Nonthermal Bioeffects of Electromagnetic Fields: A Case Study of Scientific Controversy

Carolyn R. Miller
North Carolina State University
ICEMS, Benevento
24 February 2006

Scientific controversy

- EMF research is "deeply tortured" (*Science* 1992)
- new findings violate expectations
- no theory to explain findings
- findings difficult to replicate
- many variables to control
- many disciplines involved

Scientific controversy

anomaly	heresy
novelty	error
puzzle	incompetence
discovery	fraud

"In science, novelty emerges only with difficulty, manifested by resistance, against a background provided by expectation." —Thomas Kuhn

EMF controversy: multiple disciplines

PHYSICAL SCIENCES	BIOLOGICAL SCIENCES
electromagnetism	cell biology
electrical engineering	neurobiology
computer science	epidemiology
physical chemistry	toxicology
etc.	etc.

Physics vs. biology

- "One of man's enduring hopes has been to find a few simple laws that would explain why nature with all of its seeming complexity and variety is the way it is." —Steven Weinberg
- "Surely no biologist would ever express such a hope." —Ernst Mayr

Rhetorical analysis

- What do we look at?
  - premises, values, and assumptions
  - strategies and appeals
  - habits and conventions of communication
  - texts and contexts
- What do we find?
  - intellectual commitments—Part 1
  - socio-political relationships—Part 2

Data sources

- Exchanges about “same” issue
- U.S. scientists, policymakers, journalists
- Mostly during 1990s

Examples of data sources

American Physical Society. 1995. *Statement on Power Line Fields and Public Health*. American Physical Society. http://www.aps.org/statements/95.2.html.
Bioelectromagnetics Society Presidents. 1996. *BEMS Presidents' Letter to the Congress*. http://www.bioelectromagnetics.org/newsletter/news131.html#BM2.

* * *

Adair, R. K. 1991. "Constraints on Biological Effects of Weak Extremely-Low-Frequency Electromagnetic-Fields." *Physical Review A* 43.2: 1039-48.
Adey, W. R. 1993. "Biological Effects of Electromagnetic Fields." *Journal of Cellular Biochemistry* 51.4: 410-16.
Jackson, J. D. 1992. "Are the Stray 60-Hz Electromagnetic Fields Associated with the Distribution and Use of Electric Power a Significant Cause of Cancer?" *PNAS* 89: 3508–10.
Savitz, David A. 1993. "Commentary on Health Effects of Low-Frequency Electric and Magnetic Fields." *Environmental Science and Technology* 27.1: 52–54.

* * *

News coverage in *Microwave News*, *New York Times*, and *Science*, as well as letters and commentary in these and other sources.

Part 1: Intellectual commitments

- Compare habitual argumentative strategies of physical scientists and biological scientists
- Focus on interchanges within scientific community
- Focus on disagreements when looking at “same” data

Examples: Physics

Inconsistency, cause

“Epidemiologic findings of an association between electric and magnetic fields and childhood leukemia or adult cancers are **inconsistent and inconclusive**. **No plausible biological mechanism** is presented that would explain **causality**.” (CIRRPC Report 1992)

Impossibility

“Biological mechanisms … **cannot violate the fundamental laws of physics**.” (Bennett 1994)

Examples: Physics

Reductionism

“… biological … and … epidemiological reports … are usually subjective; experience with **simpler, falsifiable, physical science experiments** has shown that significance levels are generally exaggerated” (Adair 1992)

Appearance vs. reality

“Experimental **errors** have been accepted as **real effects**.” (Adair 1992)

Closure

“Scientifically, it’s essentially **over now**. I hope this **puts the whole issue to rest**.” (Park 1996)

Examples: Biology

Agreement, past fact

“**Laboratory studies** have tested a spectrum of EM fields for bioeffects at cell and molecular levels, focusing on exposures at athermal levels. A **clear emerging conclusion** is that **many observed interactions** are not based on tissue heating.” (Adey 1993)

Future fact or possibility

“As evidence has mounted confirming occurrence of bioeffects of EM fields … there is a mainstream of theoretical and experimental studies **seeking the first transductive steps**.” (Adey 1993)

Examples: Biology

Complexity
"These phenomena are in the realm of **nonequilibrium thermodynamics**, and are thus far removed from traditional equilibrium models of cellular excitation based on depolarization of the membrane potential and on associated massive changes in ionic equilibria across the cell membrane." (Adey 1993)

Openness
"A great deal is **yet to be discovered** about the interaction of EMFs with biological systems." (BEMS Board of Directors 1996)

Intellectual preferences

PHYSICS	BIOLOGY
inconsistency	agreement
cause	past fact
impossibility	possibility
simplicity, reduction	complexity
appearance vs reality	appearance
closure	openness

Intellectual commitments

PHYSICS	BIOLOGY
rational ontology	phenomenological ontology
deductive epistemology	inductive epistemology
closed, axiomatic world	open, empirical world

"The proponents of competing paradigms practice their trades in different worlds."
—Thomas Kuhn

Part 2: Social relationships

- Asymmetrical scientific debate
  - heretical challengers vs defenders of orthodoxy
  - whose orthodoxy?
- Science-based public policy debate
  - multiple interests: commercial, military, health, etc.
  - whose authority?

Defense strategies

- **Forum control** — controlling internal communication through peer review, membership on committees, etc.
- **Strategies of argument** — public correction, ridicule, questioning competence and motives
- **Boundary work** — driving out the heresy and/or the heretic, scapegoating

Forum control

- Disagreements about membership of review panel for 1991 EPA draft report (*Science* 1991)
  - "Physicists have trouble accepting what's going on in the field."
- Disagreements about NCRP committees for RF/MW standards and for revising 1986 report on RF exposure (*Microwave News* 1995)
  - "Where are the biologists?"

Public correction

- **Physicist**: EPA's "findings of a 'positive association' between EMFs and childhood cancer are **'quite incorrect'**" (Bromley in *Microwave News* 1991).
- **Biologist**: The CIRRPC report claims that "electric or magnetic fields could not adversely affect health because the rise in electric power use over time has not produced epidemics of cancer, birth defects, or miscarriage. In fact, the two observations are **true but unrelated**." (Savitz 1993)

Ridicule

- **Physicist**: "If fields of two milligauss really are a serious threat … then commuters on East coast electric trains—where the fields at power line frequencies can be hundreds of times larger—ought to be dying like flies." (Bennett 1994)
- **Biologist**:" Accepting the article by [Bennett] as guidance on the question of health effects of [EMFs] seems to me analogous to accepting the advice of the village blacksmith on how to fix your Swiss watch." (quoted in *Microwave News* 1995)

Questioning motives

- **Physicist**: "The **self-interest** that leads to scientists grossly exaggerating the linkage between their researches and health effects is also enormous." (Adair 1992)

Boundary work

- **Physicist**: "My role as science advisor to the president is to be sure that statements that come out of this administration are based on **sound science**." (Bromley in *Microwave News* 1991)

Scapegoating

- Liburdy sanctioned by NIH Office of Research Integrity
- Physicist: "Liburdy's deception was probably typical for the field." (Park in *New York Times* 1999)

"The very existence of science depends on vesting the power to choose between paradigms in the members of a special kind of community."

—Thomas Kuhn

Conclusions

The EMF controversy

- demonstrates strong and persistent disciplinary differences in intellectual commitments
- illustrates well known patterns of defensive orthodoxy
- is complicated by policy and economic implications

Implications

Precautionary principle affects the conditions of debate

- changes relationship between scientific and policy communities
- keeps options open in conditions of scientific controversy
- allows science to catch up with policy needs

Selected references

Gieryn, Thomas F. 1983. Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists. *American Sociological Review* 48:781–795.

Kuhn, Thomas S. 1970. *The Structure of Scientific Revolutions*. 2nd ed. Chicago: University of Chicago Press.

Lessl, Thomas M. 1988. Heresy, Orthodoxy, and the Politics of Science. *Quarterly Journal of Speech* 74 (1):18–34.

Mayr, Ernst. 1985. How Biology Differs from the Physical Sciences. In *Evolution at a Crossroads: The New Biology and the New Philosophy of Science*, ed. D. J. Depew and B. H. Weber. Cambridge, MA: MIT Press.

Sullivan, Dale. 2000. Keeping the Rhetoric Orthodox: Forum Control in Science. *Technical Communication Quarterly* 9 (2):125–146.

Acknowledgments

- Carl Blackman
- Louis Slesin
- Dale Sullivan

Complete study is available

- Published in *Rhetoric and Incommensurability*, 2005. Ed. Randy Allen Harris. Parlor Press. pp. 464–505. http://www.parlorpress.com/harris.html
- Also on my website: http://www4.ncsu.edu/~crm/publications

Thank you!

Questions?