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Are Electromagnetic Fields Making Me Ill? How Electricity and Magnetism Affect our Health FREE

Are Electromagnetic Fields Making Me Ill? How Electricity and Magnetism Affect our Health.. Bradley J. Roth 122 pp. Springer, 2022. Price: $29.99 (paper). ISBN 978-3-030-98773-2.

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Are Electromagnetic Fields Making Me Ill? How Electricity and Magnetism Affect our Health. Bradley J. Roth. pp. Springer, 2022. Price: $29.99 (paper). ISBN 978-3-030-98773-2. (Robert G. Olsen, Reviewer.)

Many claims have been made over many years about the interaction of electromagnetic fields with the human body. These claims range from therapeutic to catastrophic. If you are looking for a short (mostly non-technical) introduction to many of the controversies regarding these claims, look no further. The author of this book tackles claims that include pain relief due to magnets, cancer from power lines, therapeutic use of electrical stimulation, and possible side effects of millimeter-wave airport scanners and 5G cell phones. It is designed for nonscientists and contains no math. Nevertheless, it is valuable to those with a technical background but not necessarily in the specific area of bioelectromagnetics. I heartily recommend it.

Each section begins with a short introduction to the background science needed to understand the issue. Following this is an introduction to the specific claims made by the proponents and questions raised by the skeptics. The evidence for and against is laid out and evaluated using the standard methods of good science. These include the results of clinical trials, the use of well-accepted physics (e.g., the skin effect or the impact of losses on resonance phenomena) to evaluate claims, the comparison of exposure levels to known background fields (e.g., noise), critical reviews of the literature, and meta-analyses and expert panel reviews. When appropriate, a point/counterpoint approach is used to help the reader understand arguments made by proponents and skeptics. Finally, Roth summarizes his conclusions.

While the focus is on the specific controversies listed in the table of contents, an even more valuable contribution of the book is the description of Roth's methodology. In describing his approach to evaluating the science (or lack thereof) behind each claim, you will learn some of the thought processes needed to evaluate any new technology. Anyone who adopts these approaches will become a better investigator of new claims.

For many years, I have interacted with proponents and opponents of claims that predicted harm due to electromagnetic field exposure. My observations are similar to those expressed by Roth. Good scientists are careful to evaluate all relevant literature, while those who are not often "cherry pick" the portion of it that fits their narrative. Good scientists also evaluate the quality of each piece of work. Are clinical trials double blind? Has an appropriate placebo been used? Are the numbers large enough to make solid statistical inferences? Are there concerns about the quality of an epidemiological study (e.g., case-control vs cohort)? Good scientists also recognize that "peer review" is not enough to ensure the quality of a paper. While peer review is both appropriate and necessary, it is not perfect. It can be "leaky" and publication bias (i.e., positive results are more likely to be published than negative results) is real. Furthermore, given the variation in quality within the literature, the World Health Organization (WHO) has published a set of guidelines for its assessment of the literature in order to identify the health risks of electromagnetic fields. They state,

> "*All studies, with either positive or negative effects, need to be evaluated and judged on their own merit, and then all together in a weight-of-evidence approach. It is important to determine how much a set of evidence changes the probability that exposure causes an outcome. Generally, studies must be replicated or be in agreement with similar studies. The evidence for an effect is further strengthened if the results from different types of studies (epidemiology or laboratory) point to the same conclusion*".

As mentioned by the WHO, claims can be made stronger (or weaker) if a study or experiment is (or is not) replicated in another laboratory. Both proponents and opponents should believe that replication will bolster their position, and opposition to replication should be suspect. This is especially true in the biological sciences, where experiments are difficult to carry out and replication has been problematic. Also, and consistent with the WHO guidelines, good scientists should also encourage validation of theory with experiments and will wait until this is done before vigorously promoting their claim. Finally, good scientists should welcome the opinions of competent scientists from other disciplines when the claim is inherently multidisciplinary.

A good example of the proper approach to sponsoring research is the EMF RAPID program, sponsored by the federal government through the Energy Policy Act of 1992 to study power lines and cancer issues. Funding was set aside for independent replication of any significant previously reported positive results. In addition, every funded team was required to have expertise in exposure assessment. Both requirements strengthened the results of the program. As a final note, I found the story of the Tucker and Schmitt experiment in the book to be a true cautionary tale. They tenaciously improved their experiment to study whether humans could detect a 1000 μT 60 Hz magnetic field until it obtained a null result. I fear that many would have stopped the experiment short of this and reported an artifact rather than continuing to get less and less significant (and eventually null) results as the quality of the experiment improved. In fact, many might not have either tried to or been allowed to publish such a "null" result.

I do have one (relatively minor) correction and several suggestions for the author. Prior to the Wertheimer and Leeper paper,[1] electric power engineers were mainly concerned about currents induced in the body by the electric fields of power lines. Published values for maximum induced current densities in a typical human body by vertical electric (10 kV/m, 60 Hz) and magnetic (50 μT, 60 Hz) fields were 1.9 and 0.16 mA/m^2 (for the latter at the periphery of the chest—smaller in the middle), respectively.[2] The concern shifted to magnetic fields when the Wertheimer and Leeper paper was published. Also, while I recognize that the book is short, there are several legitimate concerns that could have been included. One is contact current issues, which arise when a person touches a large metallic object immersed in an electromagnetic field with an amplitude that may be smaller than exposure standard levels. Examples of this include shocks when touching objects insulated from the earth in quasi-static electric fields and radio frequency burns when touching resonant structures exposed to high frequency electromagnetic fields. Another legitimate concern is the impact of stray voltage on milk production at dairy farms due to issues in electrical distribution grounding.

One lingering concern I have about many of the issues discussed by Roth is that science has not effectively communicated how improbable some claims are. For example, Roth states that the power line and cancer claim has been "debunked." However, the fact that scientists cannot completely rule out an effect (he quotes Foster and Moulder, who said "impossibility arguments are difficult to sustain in biology") leads to other problems. Given this fact, the (sometimes, somewhat ambiguous) summaries of expert panels can be used in ways that were unintended by their members. Perhaps the most relevant example is that the International Agency for Research on Cancer (IARC) publishes lists of agents or exposures considered to be carcinogenic. Both extremely low frequency (ELF) magnetic fields and radio frequency (RF) electromagnetic fields are listed as "Group 2B (possible) carcinogens." A close examination of the criteria used for identifying these exposures in a particular group provides the proper context for the word "possible." A friend who was a member of the ELF panel told me that the panel voted for the 2B Group (possible) carcinogen rather than the 2A Group (probable) carcinogen because the evidence was so thin. However, these listings by an international body such as IARC are often used in public meetings (without proper context) to give credence to the claim that ELF and RF electromagnetic field exposures are quite dangerous. As a result of this improper usage, ELF and RF exposure issues must still be dealt with by the power and communications industries, costing them appreciable time and effort. Furthermore, there is still a great deal of suspicion (or even hostility) among at least some elements of the public to these industries. For example, electrical utilities (as part of an environmental impact statement) must estimate the magnetic field of proposed power lines. Also, they may still be subject to lawsuits relating to exposure to ELF magnetic fields. As to cell phones, many cities (including my own, where I am a member of the Planning Commission) are spending considerable time discussing regulations for 5G base station installations despite having been told that standards approved by the Federal Communications Commission must be used. As a final note, coffee was removed from the list of IARC Group 2B carcinogens in 2016. Perhaps the same might happen for ELF and RF electromagnetic field exposures.

In summary, this book is a good introduction to the subject and is worth your time to read.

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[1]N. Werthheimer and E. Leeper, "Electrical wiring configurations and childhood cancer," Int. J. Epidemiol. **109**, 273–284 (1979).
[2]EPRI, *Transmission Line Reference Book, 345 kV and Above*, 2nd ed. (Electric Power Research Institute, Palo Alto, CA, 1982).