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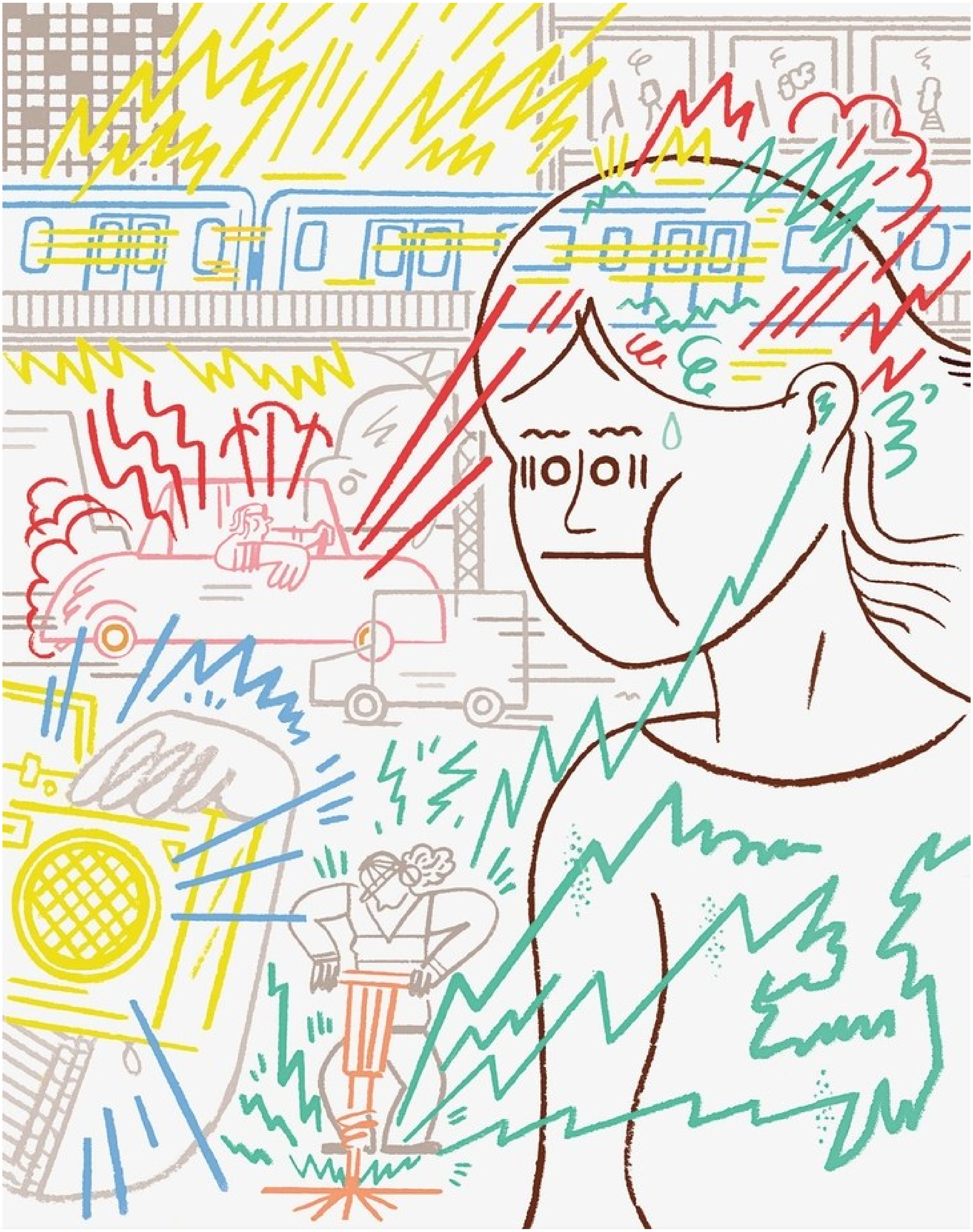
IS NOISE POLLUTION THE NEXT BIG PUBLIC-HEALTH CRISIS?

Research shows that loud sound can have a significant impact on human health, as well as doing devastating damage to ecosystems.

By David Owen May 6, 2019



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I worried about ringing the doorbell. Then I noticed two ragged rectangles of dried, blackened adhesive on the door frame, one just above and one just below the button. I deduced that the button had been taped over at some point but was now safe to use. I pressed as gently as I could, and, when the door opened, I was greeted by a couple in their early sixties and their son. The son has asked me to identify him only as Mark, his middle name. He's thirty years old, and tall and trim. On the day I visited, he was wearing a maroon plaid shirt, a blue baseball cap, and the kind of sound-deadening earmuffs you might use at a shooting range.

Mark and I sat at opposite ends of a long coffee table, in the living room, and his parents sat on the couch. He took off his earmuffs but didn't put them away. "I was living in California and working in a noisy restaurant," he said. "Somebody would drop a plate or do something loud, and I would have a flash of ear pain. I would just kind of think to myself, Wow, that hurt—why was nobody else bothered by that?" Then everything suddenly got much worse. Quiet sounds seemed loud to him, and loud sounds were unendurable. Discomfort from a single incident could last for days. He quit his job and moved back in with his parents. On his flight home, he leaned all the way forward in his seat and covered his ears with his hands.

That was five years ago. Mark's condition is called hyperacusis. It can be caused by overexposure to loud sounds, although no one knows why some people are more susceptible than others. There is no known cure. Before the onset of his symptoms, Mark lived a life that was noise-filled but similar to those of millions of his contemporaries: garage band, earbuds, crowded bars, concerts. The pain feels like "raw inflammation," he said, and is accompanied by pressure on his ears and his temples, by tension in the back of his head, and, occasionally, by an especially disturbing form of tinnitus: "You and I would have a conversation, and then after you'd left I'd go upstairs and some phrase you had been saying would repeat over and over in my ear, almost like putting in the recycling bin. By the end of our conversation, which lasted a little more than an hour, he had put his earmuffs back on.

Hyperacusis is relatively rare, and Mark's case is severe, but hearing damage and other problems caused by excessively loud sound are increasingly common worldwide. Ears evolved in an acoustic environment that was nothing like the one we live in today. Daniel Fink—a retired California internist, whose own, milder hyperacusis began in a noisy restaurant on New Year's Eve, 2007, and who is now an anti-noise activist—told me, "Until the industrial revolution, urban dwellers' sleep was disturbed mostly by the early calls of roosters from back-yard chicken coops or nearby farms." The first serious sufferers of occupational hearing loss were probably workers who pounded on metal: blacksmiths, church-bell ringers, the people who built the boilers that powered the steam engines that created the modern world. (Audiologists used to refer to a particular high-frequency hearing-loss pattern as a "boilermaker's notch.")

Today, the sound source that people first think of when they think of hearing loss is amplified music, the appeal of which may be biological. In 1999, two scientists at the University of Manchester, in England, conducted an experiment in which they had students listen to songs at dance-club volumes, which are high enough to cause permanent damage if the exposures are long enough. The scientists concluded that the loud music stimulated the parts of the subjects' inner ears that govern balance and spatial orientation, thereby creating "pleasurable sensations of self-motion": crank up the volume, and you feel as though you're dancing when you're sitting in your seat. Classical musicians and their audiences face risks as well. For the musicians, the threat comes not just from their own instrument (violinists, like right-handed infantrymen, tend to lose hearing on their left side first) but also, often more significant, from the instruments of the musicians who sit behind them.

Modern sound-related health threats extend far beyond music, and they affect more than hearing. Studies have shown that people who live or work in loud environments are particularly susceptible to many alarming problems, including heart disease, high blood pressure, low birth weight, and all the physical, cognitive, and emotional issues that arise from being too distracted to focus on complex tasks and from never getting that can be as devastating as those of more tangible forms of ecological desecration. Les Blomberg, the founder and executive director of the Noise Pollution Clearinghouse, based in Montpelier, Vermont, told me, "What we're doing to our soundscape is littering it. It's aural litter—acoustical litter—and, if you could see what you hear, it would look like piles and piles of McDonald's wrappers, just thrown out the window as we go driving down the road."

In February, Bruitparif, a nonprofit organization that monitors environmental-noise levels in metropolitan Paris, published a report that combined medical projections from the World Health Organization with "noise maps" based partly on data from its own network of acoustic sensors. It concluded, among many other things, that an average resident of any of the loudest parts of the Île-de-France—which includes Paris and its surrounding suburbs—loses "more than three healthy life-years," in the course of a lifetime, to some combination of ailments caused or exacerbated by the din of cars, trucks, airplanes, and trains. These health effects, according to guidelines published by the W.H.O.'s European regional office last year, include tinnitus, sleep disturbance, ischemic heart disease, obesity, diabetes, adverse birth outcomes, and cognitive impairment in children. In Western Europe, the guidelines say, traffic noise results in an annual loss of "at least one million healthy years of life."

The headquarters of Bruitparif is in a low-rise office complex in Saint-Denis, a suburb just north of the Eighteenth Arrondissement. I visited a couple of weeks after the February report was issued, and met with Fanny Mietlicki, who has been Bruitparif's director since 2005. She had warned me, before my trip, that she spoke very little English. I, on the other hand, speak French almost as well as my father did. He studied it in school, and was stationed in France at the end of the Second World War. Years later, at a restaurant in Paris, while travelling with my mother, he said something to a Frenchman sitting at the next table, and the Frenchman said something back. Neither man could understand the other, and my mother eventually identified the problem: the Frenchman didn't realize that my father was speaking French, and my father didn't realize that the Frenchman was speaking English.

Mietlicki's English turned out to be better than she'd let on. "You need to have data in necessarily where the most people live." In 2014, Bruitparif was one of the principal creators of the Harmonica index, a way of presenting the severity of sound disturbances with a simple graph. Harmonica's most appealing feature is that it makes no reference to decibels, which even acousticians have trouble explaining. (Part of the difficulty—but only part—is that decibels are logarithmic. A hundred-decibel sound isn't twice as intense as a fifty-decibel sound; it's a hundred thousand times as intense.)

Bruitparif's director of technology is Christophe Mietlicki, Fanny's husband. He used to develop computer systems for financial institutions, but, in 2009, he decided that his wife's job was more interesting than his, and went to work for her. They are in their forties, have three children, and commute each day from Suresnes, a suburb directly across the Seine from the Bois de Boulogne. At the headquarters, Christophe and I spoke in a sort of reception-and-recreation area on the floor below Fanny's office. On one of the walls was a large noise map of Paris and its suburbs, on which roads, train lines, and airline flight paths had been highlighted in angry, glowing red, like inflamed nerves in an ad for a pain reliever. On a wooden table in front of the map was a white bowl that was filled with what appeared from a distance to be individually wrapped pieces of candy but turned out to be earplugs.

We stepped into an adjacent room. "Here is our acoustic laboratory," Christophe said. He handed me one of Bruitparif's sound-monitoring devices, which he had helped invent. It's called Medusa. It has four microphones, which stick out at various angles, hence the name. The armature that holds the microphones is bolted to a metal box roughly the size of an American loaf of bread. Inside it is a souped-up Raspberry Pi—a tiny, inexpensive computer, which was originally intended for use in schools and developing countries but is so powerful that it has been adopted, all over the world, for myriad other uses. (You can buy one on Amazon for less than forty bucks.) Embedded in the central microphone stalk are two tiny fish-eye cameras, mounted back to back, which record a three-hundred-and-sixty-degree image each minute. Medusas are the successors of Bruitparif's first-generation sensors, called Sonopodes, which rely on expensive components imported from Japan. Sonopodes are still in use, although they are too big to move around easily. "The Japanese system is very good, but each one costs same." Bruitparif has installed fifty Medusas in the metropolitan area, and will add many more this summer.

In a nearby room, a young woman was assembling Medusa microphones from components that were spread out on a counter. Most of the parts had been 3-D-printed, and she was doing something to some of them with what looked like a soldering iron. "In fact, it's very simple," Christophe said. "And, as with many things that are very simple, finding the solution was very complex." The orientation of the microphones on a Medusa enables it to pinpoint the origins of the sounds that it monitors; the cameras preserve time-stamped images of the scene. Bruitparif can place a Medusa on a street lined with noisy bars and, later, document precisely which bar, at what time, was playing music, say, eleven decibels louder than the local code allows.

I said that documentation like that would be useful in New York, where the police often ignore noise complaints or respond to them days later.

"The idea of this system is not to depend on the police," Christophe said. "That should be the last resort. We prefer a system in which people like you, like me, can put a sensor somewhere and have objective data, and then we can talk with one another and find some solution together."

MORE FROM THIS ISSUE

MAY 13, 2019

LIFE AND LETTERS
A Village Doctor's Literary Calling
By Joshua Yaffa

BOOKS
Science Fiction Doesn't Have to Be Dystopian
By Joyce Carol Oates

ON THE STREET
Maggie Siff and the Women of Wall Street
By Rachel Syme

SHOUTS
O.K., Y
Dog
By Colin

A few weeks later, back in the States, I visited the headquarters of a smaller but similar noise-monitoring project, at N.Y.U.'s Center for Urban Science and Progress, on Jay Street, in Brooklyn. That project is called Sounds of New York City (SONYC) and is funded mainly by the National Science Foundation. SONYC's purpose, Mark Cartwright, one of the scientists on the project, told me, is "to monitor, analyze, and mitigate noise pollution." Each sensor in its network has just one microphone, which is roughly eight inches long and covered in foam. The microphone is attached to a small, weatherproof aluminum box, which also contains a Raspberry Pi. Sometimes the sensors are mounted with a long strip of plastic spikes, which are meant to deter pigeons from using the devices as latrines, and which, on monitors installed near Washington Square Park, have developed the unanticipated additional function of accumulating tangled masses of the wind-borne hair of N.Y.U. students.

The method that SONYC uses to collect data and to document noise-code violations is different from the one used by Bruitparif. The SONYC researchers are developing algorithms that they hope will eventually be able to identify a full range of noise sources by themselves—an example of so-called machine listening. "Having a network of sensors deployed around the city enables us to start understanding the patterns of noise and how they develop around things like construction sites," Charlie Mydlarz, another scientist on the project, told me. He said that SONYC also gives the city's Department of Environmental Protection actionable evidence of violations. Mydlarz and his colleagues are still training their algorithm, with help from "citizen scientists," who visit a Web page and annotate ten-second audio files, collected by the sensors, with what they think are the sounds' likeliest sources: jackhammer, car alarm, chainsaw, engine of uncertain size. He demonstrated the algorithm's current iteration by alternately operating a Black & Decker electric drill and the siren of a toy fire truck near a sensor on the table in front of him. The algorithm successfully identified each and measured its decibel level. (It can also identify the fire truck's horn.)

I was accompanied to the SONYC lab by Charles Komanoff, an economist who created models that the city's congestion-pricing plan is based on. In the course of the past five decades, he's worked on just about every environmental issue, including noise. "In the majority chose noise." I had asked him to join me mainly because he owns a professional sound-level meter.

Komanoff and I travelled to and from Brooklyn by bicycle, and halfway across the Manhattan Bridge we stopped to take sound readings. His meter showed that, at the spot where we were standing, the average ambient-sound level, arising mostly from motor traffic on the bridge, was about seventy decibels, or roughly what you'd experience while using a vacuum cleaner at home. Then a train went over the bridge, on tracks twenty or thirty feet from where we were standing, and the reading jumped to ninety-five decibels—more than a three-hundredfold increase in sound intensity and a five- to sixfold increase in perceived loudness—or roughly what you'd hear while using a gasoline-powered lawnmower in your yard. The train sound wasn't physically painful, but almost; even shouted conversation became impossible.

In the United States, sound exposure in the workplace has been regulated by the federal government since the nineteen-seventies. But the rules don't cover all industries, and they're applied inconsistently. The government has acknowledged that, even when compliance is absolute, the limits aren't low enough to protect all workers from hearing loss. The regulations of the Occupational Safety and Health Administration, for example, allow workers to be exposed to ninety-five decibels for four hours a day, five days a week, for an entire forty-year career. That's always been crazy, but in the past decade it's begun to seem even crazier, because recent research into what's known as hidden hearing loss—which involves a previously undetected permanent reduction in neural response—has suggested that catastrophic losses could occur at sound levels that are much lower than had been thought, and after much shorter periods of exposure.

By the mid-nineties, some scientists had begun to believe that traffic noise must be harmful to creatures other than humans, but they didn't know how to measure its effects in isolation from those of roadway construction, vehicle emissions, highway salting, and all the other direct and indirect ecosystem insults that arise from our dependency on cars and trucks.

In 2012, Jesse Barber, a professor at Boise State University, in Idaho, thought of a way.

migration in autumn, played recordings of traffic that Barber had made on Going-to-the-Sun Road, in Glacier National Park. Chris McClure, who worked on the project, told me, "We cut up garden hoses to run the wires through, so that mice wouldn't chew on them, and we duct-taped pieces of shower curtains over the loudspeakers, to keep off the rain." The recorded sound wasn't deafening, by any measure; to a New Yorker, in fact, it might have seemed almost soothing. But its effect on migrating birds was both immediate and dramatic. During periods when the speakers were switched on, the number of birds declined, on average, by twenty-eight per cent, and several species fled the area entirely. Some of the biggest impacts were on species that stayed. Heidi Ware Carlisle, who earned her master's degree for work that she did on the project, told me, "If you just counted MacGillivray's warblers, for example, you might say, 'Oh, they're not bothered by noise.' But when we weighed them we found that they were no longer getting fatter—as they should have been, because fat fuels their migration."

A dozen years before the phantom-road experiment, a group of American researchers accidentally performed a similar study underwater. They had been measuring concentrations of stress-related hormone metabolites in the feces of right whales in the Bay of Fundy. (They were assisted by dogs trained to detect the scent of whale turds from the side of a boat.) In mid-September, 2001, the metabolite concentrations fell; when they were measured again the following season, they had gone back up. The scientists had been using hydrophones to monitor underwater sound levels in the bay, and they realized that the drop in stress had coincided exactly with an equally sudden decline in human-generated underwater noise. The cause was the temporary pause in ocean shipping which followed 9/11.

I learned about the Bay of Fundy project from Peter Tyack, an American behavioral ecologist, who, for the past seven years, has been a member of the faculty at the University of St. Andrews, in Scotland. He also does research at the Woods Hole Oceanographic Institution, on Cape Cod, where he used to work full time—and that's where we met. We sat in a lab on the second floor of W.H.O.I.'s Marine Research Facility, and he explained that sound can harm marine creatures both directly, by physically injuring them, and indirectly, by interfering with their feeding, their mating, guns, which are used to search for undersea deposits of oil and natural gas. (They're so loud that acoustic monitors on the Mid-Atlantic Ridge pick them up from hundreds, and even thousands, of miles away.) "In terms of the total sound energy that humans put into the ocean, though, shipping is by far the biggest source," he said.

Tyack gave me a tour of the research facility downstairs. We passed a bank of freezers, a room with a CT scanner, and a band saw big enough to carve a small whale into chunks, and then entered a room that was furnished with supersized versions of the kind of stainless-steel tables you'd find in the autopsy room of a morgue. "There's a big door over there, so that a truck can back right up," he said. "And those gantries up on the ceiling move the animals onto the tables."

One of Tyack's ongoing research interests is the impact of sonar on marine mammals. He and his colleagues have developed a sound-and-movement monitor—"sort of a waterproof iPhone"—which they can affix, with suction cups, to whales' backs. They have discovered, among other things, that some species are more sensitive to sonar than anyone had previously suspected. "If they hear sonar, they'll stop foraging, leave the area, and not come back for several days," he said. Sometimes frightened whales bolt toward the surface and die of decompression sickness—the bends—or of an arterial gas embolism. He continued, "We are now quite sure that what happens is that the whales are a kilometre deep, and they're foraging in the dark for food, and the sound of sonar from a naval exercise triggers a panic reaction."

Tyack said that it's long been known that human-created sound can also interfere with mating calls, thereby reducing the reproductive success of many species, including ones that have already been hunted virtually to nonexistence. Consequent reductions in those species' numbers can be invisible even to marine biologists, since the failure to reproduce doesn't result in carcasses on beaches. "Even now, our estimates of the population size of marine mammals are plus or minus fifty per cent," he said. "So, basically, the population would have to be on its way toward extinction before we'd notice. And by then it would be too late."

On the day that Charles Komanoff and I took those sound readings on the phantom-road and whale-poop studies, hinged on an accidental discovery. "One of my students, at Lehman College, told me that her child attended an elementary school next to an elevated train line, and that the classroom was so loud that the students were unable to learn," she said. The school was P.S. 98, in Inwood, near the northern tip of Manhattan, and the track was two hundred and twenty feet from the building. Bronzaft's student said that she and some other parents were planning to sue, but Bronzaft, whose husband was a lawyer, told her that, in order to be successful, they would need to prove that their children had been harmed. Bronzaft offered to help and found that, in classrooms on the side of the building facing the tracks, passing trains raised decibel readings to rock-concert levels for roughly thirty seconds every four and a half minutes, and that, during those periods, teachers had to either stop teaching or shout; then, once a train had passed, they had to regain their students' attention. Bronzaft obtained three years' worth of reading-test scores from the school's principal —"I must say, he was an activist principal," she said—and was able to demonstrate to the city that the sixth graders on the track side of the building had fallen about eleven months behind those on the quieter side.

Bronzaft stayed involved. She helped persuade the city to cover the classroom ceilings with sound-deadening acoustic tiles, and the M.T.A. to install rubber pads between the rails and the ties on tracks near the school (and, eventually, throughout the subway system). In a follow-up study, published in 1981, she was able to show that those measures had been effective and that the gap in test scores between students on the exposed and less exposed sides of the building had disappeared.

Those experiences increased Bronzaft's impatience with scientists and politicians who hesitate to act on persuasive but incomplete data. She asked me if I knew who had been the President of the United States at the time of the passage of the federal Noise Control Act and of the establishment of the Environmental Protection Agency, the Occupational Safety and Health Administration, and the National Institute for Occupational Safety and Health. And I did know: Richard Nixon. She took me into her office, a book-filled study that she calls the Noise Room, and, on a couch, opened an accordion folder that contained a dozen or so U.S.-government pamphlets, most of with a quotation from William H. Stewart, who served as the Surgeon General under both Lyndon B. Johnson and Nixon. In his keynote address at the 1968 Conference on Noise as a Public Health Hazard, in Washington, Stewart said, "Must we wait until we prove every link in the chain of causation?" and added, "In protecting health, absolute proof comes late. To wait for it is to invite disaster or to prolong suffering unnecessarily."

That was half a century ago. Scientists still don't know everything there is to know about the effects of sound on living things, but they know a lot, and for a long time they've also known how to make the world substantially less noisy. Peter Tyack told me that reducing the sound impact of global shipping would be possible, since "the navies of the world have spent billions of dollars learning how to make ships quiet." One method, he said, is to physically isolate engines from metal hulls; another is to shape propellers in ways that make them less likely to produce shock waves in the water. Subway cars everywhere could roll on rubber tires, as some of the ones I rode in Paris do. Highway speed limits could be enforced; so could laws requiring the use of E.P.A.-approved exhaust systems on all motorcycles. Maximum earbud volumes could be limited to indisputably safe levels. Directional sirens could significantly reduce or eliminate noise for people who are not in the path of an emergency vehicle. Measuring noise is important, Bronzaft said, but it isn't an end in itself. "If I don't see the data being used to get action, I'm not going to be happy," she continued. "We had all this stuff in the nineteen-seventies. And what have we done?" ♦

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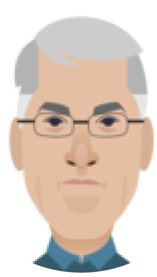

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