

THE DOCTOR WHO DANCED WITH THE DEVIL

The desire to tell the truth is therefore only one condition for being an intellectual. The other is courage, readiness to carry on rational inquiry to wherever it may lead. . . . —**Paul Baran**

Herr Professor Doktor Franz Adlkofer was flummoxed. For close to two decades, this tall, powerful man was someone everyone wanted to know. Adlkofer had the one thing on which all scientists depend—lots of ready money. His job was to dispense millions in euros to scientists around the globe investigating one of the most profitable gaseous mixtures—tobacco smoke. So long as the questions they were asked to study seemed like serious science, professors found ways to accept tobacco moneys, hire more research assistants, and publish their research. The urbane, multilingual Adlkofer was used to being listened to.

He was not used to being marginalized.

A frequent spring time visitor to Greece, he had ambled through the harbor streets of Piraeus, just outside Athens, many times. Hewing to the cooler shaded sidewalks of the big old buildings at Platia Karaiskaki near the bus station across from the Metro, he would stay out of the sweltering heat. At the start of his visit to his Greek home, he bought tickets on the regular ferry to the island of Paros. He avoided the street hustlers on Nikis Street who sell gullible tourists fake Rolexes and pricey tickets for cruises when all they want is a simple ferry fare.

Surrounded by rich green vines and gardens of olives, oranges, and pomegranates, Paros rests on cool, white marble rising out of the sea. Adlkofer's home, like most of those on this Cycladic island, was built with flat roofs, thick whitewashed walls, and bright blue painted doors, window frames, and shutters. Paros offered a safe, solid haven and cool, steady sea breezes.

At the beginning of the summer in 2008, the air full of the scent of flowers, Adlkofer was preparing to take a string of slow car ferries that would bring him back to Germany. First, his wife and he had sailed on the ferry back to Pireaus. From that bustling port they had to drive the serpentine coastal road to Patras, where three months earlier they had booked the slow overnight boat to Venice. Adlkofer knew that, like most of the seaside roads of Greece, the road to Patras had no guardrails. Every month or so, someone drives over the edge. But he'd planned the journey meticulously and made the drive without incident.

Just a half hour after his arrival in Patras, at about ten o'clock, Adlkofer was about to board and secure space for his car. The late sunset had just given way to a glistening moonlit sea.

But the darkness that hit Adlkofer as he was about to set foot on the ferryboat ramp would shatter his end-of-summer reverie. While looking out at the Aegean, taking in the salty air, the muffled but persistent ring of his cell phone startled him. He had not remembered turning it on. He rummaged for it in his hand luggage, unsure of where it was. He thought that whoever was calling probably had the wrong number. But he hastened to grab the phone to be

sure that nothing important was wrong. As he pressed the speaker button, he heard the distraught voice of his senior colleague Herr Professor Doktor Hugo Rüdiger. Blood drained from his face as he listened. His decades-long, distinguished scientific career was kaput. Adlkofer had been accused of fraud—the kiss of death for any scientist. He had just stepped onto the ferryboat deck but could not move.

THE DANCE

For years, as the chief of tobacco research in Germany, Adlkofer had danced with the devil. He had produced dazzling technical research that kept executives at Reemtsma, Sturm-Zigaretten, and other German tobacco firms confident of their strategy of investing in complicated scientific work. The complexity of the science became a kind of shield. We don't precisely understand how the more than four thousand compounds in tobacco smoke work, they reasoned. We just know that combined they cause an enormous risk to the health of people. Therefore, let's make the products less harmful.

Of course, Adlkofer himself never smoked and never would. But like many scientists who grew up in postwar Germany, he knew a good opportunity when he saw it. Adlkofer had held sway over the expansive German tobacco research empire because he managed to have it both ways: He told the truth where he found it, and what he found about the way that tobacco affected living cells was often more complicated than convenient. For a long while his work did dovetail with commercial interests, but ultimately it did not.

When Adlkofer spoke about all this to me one hot summer day in Vienna, he was determined to convince me that becoming the chief of the scientific department of the German Industry Association had been merely a sensible career option. We sat outside the nineteenth-century wedding cake structure of the Hotel Regina, on a terrace surrounded by tired-looking palm trees, drinking mineral

water. Occasional breezes cooled the humid ninety-degree temperature. Even the ants moved slowly across the granite pavers beneath our feet.

Adlkofer explained that early in his professional life, dazzling technologies that deciphered the most basic operations of cells enthralled him. He had spent hours riveted by images of the engines of cellular life—mitochondria—that fueled all growth. He longed to spend a lifetime exploring the exquisite complexity of living matter. “In 1975, in Berlin when I finished my medical training in endocrinology and internal medicine, there were no jobs for me, none at all. Prized posts in academic medicine were almost inherited, passed down from one mentor to another. You had to wait for someone to die to get one.

“I had a wife and young family and had achieved some distinction academically. All of a sudden an invitation from industry arrived. I was surprised when I met people in the tobacco research group who were totally different from the people who work with tobacco today. These were not the slimy bastards I’d expected, but honorable people with what looked like important questions. Germany had its own cigarette industry. The bosses of this industry suffered personally. They got it. They knew that their product was killing people.”

As he talked, I sat with my arms folded, feeling skeptical.

Adlkofer flashed a tight smile that told me to hold my fire. He took a sip of sparkling water and went on.

“The Germans believed there simply had to be a way to make smoking safer, they really did. So they went about

collecting a lot of scientists around them who would advise them about how to do this. They needed someone to organize the scientists who understood the work and who could work alongside them and get things done.”

Even in his seventies, Adlkofer has a commanding, confident air. Standing more than six feet tall, he has a large forehead and an assertive voice. He comes from a family of organizers. His father survived as a prisoner of war in Italy directing inmates to carry out sanitation projects. As a young man, Adlkofer had served as an officer in the German army on various education efforts. He retains the demeanor and the temperament of someone used to giving orders and having them followed.

With my chin in my hands, my elbows on the table, I’m sure I didn’t look convinced. I wasn’t.

“I can appreciate that you find all this hard to believe, but I was given what I thought was the chance of a lifetime. My research council on smoking and health had the leading scientists in the medical field simply because tobacco money could provide funding when there was frankly nothing else available. Our German bosses believed that there had to be a real chance that their product could be improved. They really, really believed this. The Americans never did.

“All of a sudden, I was working with the highest ranking scientists in the entire world. We had enough money to do so.”

He paused, looked up, and moved both his open hands over the tabletop, then thudded his palms onto the table and repeated, “We had a lot of money.”

I nodded hesitantly as he continued.

“This went on for years. Our funds supported conferences, graduate students, postdocs, publications, and lots of trips to attend meetings and even issue special issues of journals based on select conferences—all the usual sorts of scientific work that people still struggle to support.”

IN THE DECADES following the war, the sense that science could be value-free and open had been hailed as the mark of a democratic society. The philosopher Karl Popper argued in *The Open Society and Its Enemies*—his two-volume work published during World War II—that a truly free marketplace of ideas was central to democracy. In his essays Herbert Marcuse, an intellectual father of sixties student revolutionaries, countered that only science that served political and economic justice would prove worthwhile. Germany’s population continued to reel from the corruption of science and technology under the Nazis, and wanted to believe in the neutrality of good, honest scientific investigation. In such a culture, where research money came from to support science might reasonably be seen as unimportant.

The Free University of Berlin, where Adlkofer completed his medical training, was free but not much of a university in the early 1970s. Still isolated by the Soviet Union’s “iron curtain,” West Berlin remained more or less dependent on the air bridge the Allies had set up decades before. New graduates, like Adlkofer, from East Berlin, were treated as though they were tainted by the communism that pervaded the region. Encircled by walls, guns, and tanks within sight

of the rubble of East Berlin, young researchers had limited resources and avenues for advancement.

Those living within university walls, real or imagined, tend to maintain a cocky disinterest in practical matters. Freud once said, clearly referring to himself, that those who become scientists tend to have the habits of mind that make them appear far older and more serious as children. A photo of the five-year-old Sigmund in the Freud Museum in Vienna shows a suited and bespectacled young boy seated at a huge desk, looking like a junior professor. As adults scientists manage to retain the bold curiosity, playfulness, bravado, sense of immortality, and indifference to doubt of the young. In my meetings and correspondence with Adlkofer, I found the symmetry uncanny. Here was a man who looked like central casting's version of a somber gray eminence with the audacity of an adolescent.

To the annoyance of his tobacco industry patrons, by 1992 Adlkofer began to make a simple argument. We know that tobacco is killing people and we know that nicotine becomes a hard habit to kick because of what it does to the brain. But if we can find a way to isolate or remove the most damaging components of tobacco, we can halve the toll of lung cancer and let people smoke in a safer manner that will also be highly profitable.

The tobacco industry had a problem. They had started out dispensing funds generously throughout the impoverished university system to generate public confusion and buy scientific goodwill. There were growing complaints that they couldn't control Adlkofer. After all, like the defiant adolescent who never quite grows out of

the role of provocateur, he had repeatedly produced a body of work showing that smoking was a public health catastrophe.

Adlkofer was ready to move on but perhaps not as ready as the tobacco industry was for him to do so. The deal they cut was simple. In 1993, Adlkofer got start-up money to become head of a new foundation—the Verum (the Latin noun for “truth”) Foundation— focusing on narrow scientific questions, devising models and methods for studying how the brain responded to various cues from the environment. It would be funded by tobacco money for several years. The scientific truths that Verum began to uncover would turn out to have a much longer life.

At the time, antitobacco activists smelled a rat. Watch out, they said, he is just going to distract people from realizing how bad tobacco really is.

Not surprisingly, Adlkofer started at Verum detailing the addictive effects of nicotine on the brain. But within two years Verum had begun broader studies of proteins that can affect the speed with which the brain thinks, hears, or reacts. The research moved from dissecting nicotine to identifying other agents that harm nerve cells and underlie Alzheimer’s, Parkinson’s, and other devastating syndromes of a degenerating nervous system like autism. The Verum-funded researchers knew that, like cancer, most cases of these diseases do not come about because of who your parents are but because of what happens to you after you are born. While degenerative diseases of the brain have a range of names and limited types of treatments, they share

one thing: All include strange abnormalities and clumping of proteins.

In securing support for his ambitious neuroscience research program, Adlkofer played scientific double agent. To the original tobacco industry funders, he was adding legitimacy to their enterprise and moving on and out of their hair by taking their money to do credible and basic work on mysteries of the brain. To tobacco critics, he was ending the pretense that there was any way to make tobacco smoking healthy and switching to other even more esoteric work.

As the twenty-first century began, Verum and Adlkofer achieved a major coup. The European Union awarded the REFLEX group of laboratory collaborators that Adlkofer led five million dollars to study electromagnetic signals, including the sort that come from cell phones. Might these affect our brains? Fundamentally, Adlkofer didn't think this was possible. He knew that most scientists felt that low levels of radio frequency radiation could not have any impact on neurons. Still, people were beginning to ask what the new cell phone technology might do to their brains and bodies. And this was the kind of question he had devoted his life to investigating.

In 1993, fewer than 1 percent of all Americans used cell phones. That same year, the family of Susan Reynard of Tampa, Florida, filed a lawsuit claiming that her deadly brain tumor had been caused by her unusually heavy use of one of those older clunky cell phones. Within a week of her widower David's appearance on Larry King Live discussing the case, stock prices for phone companies and service

providers dropped about 10 percent. The filing of a lawsuit alleging that any technology produces a serious health problem is not easily undertaken. Such a suit usually only happens after attorneys and experts have concluded that there is merit to the matter and that they are willing to put up the time and money to pursue it. Other claims soon followed.

By 1997, Congressman Edward Markey, chair of the House Subcommittee on Telecommunications and the Internet, expressed serious doubts about whether the widely touted multi-million-dollar industry-governmental partnership to study cell phones and health with the Cellular Telecommunications Industry Association (CTIA) could produce reliable and independent results. The congressman called for a firewall to be created to assure that the research was carried out without improper influence. As a result, the Wireless Technology Research Limited Liability Company (WTR) came into existence. The industry was not comfortable with all this public attention coming just as the marketing of cell phones was about to take off. It seems likely they saw the new body as a good hedge. The head of the twenty-five-million-dollar WTR was a lawyer-scientist, George Carlo, who had defended the chemical industry when it was under fire for dioxin pollution. By 2000, more than a hundred million phones were in use in the United States and more cases alleging that brain tumors had been caused by cell phones had been filed. The very existence of a large ongoing research program provided a sort of sop to those who expressed any

concerns: Trust us. We are so concerned about the issue that we are spending lots of money studying it.

Adlkofer recalls, “Before we began our own study of cell phones, Verum had supported the work of Michael Repacholi at the World Health Organization. Repacholi had a sophisticated view of the issue. Let’s just say he was inclined toward the idea that we needed to find out if electromagnetic signals pose a health risk.” “So,” I said, “Repacholi knowing your tobacco history thought of you as someone who was, shall we say, a bit flexible?”

Adlkofer took this as an affront. “Well, of course, any sensible scientist knows that if you could actually make tobacco less toxic, that would have been a good thing. But that was not what we focused on then. As to radio frequencies, what little I knew about the topic told me that it simply had to be safe. We hypothesized that if we were to run the studies on radio frequency radiation using live cell cultures in our laboratory and did not see anything happening at this cellular or molecular level, we could conclude it would be a waste of money to do any further research. Our a priori opinion was that we would find no health effects at all from radio frequency radiation.”

A NEW FINDING?

In 2000, Adlkoker's team started the REFLEX project within the fifth European Framework Programme. Under carefully controlled conditions, Verum researchers worked with two different types of cells. Human cells and animal cells taken from rodents were each subjected to levels of radio frequency radiation found in cell phones. Exposed and unexposed cells were then run through an array of laboratory exams to see if exposed cells looked any different in how they communicated, healed, or died. Groups of scientists working at a dozen different institutions across Europe were examining whether radio frequency signals had any impact on the complex acid making up the genetic materials of all cells— our DNA.

Adlkofer says, "After several months of research, I got the first information that there is something strange going on. It looked like radio frequency was damaging cells. So the first thing we did was to look at the equipment to see if there was some problem. Our idea was that this equipment we were using must not be not good enough. Our equipment belongs in a museum. I just did not believe these results could be true."

Problems with measuring equipment can create all sorts of strange findings. Many scientists scrounge for funds for their labs to get reliable microscopes, centrifuges, and good old-fashioned refrigerators. Some become adept at shopping at bankruptcy sales for spare parts. Adlkofer was in a different league. He didn't need to worry about such things.

“We had lots of money, so we went out and got brand-new equipment. We set it all up carefully. And we ran the work again, exposing the cells to RF and looking inside at their DNA. And again we found the very same effects. The DNA from the exposed cells looked sick. We saw an increase in DNA strand breaks. Not just in one of our laboratories, but in two separate facilities, in Charité in Berlin, also in Vienna. We were astonished.”

The cell phone industry was also stunned. It had never imagined that one of its own—so to speak—a man whose reputation had been cut by working with the tobacco industry—might prove to be difficult to control. The REFLEX team had followed all the rules. First they issued a number of posters and papers explaining the results to scientific conferences full of intense, earnest young and old scientists eager to be seen as on the cutting edge of various specialties. Then they repeated the same tests and got the same results in different laboratories. Finally, they submitted the work for publication and it went through the usual process of review, where experts try to pick apart the interpretation. Having survived these gauntlets, the REFLEX results finally appeared as a series of publications, all showing an increase in profound disruption of genetic material—DNA strand breaks. The teams also consistently found increases in a type of damage called micronuclei, which proves the existence of serious genetic defects leading down the path to cancer. The normal nucleus at the center of healthy cells contains all that is needed to keep things under control. Deformed copies of the nucleus,

micronuclei, demonstrate that this cell will not be able to continue its normal life.

This was yet another scientific finding that displeased the cell phone industry. Nearly ten years after Lai and Singh's comet assay and its demonstration, and forty years after the Office of Naval Research had sponsored studies finding biological impacts that few ever heard of, here was even more incontrovertible evidence that DNA could be damaged by radio frequency of precisely the sort used by the latest generation of phones—both 2G and 3G. This kind and extent of DNA damage became a very inconvenient fact of life—one that could not be allowed to stand unchallenged. These results were seen by the industry as a major public relations problem requiring a strong and swift response: Deny that the analysis could possibly be valid. Attack those who did the work.

And secure others to come up with studies that look just like those you don't like that manage to reach opposite conclusions.

A BURIED FINDING

Adlkofer's team did not know much about the details of Lai and Singh's work from 1996, which had pretty much been dismissed after more and more studies were soon published that failed to reproduce the same results. At that point, few working in the field had heard about extensive work carried out nearly half a century earlier by Frey and others—long before cell phones had been commercialized—showing that radio frequency radiation could break the brain barrier and interfere with other biological membranes. In 1960, when the navy was forging improved types of radar, neuroscientist Allan Frey, then with Cornell University's General Electric Advanced Electronics Center, had become curious about the impact on the nervous system of electromagnetic fields moving at the speed of light. A fellow who had been tasked with measuring signals released by radar stations told Frey that he could "hear" radar.

At the time, psychiatrists treated people who claimed to hear radio signals inside their heads as delusional schizophrenics. Frey was understandably skeptical. But this radar technician seemed perfectly sane. He was. When Frey traveled to the radar station near Syracuse, New York, to listen for himself, he heard the same strange humming sound as well.

When we met in Annapolis in the spring of 2010 to discuss this work, Frey explained that, in the effort to ramp up American science capacity during the Cold War, he had been one of those chosen to receive extraordinary

resources to explore basic scientific questions. “I was frankly just curious about lots of things back then and I had the freedom to explore basic science questions because the Office of Naval Research gave me unrestricted support. So I went with this fellow to the station where he worked. Sure enough, I heard a sound that I knew was not going through my ears but echoing inside my head, a kind of low soft sibilant Zzzzipppp. Zzzzipppp, zzzzippp.”

“How could you be sure where it was coming from?” I asked. “I made a kind of crude shield out of a metal screen. I knew that metal would block microwave signals of radar. Whenever I held this screen between his head and where the radar was coming from, the sound would disappear. When I removed the screen, the sound would return. I tried it myself and the same thing happened.”

By the end of this visit, Frey was convinced that the hearing nerve was resonating in some way with the radar beam. Frey also realized that the sounds that were being heard were not coming from conventional sound waves that moved externally through air, hitting the eardrum and moving up the acoustic nerve to the brain to register as noise. In fact, the hum was being produced within the brain itself, which is why blocking the radar blocked the sound. This meant that electromagnetic waves from radar directly reached nerve cells within the brain and created tiny vibrating fields. The capacity of electromagnetic fields to cause the brain to hear sounds stunned neurobiologists. During World War II, men working close to radar equipment had also reported what became known as the

microwave auditory effect—later dubbed the Frey effect for the man who first reported it in the scientific literature.

The ability of microwave signals to produce sound within the brain stunned the neuroscience community. But the Frey effect remained little known outside of a small community of scientists and was not known to Adlkofer or other scientists who undertook basic studies on the impact of radio frequency on brain biology nearly three decades later.

In the days before the Internet, it was not at all hard to keep collaboration between the Department of Defense and universities under wraps.

The sheer complexity of bioelectromagnetics—as the field Frey helped to invent came to be known—made it easy. Few of us then or now have more than the most rudimentary grasp of electricity, where it comes from, how it's made, and what it can do to our health. To most of us electricity is that thing that happens when we turn on the light switch or plug in the hair dryer. As Frey's work evolved—and its implications became clear at least to some—those funding his efforts at the Office of Naval Research offered him the sort of friendly advice that no scientist could afford to ignore.

Frey determined that the carrier wave of 1,900 megahertz— precisely the same wavelength used by many cell phones today— interacted with the voices and noises carried on that wave, the data, in some important ways. Inject a mouse with blue dye in its blood—something a curious scientist did earlier in the last century—and the entire body and all of the organs turn blue, with one

exception. The brain remains pink-gray. The brilliant Russian biochemist Lina Solomonova Stern theorized in the 1920s, when she first did this work, that the brain is protected from taking in poisons or contaminants that get into the bloodstream by what is called the blood-brain barrier. By the 1960s the truth of this view had been made clear when electron microscopy traced the movement of injected dye through the bloodstream. Even when toxic blue agents enter the blood, this barrier will block them from entering the brain.

Frey soon found a way to change that. He showed that radio frequency signals—just like those from today's cell phones— opened up this normally closed barrier. Frey first injected a dark dye into the bloodstream of standard laboratory Sprague-Dawley white rats. Then he exposed these rats to pulsed microwave signals. Within a few minutes the brains of the injected rats that had been microwaved began to turn bright yellow-green, signaling that the blood-brain barrier had been breached. Brain cells need all the protection they can get to work normally. Frey's studies were reported in the Annals of the New York Academy of Sciences in 1975. Adlkofer had never seen them.

THE FREY EFFECT BESIEGED

In 1974, Om P. Gandhi had just started working in this field as a consultant to Walter Reed Army Medical Center. In 1973, he had been offered funding to conduct research with the military on radio frequency for four months, so he left his young family and worked from August to December in Reed's barracks laboratory.

“One thing I studied was this so-called auditory phenomenon that everybody had heard about from Frey. People were scratching their heads about this. I said we could set this up and see if this was real or not. We used a horn antenna with pulsed power. With continuous wave you get nothing. But with jagged, pulsed signals like those that power today's smart phones, we could produce this sound. “Bill Guy and the fellows that asked me to study this were well supported by the Defense Department and frankly doubted what Frey had reported. So I sat there myself and I could hear that sound. So could some of the young men who were working with us. As you changed the pulse rate to higher and higher rates per second, you could hear the tones change as well. But it was mostly a kind of low drone or hummmmmmmmm, hummmmmmmmm, hummmmmmmmm.

“Of course, Guy had suggested the experiment because he did not believe it. As I think back on it, they were determined to find some way to indicate that the Frey effect had been an artifact—not a real thing—but something that happens in an experiment because of the way things were set up. At the time, I was just getting started in this field and did not understand that there were

people out there who simply did not want to believe that microwavelike radiation could have any biological impacts. To show them that there was something real and physical going on, I crumpled up some paper and did the study again. When it was exposed to pulsed radio frequency signals, the paper would rattle. I crinkled up some aluminum foil, and it also would shake. Everybody could hear this sound made by the radio frequency radiation reverberating, because the quivering foil or paper made sounds of their own when the radiation hit.

“Although I was a senior professor in microwave engineering, I was a newcomer in the field of biological impacts of electrical matters, so I published this as simply showing that Frey had been right and let it go. A year or so later, Guy, who was senior to me in the field, decided that I had been wrong and that a thermoelastic (heat-based) wave had caused this sound. Guy was an electrical engineer who was pretty powerful and influential at the time. And I knew better than to tussle with him. He had money and clout and held sway over everyone in the field then and for a long time afterwards.”

Despite the work of Frey, Lai, Gandhi, and others, along with Adlkofer’s confirmation that microwave-like radiation from cell phones induces biological damage, the science continues to be debated. In many instances what looks like refutations of research turn out to be poor imitations. Over the past several years, Lin, an ICNIRP member, has produced a number of papers appearing to refute Frey’s work on the ability of pulsed microwave radiation to induce sounds in the brain. In point of fact, Lin’s critiques ignore

Frey's primary paper on the topic that appeared in Science magazine in 1979. Using holography, an exquisitely sensitive technique that does not destroy tissue, Frey found that microwave pulses do not create motion in soft tissue. Lin's studies finding a signal on the auditory nerve resulted from an experimental artifact. The tiny electrode assembly he used to "detect sound" actually produced it. When Frey invented and patented (for the Office of Naval Research) a special, nonintrusive electrode, he was able to show that the creation of sound in the brain does result from the low-intensity microwave signals, quite like those released by cell phones today.

In his most recent critique of Frey, Lin ignores Frey's Science paper completely. Instead, he cites five of Frey's other papers, giving the appearance of thoroughness. Frey comments on this highly selective reading of his work: "This sort of thing has always been done by the 'no hazard establishment people' since the beginning, and has misled scientists and the public. . . ."

Frey recalls that some of the studies purporting to show that Frey's work on the blood-brain barrier were wrong, did no such thing. "One group claimed to repeat our studies and find nothing. But instead of injecting fluorescent dye into the artery where it could circulate like I did, they injected it into the abdomen, waited five minutes, killed the animals, and found no evidence that the dye had reached the brain. Of course not."

To this day, Frey does not think highly of Guy.

"Bill Guy was an interesting man, an electrical engineer, who didn't know a thing about biology. The Air Force

experts in aviation medicine used to pour lots of money into him. When Bill did his big five-million-dollar study of cancer in rodents exposed to microwaves, I raised questions about the analysis. They had actually thrown out brain tumors! Of course, they found no evidence of an effect.

“Once when Bill and I were over in the Soviet Union we met at a lab to have a little discussion about the microwave stuff. We were sitting around a table—about eighteen of us, including Soviet scientists. This woman who headed the experimental lab studying health and microwaves turned to Bill and said, ‘Dr. Guy, tell me about the work being done in your lab.’ He sort of sat there and sat there, with his head down. He turned to me and said, ‘Allan, would you tell them about the work being done in my group?’ as he didn’t really know what was being done regarding biological work.”

One of the studies done in Guy’s lab was an investigation of cancer in animals exposed to radio frequency radiation. The first results showed that microwave-like radiation increased cancer in animals. Gandhi and three others have told me this story. The reported finding of a significantly increased cancer risk with microwave exposure is one that the military funders of that work did not want to have seen in print. And it wasn’t.

Frey and Gandhi today are at the ends of their careers. They understand that there was a lot of pressure exerted on researchers at the time to stay away from studies that suggested that radio frequency radiation had biological impacts of any kind. Radar installations and satellite systems were being set up around the country. Research suggesting that these required any special handling was

not welcome during the height of the Cold War—a point that Paul Brodeur thoroughly documented in his book *The Zapping of America*, published in 1977, and serialized in *The New Yorker* that same year.

In response to Brodeur's writings, the government activated a Committee on Man and Radiation (COMAR), headed up by a Veterans Administration psychologist, Don Justesen. COMAR mounted a major public relations campaign to rebut and discredit Brodeur's conclusions that certain exposures to microwave radiation could cause genetic damage, blindness, and changes in behavior. In reaching his views about these dangers, Brodeur interviewed dozens of Defense Department researchers and relied in part on some of Frey's work. Frey believed that the *New Yorker* critique that COMAR prepared included a number of misrepresentations about his own research.

When confronted about these misstatements, Justesen told Frey that the COMAR critique had been a draft that would be revised further and had not been widely distributed. Frey knew this was not true. He had been given a copy of the rebuttal that had in fact been submitted to *The New Yorker* for publication, but had been rejected. Even today, some three decades later, Frey is appalled by two facts:

“The guys heading up COMAR just did not understand biology. What happened here was a naked use of power to try to discredit what had been basic scientific work because it did not comport with what those funding the work wanted at the time.”

At one point, in 1978, Frey was invited to a major meeting ostensibly set up to review his work that was billed as an effort to reach consensus in the field. It proved to be no such thing. Rather, Bill Guy and others came and presented studies that the Department of Energy had funded that had been designed to show that, contrary to Frey, microwave radiation did not affect the blood-brain barrier, did not affect the formation of cataracts, nor genes of living tissue. The existence of conflicting science was used in a magical way. Frey saw that the margins of the draft report had contained a penciled query regarding the advice that there was no need to study the blood-brain barrier: "Do you really want to say this?"

In his summary of this meeting, Justesen, who himself was not an expert in the field, basically wrote that since there was conflict among scientists on the issue, there was no problem. And there was also no need for further research.

Today, Gandhi looks back on these efforts with a different perspective.

"At the time I did the work on the Frey effect, and even later when I showed that brain models needed to be changed, a number of people put a lot of effort into trying to discredit findings they did not like. In our field, half of the people have made up their minds that there are no effects and they tend to get support from industry and the military. About a quarter of the people think that there are effects everywhere at any level at all, and they tend to work without any government support."

"What about you?" I asked. "Where do you fit in?"

Gandhi paused a moment and said, “The rest of us who are neither doubters nor true believers think maybe there are some important effects that need to be controlled and that microwave radiation plays some very valuable roles in our society today. Microwave technology has made remarkable improvements in many parts of our society from aviation to medicine. But we certainly need to find out how to use it as safely as possible and not deny that it can be harmful. As long as the funds were available, back then we did the work. But a lot of people in this field had made up their minds, and many of those who did, like Bill Guy and Don Justesen, got the most money and basically set the stage for what could and could not be done for years. Of course, now, there is no money for independent research at all.

“So long as I stayed out of the biology of radio frequency radiation, I was able to find funds for my students and me to study electrical engineering. But in the United States the Bioelectromagnetics

Society has died off, because most people in positions of power decided that there can be no biological effects. Of course, there can't be effects if we can't get funding to study them. Anytime there is evidence of an effect, there are many others brought in to show that there is nothing.”

Gandhi has repeatedly provided one message on all this. In the United States the standards for radio frequency radiation that he helped to write were set up long before cell phones were in wide use, based in large part on work that Gandhi and his students carried out in the 1970s

through the early 1990s. Those standards have not been changed since then.

In decades past Defense Department researchers carried out an entirely separate line of inquiry on radio frequency. They sought to build new weapons and ways of deactivating land mines. Scientists had long known that pulsed microwave signals could kill rats by stopping their breathing and could also produce potentially lethal blood clots. In a dramatic demonstration of the power of radio frequency in 1985, the Spanish neuroscientist José Delgado used a pulsed signal sent deep into the brain to stop a charging bull. Prospects for using such signals for a variety of other purposes—ranging from destruction to construction to medicine—seemed limitless.

BACKS TO THE FUTURE

Adlkofer didn't know about Frey or his studies until he and I met almost forty years later. After his encounters with those who urged him to move on to other work, Frey's efforts became one of those little known developments in the history of science.

When efforts were started to undermine the findings of the REFLEX project, Adlkofer recognized them for what they were. Perhaps it was hubris, but he had not ever imagined that he would find himself subject to the same sort of blunt attacks that the tobacco industry had carried out for years against its own critics. He had a strange sort of self-understanding throughout his career. He recognized that the tobacco industry on some level didn't really care about what he was doing. They were buying complexity as a way to stave off regulatory action and responsibility. So long as his own work was truly independent and scientifically grounded, he felt no moral compunction about carrying it out.

But the cell phone story was different. Adlkofer had grandchildren and had reached a moment in his career when he was in the position to retire to a pleasant life. But he could not leave in disgrace, because he knew something that others did not. He knew that the work carried out on DNA damage caused by radio frequency radiation was firmly established. He suspected foul play behind the swift and unusually public efforts to charge him with fraud.

Just the accusation of fraud often ends a scientist's career. As the REFLEX results began to appear, a major

public relations firm in Germany was brought in to respond for the cell phone industry and cloud what Verum had in fact determined. The German cell phone industry's lobbying group—Forschungsgemeinschaft Funk—led by Dr. Gerd Friedrich, dismissed the results as being flawed.

Meanwhile, Professor Alexander Lerchl at the private Jacobs University in Bremen wrote a letter to the rector of the University of Vienna alleging that the REFLEX statistics were wrong, demanding that the data be reviewed and that the paper be withdrawn from the scientific literature. Lerchl sent similar demands to the editors of the journal *Mutation Research and International Archives of Occupational and Environmental Health*, which had published the results, and to the authors as well, asking them to print a retraction. In sending this letter, Lerchl failed to note one important detail—he was not merely a concerned independent scientist, as he represented himself to be. For years, Lerchl had received generous funding from a joint industry-government program. From 2002 to 2008, the Deutsches Mobilfunk Forschungsprogramm (German Mobile Phone Research Program) provided 8.5 million euros, matched by government funds, to various research groups all over Europe. Lerchl himself got more than one million euros to carry out five different projects on the biological impacts of radio frequency. His work has been unerringly consistent—none of it has found any biological impact of radio frequency on health. Vodafone Foundation—created by the world's largest cell phone company—is also a major supporter of this university. Lerchl became chair of the commission responsible for the

protection of people from nonionizing radiation, within the
German national committee SSK
(Strahlenschutzkommission).

THE BLOOD-BRAIN BARRIER REVISITED

When someone who has spent years working for and getting rich off of tobacco money suddenly presents himself as a champion of truth, well, how credible is he?

“What did you think industry would do when you produced this work showing that cell signals could disrupt basic biology? After all, you had been one of the tobacco boys for quite a while,” I asked him.

“Of course, some people may not trust me. But what happened to us after we published our findings showing DNA damage from radio frequency radiation certainly was not the sort of thing that happens to those who are in the inner circle of power. After our results started to come out showing that radio frequency radiation damaged cells, first industry ignored us. Then they decided to take us on, and they did so in what turned out to be a pretty dirty fashion.”

Dirty or not, the same European Union that had provided groups Adlkofer headed with more than twenty million euros, mostly for research on what can turn our healthy nervous systems sick, decided not to renew the work on cell phone radiation. And it did so—basically pulling the plug midstream—while Adlkofer was in the middle of determining what radio frequency signals did to basic biology. There are always budgetary concerns and other factors in political decisions such as this, but it does seem that those unhappy with these results made sure that funding would end quickly. Under normal circumstances a loss of millions of dollars in funding for a big, complicated project would have been a death sentence. But this project

was exceptional. Adlkofer was not accustomed to running out of money for any of his work and he had lots of wealthy people, in addition to himself, who believed in what he was doing.

“I knew we could not be sure of what we had, but that it looked pretty damning. To stop this work with all this uncertainty was for me unacceptable. Together with Dr. Rüdiger from the Medical University of Vienna I tried to continue. So we found other money. We set out to study how DNA responds to the most modern cell phone technology, which allows a much more efficient transfer of data in a much shorter time.”

Adlkofer’s group did not study living rodents in comfy chambers, as did the Swedish neurosurgeon Leif Salford, described in an earlier chapter. Instead they looked carefully into a number of different human cells grown in small lab dishes and examined what happened to them after exposures quite like those that most of us get from using the phone. They examined adult cells and those from children.

The human cells that Adlkofer probed after such exposure also looked unhealthy.

“We found a ten times higher rate of broken DNA with the new 3G phones (using what is termed the UMDS system) as compared to 2G (using the older GSM system). This could be a catastrophe for the industry. It took us two years, but we finally published our work showing major damage to genetic material in cell-phoneexposed human cells in the International Archives of Occupational and Environmental Health, 2008.”

In the years leading up to this publication, every time Adlkofer presented a paper on the topic to meetings of the Bioelectromagnetics Society in Europe, the United States, or Asia, industry-sponsored experts came well prepared to challenge the work. Scientists working for the U.S. military and NATO—groups that used radio frequency both to communicate and to make novel weapons—went on the attack. Broken DNA does not sound like a good thing even to those not steeped in biology. After all, the destruction of DNA means that our cells have lost their ability to repair themselves, to stay under control, and eventually to suppress uncontrolled growth that is the hallmark of cancer.

Perhaps Adlkofer had figured that the complexity and elegance of the study his group had carried out would insulate it. Maybe he even thought he had acquired immunity against attack because of his many years working with industry. Or perhaps he figured that the fact that several others were repeating his study and finding the same results meant it would be accepted. On all accounts he could not have been more wrong.

By 2008, the work Adlkofer and his team at the University of Vienna had been carrying out for more than a decade suddenly made headlines in all major science journals in precisely the way a scientist never welcomes.

“Vienna Studies Withdrawn. Fraud Admitted in DNA Damage Studies in Vienna.” Science magazine claimed that . . . the only two peer-reviewed scientific papers showing that electromagnetic fields (EMFs) from cell phones can cause DNA breakage are at the center of a misconduct

controversy at the Medical University of Vienna (MUV). Critics had argued that the data looked too good to be real, and in May a university investigation agreed, concluding that data in both studies had been fabricated and that the papers should be retracted.

The technician who worked on the studies [Elisabeth Kratochvil] has resigned, and the senior author on both papers [Hugo Rüdiger] initially agreed with the rector of the university to retract them. But since then, the case has become murkier as the senior author has changed his mind, saying that the technician denies wrongdoing.

Microwave News pointed out that Science magazine got it wrong. The Viennese researchers were not lone rangers producing studies unlike everyone else. There were not just two studies showing DNA damage from radio frequency radiation, but eleven others. Despite this error, the Science magazine story was reported around the world. “Scandal Rocks Vienna Research,” “Cell Phones Do Not Damage DNA.”

Industry saw these headlines as a tremendous break. These scientists claiming that cell phones could be harmful had been wrong and had committed fraud—what could be clearer?

A letter to the editor by the Australian neurosurgeon Vini Khurana noted that the Science story was in fact wide of the mark. The REFLEX studies were not an isolated finding. More than a dozen different studies from highly respected researchers showed that radio frequency signals could damage DNA, alter the ability of cells to repair themselves, or cause them to die off at unusual rates. But

by then the genie was out of the bottle. In a world where headlines may be all that many ever read, even if they are proved wrong eventually, the damage was done.

A DEVIL IN HELL?

In the rush of folks arriving at the InterCity Premium Hotel in Porto Alegre a few hundred meters from the great glass modern buildings of the Health Ministry, where we met in the spring of 2009, Adlkofer kept to himself. He stood with his large head tilted down just a bit more than seemed right, even for someone who spends too much time looking down a microscope. He was dressed more elegantly than other scientists, with rimless glasses and a tailored Egyptian cotton blue shirt. Something was on his mind.

It had been about two years since Adlkofer had seen the headlines about fraud in his lab. He was still recovering, recounting, and seeking to restore himself. People who have been traumatized often talk about what happened over and over again. Adlkofer spoke about how he felt when he first learned he had been charged with fraud.

“I was just entering the boat. At this instant, my cell phone rang. I will never forget this moment ever in my life. My colleague, Professor Hugo Rüdiger, head of occupational health at the Medical University of Vienna, was on the line. ‘Please, Franz, sit down.’

“This was very strange to get any call at all at this time. Rüdiger himself was in Turkey, also on holiday. When I heard his voice on the phone ordering me to get a seat, I thought someone must have died. Rüdiger went on, ‘Elisabeth has forged our data. I just got a phone call from a colleague in Vienna that she admitted that she had done this.’

“For a moment my brain froze. I had no words of reply. He was telling me that the best technician I had ever worked with, on whom our entire work rested, had done us in. Then, I blurted out, ‘What are you telling me! Could this possibly be true?’

“Rüdiger replied, ‘I am very sorry to tell you this, but my colleague told me that Elisabeth confessed to him. She had forged the reports.’”

Adlkofer looked uncomfortable; beads of sweat broke out on his forehead. He continued, “Frankly, I did not know what to think. I had a hard time believing my own ears. But this was a most serious matter. The future of all of our research on radio frequency signals and brain cells was at risk. My reputation would be ruined.”

Adlkofer had himself mastered techniques for separating out the amino acids and other essential compounds from the proteins that keep us alive. As a teacher he had mentored dozens of younger faculty members. This role has a great tradition in Germany; there is a term for a postdoctoral mentor: Doktorvater, meaning roughly “doctor father”—a man who holds total dominion over his student children. He now found himself torn between loyalty to his junior lab technician and dread of the awful consequences of her alleged actions.

Back in Germany, Adlkofer tried to contact Elisabeth but failed. She had left the university and was looking for another job. He had no reason to doubt what he had been told about Elisabeth, no matter how hard it was to accept that his lab results had been fraudulent.

Adlkofer noticed the University of Vienna moved fast in attempting to control the damage to its public profile.

“The university quickly issued a press release that the data we had published showing that low levels of radio frequency signals from commonly used phones could damage DNA would have to be withdrawn from the journals *Mutation Research* and in the *International Archives of Occupational and Environmental Health*.”

Once a scientist is charged with fraud, that’s it—but maybe not this time. Adlkofer had two things going for him that most scientists do not. He had a lot of money from all those years working for tobacco, and he had the respect of the scientists with whom he had worked on radio frequency. He spent the next two years learning what had gone on and fighting for the record to be corrected.

Adlkofer had arrived at the conference in Brazil, where he told me his story uncertain of what lay ahead, of what this all would finally mean for someone nearing retirement. It was spring, but wind and rain can be very brisk in May there, where the weather blows straight from the Antarctic. Porto Alegre in southern Brazil was cold that week. All of us had flown through the night—there is no other way to reach this place. I’d traveled there along with Adlkofer and some two dozen other scientists to discuss the latest scientific findings on cell phones and other forms of nonionizing radiation. Porto Alegre is surrounded by some stands of original forest and assorted sprawling industrial complexes. With fewer than two million people, the area is one of the most beautiful and accessible wild regions in the country.

As we waited for the rains to abate, Adlkofer tried to tell his story from beginning to end. I had become part of his agenda, in a way that I was not fully comfortable with. Truth in science, as in much of life, depends on where you stand and who has brought you there. We were all guests of the Brazilian government at this conference convened by the International Commission for Electromagnetic Safety—a group of scientists who have been holding meetings around the world for more than a decade, seeking to promote research and policy changes. Adlkofer and I were relatively recent members.

Adlkofer had long enjoyed close contacts with many industry scientists and was astounded by what had ensued when his group began to produce results the cell phone industry did not like.

“I’d been conducting research on the fundamental and basic science of cell phones for three decades. As we set up the studies of radio frequency signals, of course, I relied on industry help to do so. Industry scientists had been my close colleagues throughout. They were not at all happy with this work that we had published in *Mutation Research*, in 2005. They let me know it. This study belonged to the REFLEX project, which had received nearly three million euros from the European Union and was well funded by my own foundation, the Radiation and Nuclear Safety Authority (STUK) of Finland and the Swiss government. No direct industry money was involved.

“We found that radio frequency, especially at the level then found in regular cell phones using GSM radiation, caused big and obvious toxic effects in human fibroblasts.

We exposed fibroblasts from persons young and old to electromagnetic fields used to modulate the carrier frequencies of mobile phone radiation. Fibroblasts from younger persons have a slower increase in DNA strand breaks and a faster decrease; this means their repair systems were obviously better. Several hundred pages of our work also appeared in a special issue under the Verum Foundation final report of the REFLEX project.

“Different groups were involved with different ways of charting cell damage. We looked at gene expression. We counted and measured rates of cell growth and death. We examined how the immune system responded. The most important results showed genotoxic impacts. We presented the data several times, including at Bioelectromagnetics Society meetings. Each time efforts were made to explain why we were wrong. So we refined our studies and got the same results. They knew what was coming was not to their liking.”

Having worked with Elisabeth for nearly a decade, Adlkofer could not believe that she would have betrayed their work so easily.

“I can’t prove this, but here’s what I think they did. The industry never liked this work. From the first they heard about it, they set out to discredit it. I had seen this happen with tobacco science so often, especially at the hands of the American companies. Yet suddenly it was happening to me. They hired people to show that our results could not be replicated. But these groups carried out their studies in a way that our data could not be reproduced. So what happened next?

“Today, this same Professor Lerchl—whom industry supported to attack our work—is the chairman of the independent government commission for the science on nonionizing radiation. He has written a book that he published himself, outlining his story in this sorry episode. He claims to have determined the truth, when what he really did was to shanghai and undermine our work. This is a man who wouldn’t know the truth if it fell on him!” What happened next dumbfounded Adlkofer. Before the ink was dry on the declarations of guilt made by those appointed to succeed him, and before any final decision had been reached about the accusation of fraud, the rector of the university ordered the laboratory to have all records of this research destroyed, completely wiped out.

“I refused. I knew something few others could. During the time that my technician was allegedly cooking the books, there was no way she could have possibly known how to do so. Nobody in our labs, not even me, had the information on the codes. The codes were not known to any of us. Nobody.

“As I was struggling with all this, then something even more strange happened. The ethics committee set up by the rector confirmed that the data should be considered forged. And they reached this conclusion without ever trying to talk with me directly. I soon found out that something was fishy. I got a phone call tipping me off. It turned out that the chairman of this foundation’s ethics committee—the very same Professor Lerchl who had raised such a fuss about our work and demanded that we retract it—was himself directly sponsored by the

telecommunications industry and his university received millions from them as well.”

The battle began in earnest.

“We fought hard. We did not accept any claim to destroy the data. We made use of this conflict-of-interest information in talking to the journals. We demanded that the university set up a new ethics committee with a chair not from the industry.

“The rector finally agreed. He set up an ethics committee with a new chairman, while two of its three members remained in their positions. This means that a conflict of interest could not be fully excluded.

“After some investigation, I was told that this new committee would reach the same conclusion that the data had been fabricated. I wrote to them that before I could accept this, I would like to read the protocol of the ethics committee.

“They refused to send it to me. So I went to Vienna with Hugo Rüdiger and we went through the report. At the end, I said, ‘I do not see any proof that the data has been fabricated.’

“The rector’s representative tried to convince me that I should read between the lines.

“But by then, Rüdiger and I had managed to speak with Elisabeth. She had been avoiding us for months. I didn’t know if she was ill or merely heartsick. When we finally spoke, I learned that she had never confessed to forgery at all. She had been set up. When she was finally asked directly about this, Elisabeth said she hadn’t done it. The whole story of fraud was itself a fraud!”

Was it really possible that a major university would go through an investigation on such a flimsy pretext? Elisabeth's story gets harder to confirm beyond that point, but according to Adlkofer, she was adamant. She never admitted fudging the radio frequency radiation data.

The journals in which Adlkofer's REFLEX team's work first appeared, *Mutation Research* and the *Archives of Occupational and Environmental Health*, investigated on their own. They determined that the Adlkofer lab reports should not be retracted and that their reports were valid. They agreed that cell phone microwave-like signals like those in our phones today can profoundly alter the ability of cells to repair themselves. The peer-reviewed science is there. Since this extraordinary review took place, several other investigators in other countries have produced the same results—cell phone radiation does damage DNA.

The REFLEX team's extensive research program on the biological effects of cell phone radiation found harmful effects. Its leader was accused of fraud. Then he was totally exonerated.

How has the story been told so far? Aside from a few trade journals, no major newspapers have reported the fact that the so-called fraud of Vienna—publicized at one point around the world—is not actually a fraud at all. *Der Spiegel*, Germany's highest circulation newsweekly, was sarcastic at the time. Imagine, they joked, the professors think cell phones could be dangerous. In 2008, the magazine ran a Photoshopped image of Professor Rüdiger. It showed him sitting next to an attractive young girl on a cell phone. The notation called him Professor Unrat. In

Heinrich Mann's novel of the same name, *Unrat* loses his dignity when he becomes obsessed with Lola—a cabaret singer. Marlene Dietrich became famous for hypnotically chanting the song “Falling in Love Again” in the film version of the book, *The Blue Angel*.

“The best journalists are with *Der Spiegel* and I thought they had understood what had happened and would report the truth. They did not,” says Adlkofer.

Adlkofer and Rüdiger are nearing the end of their work, but Adlkofer is not stopping at this point. He refuses to accept retirement as an out and is working to ensure that the results stand. He proudly notes that several recent papers confirm that pulsed digital radio frequency radiation can damage DNA. When asked why most studies on the question have been negative, he retorts, “Follow the money.”

What of the younger researchers who have been close observers or involved in this drama? Many of them are afraid. Some are even publishing under pseudonyms to avoid being targeted. Perhaps they've learned to be very careful. Being careful is the hallmark of a good scientist. So, it seems, is being quiet.

As I left Porto Alegre and caught my plane back to North America, I reflected on the fact that about a hundred million people in Brazil use cell phones today and many of them are under age twenty. Many cities there restrict the placement of radio towers, keeping them far from schools and bedroom windows—something that many, more developed, nations have not attempted.

The impact of Adlkofer's work showing genetic damage from cell phone exposures—a finding that has a long but little-known history—is hard to overestimate. This was not the effort of a lone scientist working in a garage, but the result of teams of scientists using the same methods, repeating the same work, in different laboratories. And the findings confirmed results produced decades earlier by several other teams of investigators. Here was a group of distinguished researchers showing what many physicists assumed was impossible. Damage occurred to cells that had nothing at all to do with detectible changes in heat. Radio frequency signals at levels that could be found every day caused havoc inside cells, blocking their ability to function normally and breaking down the brain's barrier to pollutants or drugs in the bloodstream.

In their investigations, Adlkofer's team found that the newly launched 3G phones were much worse than the now outdated 2G phones.

A hundred million cell phone users in Brazil. Five billion around the world.

A global public health problem is getting worse.