

## Warning: Your Cell Phone May Be Hazardous to Your Health

Ever worry that that gadget you spend hours holding next to your head might be damaging your brain? Well, the evidence is starting to pour in, and it's not pretty. So why isn't anyone in America doing anything about it?

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EARLIER THIS WINTER, I met an investment banker who was diagnosed with a brain tumor five years ago. He's a managing director at a top Wall Street firm, and I was put in touch with him through a colleague who knew I was writing a story about the potential dangers of cell-phone radiation. He agreed to talk with me only if his name wasn't used, so I'll call him Jim. He explained that the tumor was located just behind his right ear and was not immediately fatal—the five-year survival rate is about 70 percent. He was 35 years old at the time of his diagnosis and immediately suspected it was the result of his intense cell-phone usage. "Not for nothing," he said,

"but in investment banking we've been using cell phones since 1992, back when they were the Gordon-Gekko-on-the-beach kind of phone." When Jim asked his neurosurgeon, who was on the staff of a major medical center in Manhattan, about the possibility of a cell-phone-induced tumor, the doctor responded that in fact he was seeing more and more of such cases—young, relatively healthy businessmen who had long used their phones obsessively. He said he believed the industry had discredited studies showing there is a risk from cell phones. "I got a sense that he was pissed off," Jim told me. A handful of Jim's colleagues had already died from brain cancer; the more reports he encountered of young finance guys developing tumors, the more certain he felt that it wasn't a coincidence. "I knew four or five people just at my firm who got tumors," Jim says. "Each time, people ask the question. I hear it in the hallways."

It's hard to talk about the dangers of cell-phone radiation without sounding like a conspiracy theorist. This is especially true in the United States, where non-industry-funded studies are rare, where legislation protecting the wireless industry from legal challenges has long been in place, and where our lives have been so thoroughly integrated with wireless technology that to suggest it might be a problem—maybe, eventually, a very big public-health problem—is like saying our shoes might be killing us.

Except our shoes don't send microwaves directly into our brains. And cell phones do—a fact that has increasingly alarmed the rest of the world. Consider, for instance, the following headlines that have appeared in highly reputable international newspapers and journals over the past few years. From summer 2006, in the *Hamburg Morgenpost*: ARE WE TELEPHONING OURSELVES TO DEATH? That fall, in the Danish journal *Dagens Medicin*: MOBILE PHONES AFFECT THE BRAIN'S METABOLISM. December 2007, from Agence France-Presse: ISRAELI STUDY SAYS REGULAR MOBILE USE INCREASES TUMOUR RISK. January 2008, in London's *Independent*: MOBILE PHONE RADIATION WRECKS YOUR SLEEP. September 2008, in Australia's *The Age*: SCIENTISTS WARN OF MOBILE PHONE CANCER RISK.

Though the scientific debate is heated and far from resolved, there are multiple reports, mostly out of Europe's premier research institutions, of cell-phone and PDA use being linked to "brain aging," brain damage, early-onset Alzheimer's, senility, DNA damage, and even sperm die-offs (many men, after all, keep their cell phones in their pants pockets or

attached at the hip). In September 2007, the European Union's environmental watchdog, the European Environment Agency, warned that cell-phone technology "could lead to a health crisis similar to those caused by asbestos, smoking, and lead in petrol."

Perhaps most worrisome, though, are the preliminary results of the multinational Interphone study sponsored by the International Agency for Research on Cancer, in Lyon, France. (Scientists from thirteen countries took part in the study, the United States conspicuously not among them.) Interphone researchers reported in 2008 that after a decade of cell-phone use, the chance of getting a brain tumor—specifically on the side of the head where you use the phone—goes up as much as 40 percent for adults. Interphone researchers in Israel have found that cell phones can cause tumors of the parotid gland (the salivary gland in the cheek), and an independent study in Sweden last year concluded that people who started using a cell phone before the age of 20 were five times as likely to develop a brain tumor. Another Interphone study reported a nearly 300 percent increased risk of acoustic neuroma, a tumor of the acoustic nerve.

As more results of the Interphone study trickled out, I called Louis Slesin, who has a doctorate in environmental policy from MIT and in 1980 founded an investigative newsletter called *Microwave News*. "No one in this country cared!" Slesin said of the findings. "It wasn't news!" He suggested that much of the comfort of our modern lives depends on not caring, on refusing to recognize the dangers of microwave radiation. "We love our cell phones. The paradigm that there's no danger here is part of a worldview that had to be put into place," he said. "Americans are not asking the questions, maybe because they don't want the answers. So what will it take?"

TO UNDERSTAND HOW radiation from cell phones and wireless transmitters affects the human brain, and to get some sense of why the concerns raised in so many studies outside the U.S. are not being seriously raised here, it's necessary to go back fifty years, long before the advent of the cell phone, to the research of a young neuroscientist named Allan Frey.

In 1960, Frey, then 25, was working at General Electric's Advanced Electronics Center at Cornell University when he was contacted by a technician whose job was to measure the signals emitted by radar stations. At the time, Frey had taken an interest in the electrical nature of the human body, specifically in how electric fields affect neural functioning. The technician claimed something incredible: He said he could "hear" radar at one of the sites where he worked.

Frey traveled to the facility and stood in the radar field. "And sure enough, I could hear it, too," he said, describing the persistent low-level hum. Frey went on to establish that the effect was real—electromagnetic (EM) radiation from radar could somehow be heard by human beings. The "hearing," however, didn't happen via normal sound waves perceived through the ear. It occurred somewhere in the brain itself, as EM waves interacted with the brain's cells, which generate tiny electrical fields. This idea came to be known as the Frey effect, and it caused an uproar in the neuroscience community.

The waves that Frey was concerned with were those emitted from the nonionizing part of the EM spectrum—the part that scientists always assumed could do no outright biological damage. When Frey began his research, it was assumed that the only way microwaves could have a damaging biological effect was if you increased the power of their signals and concentrated them like sword points—to the level where they could cook flesh. In 1967, this resulted in the first popular microwave oven, which employed microwave frequencies at very high power, concentrated and contained in a metal box. Aside from this engineered thermal effect, the signals were assumed to be safe.

Allan Frey would help pioneer the science that suggested otherwise. At the vanguard of a new field of study that came to be known as bioelectromagnetics, he found what appeared to be grave *nonthermal* effects from microwave frequencies—the part of the spectrum that belongs not just to radar signals and microwave ovens but also, in the past fifteen years, to

cell phones. (The only honest way to think of our cell phones is that they are tiny, low-power microwave ovens, without walls, that we hold against the sides of our heads.) Frey tested microwave radiation on frogs and other lab animals, targeting the eyes, the heart, and the brain, and in each case he found troubling results. In one study, he triggered heart arrhythmias. Then, using the right modulations of the frequency, he even stopped frog hearts with microwaves—stopped the hearts dead.

Frey observed two factors in how microwaves at low power could affect living systems. First, there was the carrier wave: a frequency of 1,900 megahertz, for example, the same frequency of many cell phones today. Then there was the data placed on the carrier wave—in the case of cell phones, this would be the sounds, words, and pictures that travel along it. When you add information to a carrier wave, it embeds a second signal—a second frequency—within the carrier wave. This is known as modulation. A carrier wave can support any number of modulations, even those that match the extra-low frequencies at which the brain operates (between eight and twenty hertz). It was modulation, Frey discovered, that induced the widest variety of biological effects. But how this happened, on a neuronal level, he didn't yet understand.

In a study published in 1975 in the *Annals of the New York Academy of Sciences*, Frey reported that microwaves pulsed at certain modulations could induce "leakage" in the barrier between the circulatory system and the brain. Breaching the blood-brain barrier is a serious matter: It means the brain's environment, which needs to be extremely stable for nerve cells to function properly, can be perturbed in all kinds of dangerous ways. Frey's method was rather simple: He injected a fluorescent dye into the circulatory system of white rats, then swept the microwave frequencies across their bodies. In a matter of minutes, the dye had leached into the confines of the rats' brains.

Frey says his work on radar microwaves and the blood-brain barrier soon came under assault from the government. Scientists hired and funded by the Pentagon claimed they'd failed to replicate his findings, yet they also refused to share the data or methodology behind their research ("a most unusual action in science," Frey wrote at the time). For more than fifteen years, Frey had received almost unrestricted funding from the Office of Naval Research. Now he was told to conceal his blood-brain-barrier work or his contract would be canceled.

Since then, no meaningful research into the effect of microwaves on the blood-brain barrier has been pursued in the United States. But a Swedish neurosurgeon, Leif Salford, recently expanded on Frey's work, confirming much of what Frey revealed decades ago. Salford found that microwave exposure killed rodents' brain cells and stimulated neurons associated with Alzheimer's. "A rat's brain is very much the same as a human's," he said in a 2003 interview with the BBC. "They have the same blood-brain barrier and neurons. We have good reason to believe that what happens in rats' brains also happens in humans'." His research, he said, suggests that "a whole generation of [cell-phone] users may suffer negative effects in middle age."

THE POTENTIAL complications don't end there. In the mid-1990s, a biophysicist at the University of Washington named Henry Lai began to make profound discoveries about the effects of such frequencies not only on the blood-brain barrier but also on the actual *structure* of rat DNA. Lai found that modulated EM radiation could cause breaks in DNA strands—breaks that could then lead to genetic damage and mutations that would be passed on for generations. What surprised Lai was that the damage was accomplished in a single two-hour exposure.

"This was explosive news," Slesin said. "The reason it was so important was at the time you had all these allegations of brain tumors and cell phones being connected"—specifically the 1992 lawsuit brought by a Florida man, David Reynard, against a number of companies that manufactured phones and provided cell service, following the death of his wife from a brain tumor. "If you can break up DNA with cell-phone radiation, suddenly it's not such a stretch to think of brain tumors developing from this radiation."

Galvanized by the Reynard case, Motorola frantically mobilized to reassure its investors. Then, in 1994, the company went on the attack to discredit Lai, issuing a memo, later obtained by Slesin, stating it had "war-gamed" Lai's work. "We do not believe that Motorola should put anyone on-camera," the memo said. "We must limit our corporate visibility." It further stated that the "key question" was whether "this experiment [can] be replicated."

The cell-phone industry funds lots of risk studies, and many of them show no effect from cell-phone-related radiation. The industry pointed to those favorable studies when countering Lai's DNA findings. (In 2004, it should be pointed out, a European Union-funded study carried out by twelve research groups in seven countries found evidence of genotoxic effects resulting from cell-phone radiation—the same kind of DNA damage that Henry Lai uncovered in the 1990s.) But when Jerry Phillips, a scientist with the Veterans Administration whose work was funded by Motorola, replicated Lai's findings, the company put him under so much pressure not to publish that Phillips abruptly quit microwave research altogether.

Industry-funded studies seem to reflect the result of corporate strong-arming. Lai reviewed 350 studies and found that about half showed bioeffects from EM radiation emitted by cell phones. But when he took into consideration the funding sources for those 350 studies, the results changed dramatically. Only 25 percent of the studies paid for by the industry showed effects, compared with 75 percent of those studies that were independently funded.

The cell-phone industry has managed to exert its influence in other ways, too. In the United States, the organization most influential in the government's setting of standards for microwave exposure is the Institute of Electrical and Electronics Engineers (IEEE), which bills itself as "a leading authority on areas ranging from aerospace systems, computers, and telecommunications to biomedical engineering, electric power, and consumer electronics." According to Slesin, "The committees setting the EM safety levels at the IEEE historically have been dominated by representatives from the military, companies like Raytheon and GE, the telecom companies, and now the cell-phone industry. It is basically a Trojan horse for the private sector to dictate public policy." The IEEE's "safe limits" for microwave exposure are considerably higher than what they should be, says Allan Frey, who was a member of the organization in the '70s. "When it comes to this matter, the IEEE is a charade," Frey told me.

There have been attempts over the years to set exposure limits based on something other than industry and military preference. In the '70s and '80s, the Environmental Protection Agency was foremost in this effort. But with Ronald Reagan in office, antiregulatory sentiment crested and the EPA's research and standards programs were gutted.

Among the EPA's most talented bioelectromagnetics experts at the time was Carl Blackman, who has worked at the agency since its inception in 1970. Blackman's research at the EPA would advance much of what Allan Frey and others had discovered: The effects from EM fields were many and troubling, though far from fully understood. In 1986 the EPA killed Blackman's research entirely. Carl Blackman believes "a decision was made to stop the civilian agencies from looking too deeply into the nonthermal health effects from exposure to EM fields. Scientists who have shown such effects over the years have been silenced, had funding taken away, been laughed at, been called charlatans and con men. The goal was to only let in scientists who would say, 'We know that microwave ovens can cook meat, and that's all we need to know.'" One veteran EPA physicist, speaking anonymously, told me, "The Department of Defense didn't like our research because the exposure limits that we might recommend would curtail their activities."

Industry influence appears to have permeated even the purest international watchdogs, such as the World Health Organization. Slesin unearthed a hoard of documents showing that hundreds of thousands of dollars from the cell-phone industry was doled out to WHO personnel working on wireless health effects. Some of the heaviest pressure falls on the Federal Communications Commission, for obvious reasons. In 2005 the specially appointed thirty-member Technological Advisory Council to the FCC sought to look into EM effects on human beings. According to one member of the TAC who

spoke anonymously, officials at the FCC "told us we couldn't talk about that. They would not give us any reason. The FCC people were embarrassed and terrified."

If all this sounds like some abandoned *X-Files* script, consider the history of suppression of evidence in the major issues of consumer health over the past half century. Big Tobacco hid the dangers of smoking and the addictiveness of nicotine, supporting its position with countless deceptive studies. Asbestos manufacturers hid evidence that the mineral was dangerous even as tens of thousands of workers died from exposure; the makers of DDT and Agent Orange stood behind their products even as it became clear that the herbicides caused cancer. That the cell-phone industry, which last year posted revenues in the hundreds of billions of dollars, has an incentive to shut down research showing the dangers of cell-phone use is not a radical notion.

CELL TOWERS, AS YOU'D IMAGINE, also emit EM radiation in the microwave spectrum, and while the science is much less exhaustive than that associated with handsets, the installations have nonetheless incited violence in various places around the globe. In Spain and Ireland, saboteurs have taken to destroying cell towers, cheered on by the communities living in their shadows. In Sydney, Australia, a retired telecom worker, convinced that cell towers had sickened him, hijacked a tank in the summer of 2007 and rammed six towers to the ground before police were able to leap into the vehicle and subdue him. In Israel, which has the seventh-highest per capita use of mobile phones in the world, attacks on towers have become a regular occurrence in recent years in both Jewish and Arab communities. Two years ago in Galilee, a Druze community protested the erection of a new tower, claiming that the towers already in their midst had caused cancer rates to skyrocket. The tower was built anyway; soon after, local teenagers burned it down. When the police came for them, the Druze rioted, injuring more than twenty-five officers.

Here, in the U.S., there's been very little resistance to the march of the cell towers. In fact, in Congress there's been almost nothing but support. The Telecommunications Act of 1996—a watershed for the cell-phone industry—was the result, in part, of nearly \$50 million in political contributions and lobbying largesse from the telecom industry. The prize in the TCA for telecom companies branching into wireless was a rider known as Section 704, which specifically prohibits citizens and local governments from stopping placement of a cell tower due to health concerns. Section 704 was clear: There could be no litigation to oppose cell towers because the signals make you sick.

When President Bill Clinton signed the TCA into law in February 1996, the rollout of "personal communication services," marketed as PCS, was in full swing. By the end of the year, telecom companies had paid the federal government more than \$8 billion to purchase portions of the microwave-frequency sequence. (According to the FCC, fees paid for allocation of spectrum as of 2009 amounted to \$52 billion.) Almost immediately, cell-phone antennas sprang up across the country, appearing on church steeples and apartment buildings, in parks and along highways, on streetlights and clock towers and flagpoles. One industry estimate tallied 19,850 such installations in the U.S. in 1995. Today there are 247,000, most hosting multiple antennas.

In a study by researchers associated with the venerable Karolinska Institute in Stockholm, which hands out the Nobel Prize for medicine, the massive expansion of digital PCS in Sweden during 1997 was found to have coincided with a marked but subtle decline in the overall health of the population. Might it be, the Karolinska researchers asked, that Swedes fell victim to the march of the first big microwave PCS systems? The number of Swedish workers on sick leave, after declining for years, began to rise abruptly in late 1997, according to the study, doubling during the next five years. Sales of antidepressant drugs doubles during the same period. The number of deaths from Alzheimer's disease rose sharply in 1999 and had nearly doubled by 2001. The authors of the study—Olle Johansson, a neuroscientist, and Örjan Hallberg, a former environmental manager for Ericsson, the Swedish telecommunications company—"found that for all individual counties in Sweden there was a similar precise time" when health worsened. It occurred, they said, almost simultaneously with the rollout of the new digital service. Correlation does not mean causation, but epidemiologists I

spoke with say the data are strongly suggestive and need to be followed up. (In other studies at the Karolinska Institute, Johansson has posited that adverse reactions to cell-phone radiation may develop only after long periods of exposure, as the immune system fails, much in the way that allergies develop.)

ALL OF THESE concerns—the danger of microwaves issuing from the phones we place next to our skulls, the danger of waves emitted by the cell towers that dot our landscapes—also apply to the Wi-Fi networks in our homes and libraries and offices and cafés and parks and neighborhoods. Wi-Fi operates typically at a frequency of 2.4 gigahertz (the same frequency as microwave ovens) but is embedded with a wider range of modulations than cell phones, because we need it to carry more data. "It never ceases to surprise me that people will fight a cell tower going up in their neighborhoods," Blake Levitt, author of *Electromagnetic Fields: A Consumer's Guide to the Issues and How to Protect Ourselves*, told me. "They they'll install a Wi-Fi system in their homes. That's like inviting a cell tower indoors."

In the summer of 2006, a super-Wi-Fi system known as WiMAX was tested in rural Sweden. Bombarded with signals, the residents of the village of Götene—who had no knowledge that the transmitter had come online—were overcome by headaches, difficulty breathing, and blurred vision, according to a Swedish news report. Two residents reported to the hospital with heart arrhythmias, similar to those that, more than thirty years ago, Allen Frey induced in frog hearts. This happened only hours after the system was turned on, and as soon as it was powered down, the symptoms disappeared.

Today, Sprint Nextel and Clearwire are set to establish similar technology across the U.S., with a \$7.2 billion government broadband stimulus speeding the rollout. A single WiMAX system would provide Internet coverage for an area of up to 75 square miles. "This means an even denser layer of radio-frequency pollution on top of what has developed over the last two decades," Blake Levitt says. "WiMAX will require many new antennas."

The concern about Wi-Fi is being taken seriously in Europe. In April 2008, the national library of France, citing possible "genotoxic effects," announced it would shut down its Wi-Fi system, and the staff of the storied Library of Sainte-Geneviève in Paris followed up with a petition demanding the disconnection of Wi-Fi antennas and their replacement by wired connections. Several European governments are already moving to prohibit Wi-Fi in government buildings and on campuses, and the Austrian Medical Association is lobbying for a ban of all Wi-Fi systems in schools, citing the danger to children's thinner skulls and developing nervous systems.

I DROVE DOWN to Annapolis, Maryland, recently to visit with Allan Frey. He was preparing to set out on his forty-foot sailboat for a month at sea, so we talked at a restaurant near the marina. After retiring from full-time research in 1985, Frey, now 75, took up the philosophy of science as an avocation, looking at the question of how science progresses, how it fails to progress, how new ideas are birthed or aborted, how a shift in paradigm is a rare thing. The failure to look squarely at the dangers of microwave radiation is a case study in frozen paradigms, he said, a worldview that can't keep pace with reality.

To illustrate what he meant, Frey held up a glass of water. "We're all just big teacups, bags of water that you can heat up—that's the paradigm," he said. It's the engineer's paradigm, the mind-set of people who had no training in the complexity of living systems. The branches of the military, the major defense contractors, the manufacturers of microwave ovens, the telecom companies, were happy to embrace the engineer's paradigm. The thinking was simple and easy to understand, and most important, it indemnified their operations from liability.

"It's a very primitive mind-set," said Frey. "Plato said we don't see the reality; we see shadows on the cave walls. We've got a lot of people who are seeing shadows and saying this is the reality." He nodded at his water glass. "We now know a human being isn't a bag of water. A human being is a complex organization of electrical fields. Electroencephalograms and electrocardiograms, for example, measure these fields. Every cell has an electrical field across the cell membrane,

which is a regulatory interface and controls what goes into and out of the cell. All nerve signals are electric. And between the nucleus and the membrane there is an electrical field, you can measure voltages of individual cells! Electricity drives biology. We evolved in a particular electromagnetic environment"—the magnetic fields from the earth's iron core, the terrestrial magnetism from lodestones, visible light, ultraviolet frequencies, lightning—"and if we change that environment as we have, we either adapt or we have trouble."

Later, after Frey and I parted, I walked around Annapolis and took note of the number of cell towers poised atop the buildings, the number of people who talked on their cell phones. They were everywhere, and after a while I stopped counting. At one point, I watched two women pacing in a parking lot, heads bent against their microwave transmitters. They talked and talked and aimlessly circled. When I got home, I looked up a line from Orwell that I couldn't quite remember as I watched them, about the power that machine technology would exert over mankind. "The machine has got to be accepted, but it is probably better to accept it rather as one accepts a drug—that is, grudgingly and suspiciously," Orwell wrote. "Like a drug, the machine is useful, dangerous and habit-forming. The oftener one surrenders to it the tighter its grip becomes."

Modern society, needless to say, is in the grip of wireless technology. All you have to do to understand this is step outside your door. "It just so happens," Frey had told me, "that the frequencies and modulations of our cell phones seem to be the frequencies that humans are particularly sensitive to. If we had looked into it a little more, if we had done the real science, we could have allocated spectrums that the body can't feel. The public should know if they are taking a risk with cell phones. What we're doing is a grand world experiment without informed consent." As for Louis Slesin's question—what will it take to change the paradigm?—Frey shook his head. "Until there are bodies in the streets," he said, "I don't think anything is going to change."

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