficult to do these types of studies. As any of the frequencies may affect humans, it is important to control all of them, not just the ones studied. Otherwise it is like trying to discern whether smoke from a cigar affects a person, while there are smokers of pipes, cigarettes and marijuana present at all times. Unfortunately, many studies fail to control the test environment sufficiently, which may be a reason why today's science studies do not make clear-cut findings.

Sources

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ELF-effects on human circadian rhythms, R. Wever.

Both articles are chapters in the book *ELF and VLF Electromagnetic Field Effects,* Michael A. Persinger, Editor, Plenum Press, 1974. The articles include references to the original publications. The book is out of print, but may be obtainable through a library.

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