This Is Your Brain on Silence

Contrary to popular belief, peace and quiet is all about the noise in your head.

By Daniel A. Gross Illustration By Leonard Peng July 7, 2016

One icy night in March 2010, 100 marketing experts piled into the Sea Horse Restaurant in Helsinki, with the modest goal of making a remote and medium-sized country a world-famous tourist destination. The problem was that Finland was known as a rather quiet country, and since 2008, the Country Brand Delegation had been looking for a national brand that would make some noise.

Over drinks at the Sea Horse, the experts puzzled over the various strengths of their nation. Here was a country with exceptional teachers, an abundance of wild berries and mushrooms, and a vibrant cultural capital the size of Nashville, Tennessee. These things fell a bit short of a compelling national identity. Someone jokingly suggested that nudity could be named a national theme—it would emphasize the honesty of Finns. Someone else, less jokingly, proposed that perhaps quiet wasn't such a bad thing. That got them thinking.

A few months later, the delegation issued a slick "Country Brand Report." It highlighted a host of marketable themes, including Finland's renowned educational system and school of functional design. One key theme was brand new: silence. As the report explained, modern society often seems intolerably loud and busy. "Silence is a resource," it said. It could be marketed just like clean water or wild mushrooms. "In the future, people will be prepared to pay for the experience of silence."

People already do. In a loud world, silence sells. Noise-canceling headphones retail for hundreds of dollars; the cost of some weeklong silent meditation courses can run into the thousands. Finland saw that it was possible to quite literally make something out of nothing.

In 2011, the Finnish Tourist Board released a series of photographs of lone figures in the wilderness, with the caption "Silence, Please." An international "country branding" consultant, Simon Anholt, proposed the playful tagline "No talking, but action." And a Finnish watch company, Rönkkö, launched its own new slogan: "Handmade in Finnish silence."

Also in Neuroscience

A Crowdsourced Expert Interview

By Nautilus Commenters

In "Metaphors Are Us," biologist and neurologist Robert Sapolsky made a good case for why symbolic thinking may be the key feature separating humans from our nearest animal relatives. But that essay didn't end the discussion, which spilled onto social...**READ MORE**

"We decided, instead of saying that it's really empty and really quiet and nobody is talking about anything here, let's embrace it and make it a good thing," explains Eva Kiviranta, who manages social media for VisitFinland.com.

In a loud world, silence sells. Finland saw that it was possible to quite literally make something out of nothing.

Silence is a peculiar starting point for a marketing campaign. After all, you can't weigh, record, or export it. You can't eat it, collect it, or give it away. The Finland campaign raises the question of just what the tangible effects of silence really are. Science has begun to pipe up on the subject. In recent years researchers have highlighted the peculiar power of silence to calm our bodies, turn up the volume on our inner thoughts, and attune our connection to the world. Their findings begin where we might expect: with noise.

The word "noise" comes from a Latin root meaning either queasiness or pain. According to the historian Hillel Schwartz, there's even a Mesopotamian legend in which the gods grow so angry at the clamor of earthly humans that they go on a killing spree. (City-dwellers with loud neighbors may empathize, though hopefully not too closely.)

Dislike of noise has produced some of history's most eager advocates of silence, as Schwartz explains in his book *Making Noise: From Babel to the Big Bang and Beyond*. In 1859, the British nurse and social reformer Florence Nightingale wrote, "Unnecessary noise is the most cruel absence of care that can be inflicted on sick or well." Every careless clatter or banal bit of banter, Nightingale argued, can be a source of alarm, distress, and loss of sleep for recovering patients. She even quoted a lecture that identified "sudden noises" as a cause of death among sick children.

The Quiet Sell: Two wooden armchairs stand on a lake shore in Finland, where marketers have rebranded the Nordic country with a slogan, "Silence, Please."veer.com

Surprisingly, recent research supports some of Nightingale's zealous claims. In the mid 20th century, epidemiologists discovered correlations between high blood pressure and chronic noise sources like highways and airports. Later research seemed to link noise to increased rates of sleep loss, heart disease, and tinnitus. (It's this line of research that hatched the 1960s-era notion of "noise pollution," a name that implicitly refashions transitory noises as toxic and long-lasting.)

Studies of human physiology help explain how an invisible phenomenon can have such a pronounced physical effect. Sound waves vibrate the bones of the ear, which transmit movement to the snail-shaped cochlea. The cochlea converts physical vibrations into electrical signals that the brain receives. The body reacts immediately and powerfully to these signals, even in the middle of deep sleep. Neurophysiological research suggests that noises first activate the amygdalae, clusters of neurons located in the temporal lobes of the brain, associated with memory formation and emotion. The activation prompts an immediate release of stress hormones like cortisol. People who live in consistently loud environments often experience chronically elevated levels of stress hormones.

Just as the whooshing of a hundred individual cars accumulates into an irritating wall of background noise, the physical effects of noise add up. In 2011, the World Health Organization tried to quantify its health burden in Europe. It concluded that the 340 million residents of western

Europe—roughly the same population as that of the United States—annually lost a million years of healthy life because of noise. It even argued that 3,000 heart disease deaths were, at their root, the result of excessive noise.

So we like silence for what it doesn't do—it doesn't wake, annoy, or kill us—but what does it do? When Florence Nightingale attacked noise as a "cruel absence of care," she also insisted on the converse: Quiet is a part of care, as essential for patients as medication or sanitation. It's a strange notion, but one that researchers have begun to bear out as true.

Two-minute silent pauses proved far more relaxing than either "relaxing" music or a longer silence played before the experiment started.

Silence first began to appear in scientific research as a control or baseline, against which scientists compare the effects of noise or music. Researchers have mainly studied it by accident, as physician Luciano Bernardi did in a 2006 study of the physiological effects of music. "We didn't think about the effect of silence," he says. "That was not meant to be studied specifically."

He was in for a quiet surprise. Bernardi observed physiological metrics for two dozen test subjects while they listened to six musical tracks. He found that the impacts of music could be read directly in the bloodstream, via changes in blood pressure, carbon dioxide, and circulation in the brain. (Bernardi and his son are both amateur musicians, and they wanted to explore a shared interest.) "During almost all sorts of music, there was a physiological change compatible with a condition of arousal," he explains.

This effect made sense, given that active listening requires alertness and attention. But the more striking finding appeared between musical tracks. Bernardi and his colleagues discovered that randomly inserted stretches of silence also had a drastic effect, but in the opposite direction. In fact, two-minute silent pauses proved far more relaxing than either "relaxing" music or a longer silence played before the experiment started.

The blank pauses that Bernardi considered irrelevant, in other words, became the most interesting object of study. Silence seemed to be heightened by contrasts, maybe because it gave test subjects a release from careful attention. "Perhaps the arousal is something that concentrates the mind in one direction, so that when there is nothing more arousing, then you have deeper relaxation," he says.

In 2006, Bernardi's paper on the physiological effects of silence was the most-downloaded research in the journal *Heart*. One of his key findings—that silence is heightened by contrasts—is reinforced by neurological research. In 2010, Michael Wehr, who studies sensory processing in the brain at the University of Oregon, observed the brains of mice during short bursts of sound. The onset of a sound prompts a specialized network of neurons in the auditory cortex to light up. But when sounds continue in a relatively constant manner, the neurons largely stop reacting. "What the neurons really do is signal whenever there's a change," Wehr says.

The sudden onset of silence is a type of change too, and this fact led Wehr to a surprise. Before his 2010 study, scientists knew that the brain reacts to the start of silences. (This ability helps us react to dangers, for example, or distinguish words in a sentence.) But Wehr's research extended those findings by showing that, remarkably, the auditory cortex has a separate network of neurons that fire when silence begins. "When a sound suddenly stops, that's an event just as surely as when a sound starts."

Even though we usually think of silences as a lack of input, our brains are structured to recognize them, whenever they represent a sharp break from sounds. So the question is what happens after that moment—when silence continues, and the auditory cortex settles into a state of relative inactivity.

One of the researchers who's examined this question is a Duke University regenerative biologist, Imke Kirste. Like Bernardi, Kirste wasn't trying to study silence at all. In 2013, she was examining the effects of sounds in the brains of adult mice. Her experiment exposed four groups of mice to various auditory stimuli: music, baby mouse calls, white noise, and silence. She expected that baby mouse calls, as a form of communication, might prompt the development of new brain cells. Like Bernardi, she thought of silence as a control that wouldn't produce an effect.

As it turned out, even though all the sounds had short-term neurological effects, not one of them had a lasting impact. Yet to her great surprise, Kirste found that two hours of silence per day prompted cell development in the hippocampus, the brain region related to the formation of memory, involving the senses. This was deeply puzzling: The total absence of input was having a more pronounced effect than any sort of input tested.

Here's how Kirste made sense of the results. She knew that "environmental enrichment," like the introduction of toys or fellow mice, encouraged the development of neurons because they challenged the brains of mice. Perhaps the total absence of sound may have been so artificial, she reasoned—so alarming, even—that it prompted a higher level of sensitivity or alertness in the mice. Neurogenesis could be an adaptive response to uncanny quiet.

The growth of new cells in the brain doesn't always have health benefits. But in this case, Kirste says that the cells seemed to become functioning neurons. "We saw that silence is really helping the new generated cells to differentiate into neurons, and integrate into the system."

While Kirste emphasizes that her findings are preliminary, she wonders if this effect could have unexpected applications. Conditions like dementia and depression have been associated with decreasing rates of neurogenesis in the hippocampus. If a link between silence and neurogenesis could be established in humans, she says, perhaps neurologists could find a therapeutic use for silence.

To her great surprise, she found that two hours of silence per day prompted cell development in the hippocampus region of the brain.

While it's clear that external silence can have tangible benefits, scientists are discovering that under the hoods of our skulls "there isn't really such a thing as silence," says Robert Zatorre, an expert on

the neurology of sound. “In the absence of sound, the brain often tends to produce internal representations of sound.”

Imagine, for example, you’re listening to Simon and Garfunkel’s “The Sound of Silence,” when the radio abruptly cuts out. Neurologists have found that if you know the song well, your brain’s auditory cortex remains active, as if the music is still playing. “What you’re ‘hearing’ is not being generated by the outside world,” says David Kraemer, who’s conducted these types of experiments in his Dartmouth College laboratory. “You’re retrieving a memory.” Sounds aren’t always responsible for sensations—sometimes our subjective sensations are responsible for the illusion of sound.

This is a reminder of the brain’s imaginative power: On the blank sensory slate of silence, the mind can conduct its own symphonies. But it’s also a reminder that even in the absence of a sensory input like sound, the brain remains active and dynamic.

In 1997, a team of neuroscientists at Washington University was collecting brain scan data from test subjects during various mental tasks, like arithmetic and word games. One of the scientists, Gordon Shulman, noticed that although intense cognition caused spikes in some parts of the brain, as you’d expect, it was also causing declines in the activity of other parts of the brain. There seemed to be a type of background brain activity that was most visible, paradoxically, when the test subject was in a quiet room, doing absolutely nothing.

The team’s lead scientist was Marcus Raichle, and he knew there were good reasons to look closer at the data. For decades, scientists had known that the brain’s “background” activity consumed the lion’s share of its energy. Difficult tasks like pattern recognition or arithmetic, in fact, only increased the brain’s energy consumption by a few percent. This suggested that by ignoring the background activity, neurologists might be overlooking something crucial. “When you do that,” Raichle explains, “most of the brain’s activities end up on the cutting room floor.”

In 2001, Raichle and his colleagues published a seminal paper that defined a “default mode” of brain function—situated in the prefrontal cortex, active in cognitive actions—implying a “resting” brain is perpetually active, gathering and evaluating information. Focused attention, in fact, curtails this scanning activity. The default mode, Raichle and company argued, has “rather obvious evolutionary significance.” Detecting predators, for example, should happen automatically, and not require additional intention and energy.

Follow-up research has shown the default mode is also enlisted in self-reflection. In 2013, in *Frontiers in Human Neuroscience*, Joseph Moran and colleagues wrote the brain’s default mode network “is observed most closely during the psychological task of reflecting on one’s personalities and characteristics (self-reflection), rather than during self-recognition, thinking of the self-concept, or thinking about self-esteem, for example.” During this time when the brain rests quietly, wrote Moran and colleagues, our brains integrate external and internal information into “a conscious workspace.”

Freedom from noise and goal-directed tasks, it appears, unites the quiet without and within, allowing our conscious workspace to do its thing, to weave ourselves into the world, to discover where we fit in. That’s the power of silence.

Noora Vikman, an ethnomusicologist, and a consultant on silence for Finland’s marketers, knows that power well. She lives in the eastern part of Finland, an area blanketed with quiet lakes and forests. In a remote and quiet place, Vikman says, she discovers thoughts and feelings that aren’t

audible in her busy daily life. “If you want to know yourself you have to be with yourself, and discuss with yourself, be able to talk with yourself.”

“Silence, Please” has proven to be the most popular theme in Finland’s rebranding, and one of the most popular pages on VisitFinland.com. Maybe silence sells because, so often, we treat it as a tangible thing—something easily broken, like porcelain or crystal, and something delicate and valuable. Vikman remembers a time when she experienced the rarity of nearly complete silence. Standing in the Finnish wilderness, she strained her ears to pick out the faintest sounds of animals or wind. “It’s strange,” she says, “the way you change. You have all the power—you can break the silence with even with the smallest sounds. And then you don’t want to do it. You try to be as quiet as you can be.”

Daniel A. Gross is a freelance journalist and public radio producer who writes about history and science