

Activating the Brain



From left: Mitch Tyler, senior lecturer in biomedical engineering, Kurt Kaczmarek and Yuri Danilov

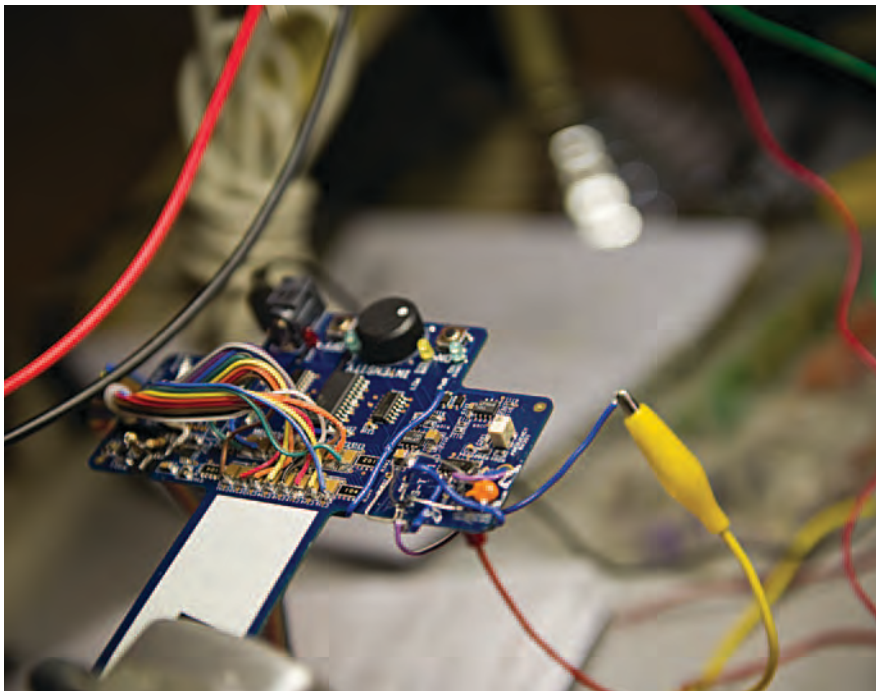
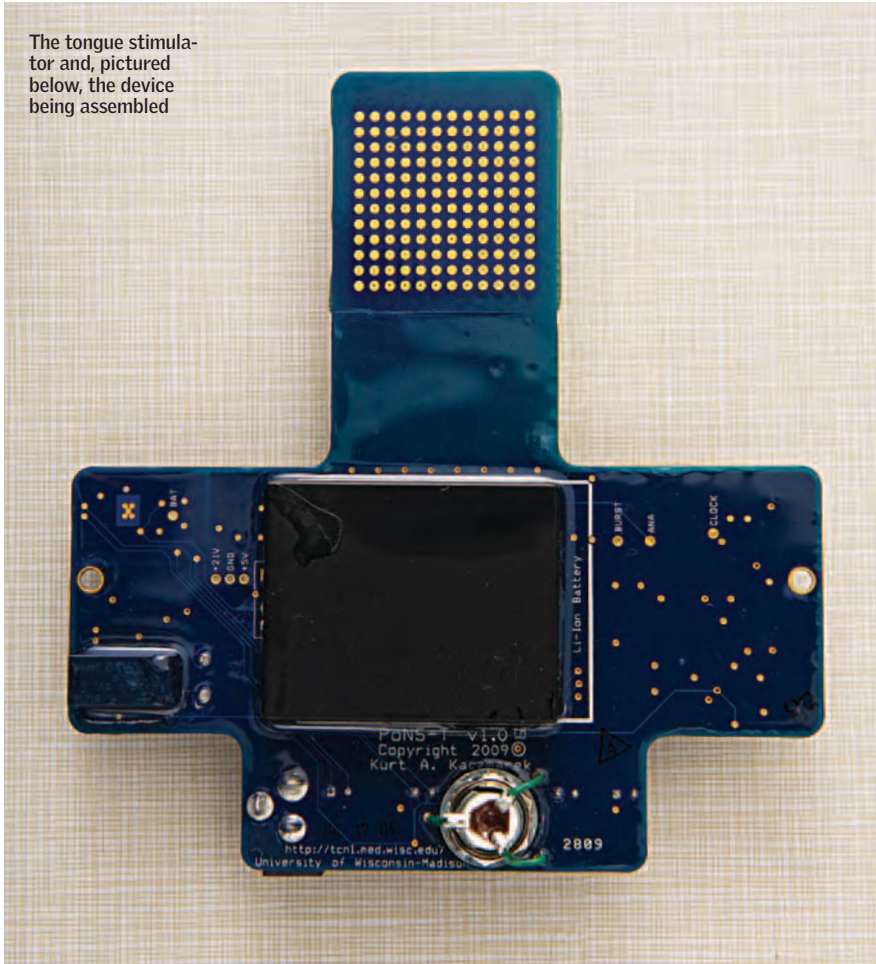
Can something as simple as an electronic tongue stimulator really help the brain heal itself? It appears so. **By Harvey Black**

Ron Husmann's life was pretty good, to say the least. By the time he was 41, he had appeared on Broadway in a featured role in the musical *Fiorello!*, toured with Howard Keel in *Camelot* and been nominated for a best actor Tony Award for his 1960 performance in *Tenderloin*. What's more, he had acted in a number of major television series, such as *Cheers*, *12 O'Clock High* and *Dr. Kildare*. But it all started to fall apart when, in 1981 at the age of 44, he contracted multiple sclerosis (MS). By the next year, his voice, his livelihood and the talent that had given so much meaning to his life were gone. But thanks to an innovative experimental technique developed at the University of Wisconsin that involved electrically stimulating the nerves in his tongue, not only can the Rockford, Ill., native talk again, but he can also sing.

"By the time I got to Wisconsin, I could hardly talk," says Husmann, who now lives in Los Angeles. "I would lose my voice completely. After the first day, I realized I was able to hum. And then I realized I could speak really loudly. It was a shock. I was able to sing. It was the first time I've been able to sing a whole song in 30 years. All of a sudden, I just totally broke down. It was incredible. It didn't sound good, but the fact that I was able to sustain all the way through was shocking."

Prior to Husmann's receiving the tongue stimulation last fall in the university's Tactile Communication & Neurorehabilitation Lab, University of Wisconsin speech pathologist Sherri Zelazny evaluated him. "If 100 is normal speaking effort, he said he

The tongue stimulator and, pictured below, the device being assembled



was working 500 to 1,000 times as hard to produce voice for speaking,” she says.

Two weeks after the treatment, he felt his voice was easier to produce. She says he rated his speaking effort at 120 — “just barely perceptible [effort],” she explains.

The success came as a surprise — and not just to Husmann. Yuri Danilov, Ph.D., the lab’s neuroscience director, recalls telling Husmann, “Losing your voice has taken years. It would be too naive to think we could fix it in a few minutes or a few hours.” Danilov now says, matter-of-factly, “I was wrong.”

MULTIPLE SCLEROSIS causes nerves to fail to properly conduct the impulses that tell our muscles and organs what to do. The fatty coating of nerves, called the myelin sheath, degenerates, thus blocking or interrupting the normally smooth and swift conduction of impulses. MS is thought by many scientists to be an autoimmune disease in which the body’s immune system essentially starts to ravage it.

Husmann was part of a pilot study exploring the effect of tongue stimulation on these MS symptoms.

Powered by a rechargeable battery, the electronic stimulator delivers millions of impulses to the tongue in a typical 20-minute session. The wafer-thin stimulator (one millimeter thick) is about two inches long and slightly less wide than the tongue.

As Danilov explains it, two major nerves in the tongue are connected to the brain stem, a region in the back of the brain that controls a variety of housekeeping functions, such as heart rate, breathing and consciousness. These are things we seldom pay attention to but that we couldn’t get along without. This stimulation, when received by the brain stem, in effect branches out and stimulates many parts of the brain, effectively repairing it.

“We’re not treating MS; we’re recovering the damaged functions of MS,” Danilov says. “We’re seeing the ability of the brain to change. The brain is fixing itself.”

The idea of the brain’s plasticity — being able to repair itself in this way — was pioneered in the 1960s by the late Paul Bach-y-Rita, M.D., a neuroscientist who worked at the University of Wisconsin.

At the time, it was a heretical notion, explains Kurt Kaczmarek, Ph.D., an engineer

and a scientist who worked with Bach-y-Rita and who now works with Danilov, because back then, the prevailing view was that the brain became fixed during adulthood and thus lacked the ability to change. But through hard work and thought (like Bach-y-Rita's), that view has been proved wrong. Famously, in the late 1950s, when his father suffered a stroke, Bach-y-Rita and his brother had their father do physical activities like sweeping the porch instead of simply resting in a nursing home. This led to their father recovering physical abilities that had been damaged by the stroke.

"The thought is that at each incremental step, the brain is improving itself. That's what we believe the tongue stimulation is doing — enhancing what the brain is already capable of," Kaczmarek says.

A major goal of Kaczmarek and his colleagues is to find out how far these "interventions" — a term he favors over the word *treatment* — can push the brain to repair itself.

Exactly how that repair happens isn't certain, admits Danilov. But there are several possible mechanisms. Pointing to a drawing of the brain stem on his office wall, he demonstrates how the impulses from the tongue travel to the brain stem and then either a) go directly to other parts of the brain via neural pathways; b) stimulate certain nerves in the reticular formation, a structure in the brain stem, which may in turn "activate the whole brain"; or c) stimulate brain stem neurons, leading to the release and diffusion of multiple neurochemical compounds (including the neurotransmitter serotonin). The brain stem activation then helps coordinate muscular activity, balance and the transmitting of information from the eyes and ears. It may also send signals to muscles involved in breathing, voice, speech and swallowing.

BUT ACTIVATING the brain is just a part of the key, explains the burly, 6-foot-6-inch Danilov, a native of Russia.

People in the research study are also exercising the function that has been impaired. "You start to exercise balance, [then] balance improves," Danilov says. "If you exercise memory and attention, these functions improve. You exercise what you need to exercise. The issue becomes how to focus this activity on the area or deficiency that

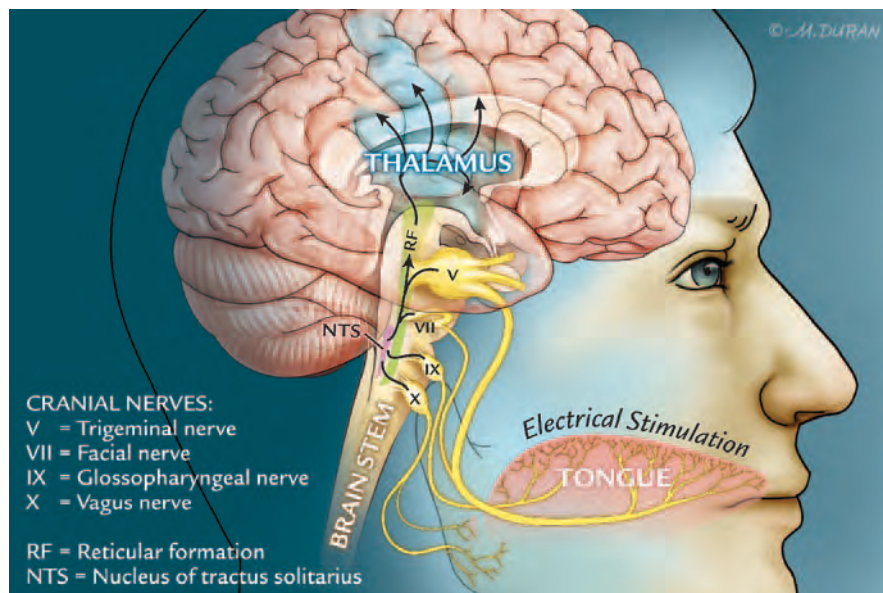


ILLUSTRATION BY MICA DURÁN

you want to fix."

Along with his voice, Husmann's balance and ability to walk have improved — in fact, the cane he once used is gathering dust.

And he's not the only one whose balance and ability to walk have improved as a result of the intervention in Danilov's lab.

Wendy Machi of West Allis, Wis., went to Danilov's lab in January. Having lived with MS since 1983, the 47-year-old mother of three had been struggling with balance. "Closing my eyes and standing was virtually impossible for me. I would immediately start to tip over and fall," she says.

During her two weeks at the lab, her regimen consisted of twice-daily 20-minute sessions that mixed balance exercises and walking on a treadmill while the tongue stimulator was in her mouth.

"I can close my eyes for 20 minutes, even longer, without falling over. The first time I did that and knew no one was helping me, I started crying, because I hadn't done that for so many years," Machi says.

Fifty-year-old Angel Tucker of Byron, Ill., has a similar story.

"Before, it was like there was no hope," she says. Prior to this, I was just going downhill, to the point where I had my dad's walker ready for use. [But] after the first three days [of the study], my outlook changed ... I could walk. The first week I was in the study, I walked, like, eight miles in a week. I had never done that in my life."

As impressive as such statements appear,

there are still significant scientific questions that Danilov and his colleagues are working to answer. For instance, are the improvements that the participants experience the result of the tongue stimulation or the exercises? To find out, they are now studying the effects of just the exercises alone.

Knowing the answer to this question is vital, as it holds the key to the development of the technology and other neurological problems.

And even as that research is in progress, Danilov and his colleagues are looking at extending their technology to other disorders.

"We want to test as many conditions as we can, and we want to see within any condition how far can we push it," Kaczmarek says. The one they're currently testing: Parkinson's disease. Not only might these efforts hold promise for people with degenerative disorders, but, "from a theoretical point of view, they tell us how capable the brain is in reorganizing itself from a very damaged state," Kaczmarek explains.

Additionally, they are also working on improving the tongue stimulator from a lab prototype to a commercial device. As for Ron Husmann, at 73, he's happily retired with no plans to sing again professionally. But these days, when he wants to sing to himself, he can.

HARVEY BLACK is a freelance science writer based in Madison, Wis. He has written for *Environmental Health Perspectives*, the *Scientist*, the *Milwaukee Journal Sentinel* and *New Scientist*, among other publications.