Medical Xpress

Researcher studies ways to enhance cochlear implants

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Credit: Rush University Medical Center

What is hearing? For Valeriy Shafiro, PhD, that question is fundamental, even though it's one that most people who hear well may probably never think about.

A researcher and associate professor in the Department of Communication Disorders and Sciences in the Rush College of Health Sciences, Shafiro can't help but consider the nature of hearing every day of his work life. On the one hand, he knows how enormously important hearing is—it's crucial to acquisition of language, safety, social contact and how we perceive the world around us. Hearing well also is essential to many livelihoods, from musicians to doctors, who have to be certain they are hearing words correctly.

Yet Shafiro also knows that this extraordinarily varied and important sensory experience ultimately is just waves of air hitting the ear at varying frequencies—and what the brain makes of them.

"What comes to our eardrum is continuous change in air pressure," Shafiro explains. Inside the ear, stereocilia—tiny hairlike projections from sensory cells in the inner ear—harness the waves' energy and send it to the brain. However, individuals' brains have to interpret what they've heard.

"We have to give it a discrete unit of meaning. In principle, I'm trying to see what the conditions are under which people can and can't do that," he says.

Taking success further

Shafiro is the principal investigator in the Rush Auditory Research Laboratory, which studies how people of different ages and hearing abilities perceive sounds, and how the brain processes them.

Much of the laboratory's current research is focused on cochlear implants, electronic devices that provide hearing assistance to deaf and other hearing-impaired individuals who do not benefit from hearing aids. Unlike hearing aids, which amplify sound, a cochlear implant directly stimulates the auditory nerve. This technology can only work when the auditory nerve is sufficiently preserved and contains enough living nerve fibers.

"Cochlear implants are the most successful artificial sensory system developed so far," Shafiro says. "They have been really helpful in alleviating the handicap of deafness." However, even though implants have improved greatly over the past 25 years, they don't restore normal hearing.

Adults who have some experience with oral language and children are the best candidates for cochlear implants, called CIs for short. For people who grew up without developing aural communication abilities and using only the American Sign Language, the benefits are considerably reduced. Although many still choose to get CIs to have some sound awareness, for them "the auditory experience can even be a nuisance," Shafiro says.

However, for hearing-impaired individuals—even those who could hear at one time—recognition of common sounds even with implants can still be a challenge. A strong thread of research at Shafiro's laboratory is the investigation into how to improve this recognition and the overall CI experience.

Online training teaches hearing impaired to recognize sounds

The laboratory has been investigating the use of computerized training to discern speech and other sounds in the environment, and it appears to help CI users hear better. Last year, the American Speech-Language-Hearing Foundation awarded Shafiro a $75,000 grant to continue this work. The grant will help extend an encouraging pilot study of the training for two years. (The foundation is the philanthropic arm of the American Speech-Language-Hearing Association, a professional group for speech and hearing clinicians and researchers.)

In the latest phase of the study, three groups of 20 to 25 people who use cochlear implants will engage in computerized auditory training tasks for 30 to 40 minutes at a time for up to four weeks. The program will be online.

During training, participants will hear words and sentences spoken by different people, either in quiet or amid background noise, and will have to guess what people are saying. In other conditions, they will hear common environmental sounds—such as alarms, cars, running water and singing birds—and will be asked to name them.

These sounds also will be heard separately or embedded in common auditory scenes, such as ambience of a person's kitchen, an urban street, or a beach. It is expected that some of these listening situations will be very challenging, while others should be quiet easy. These kinds of auditory exercises are designed to train the participants' brains to interpret information about sound their implants are providing.

The novel aspect of this work is that the training will be conducted fully through the internet. Although initially participants in this phase of the study will be drawn from the Chicago area, users could be anywhere. "Patients don't need to come in to the center," Shafiro says.

The hope is that both speech perception and the perception of environmental sounds will improve for people who receive the training, and that the improvement will persist after the training stops. "This could be an inexpensive way to help people get the most out of their implants," Shafiro says. "If we find that some kinds of training are more effective than others, we'll focus on those going forward."

Helping people understand what they're missing

Around 100,000 people in the United States have been fitted with CIs since the mid-1980s, when they were first approved by the federal Food and Drug Administration, according to the National Institute on Deafness and Other Communication Disorders. While the implants have improved considerably since then, Shafiro says the "the low-hanging fruit" of technological advances may have been harvested. However, he thinks that training in speech, music and environmental sounds, which can be trickier to perceive, still offers some exciting possibilities for enhancement.

"A lot of what we hear is affected by our expectations—what we know a church bell, or a lowing cow, will sound like," Shafiro says. The Acoustic Research Laboratory is working to expand CI users' experience of hearing to sounds people may not even realize they're missing.

Some of those sounds can be mighty important, Shafiro notes. The mother of a CI user he knows told him of driving with her daughter when the younger woman changed lanes abruptly, drawing honks from a car she had cut off. "Didn't you hear that car horn?" the mother asked, to which the daughter replied, "What car horn?"

For the clinician, this issue has to be addressed before trying to assess how well an implant is working. Otherwise, Shafiro asks, "if people don't know what they're missing, how do they know there's a problem?"

'A lot depends on how you interpret the world'

One CI can cost between $40,000 and $100,000. Insurance companies may only pay for one implant, which can make the difference between hearing and not hearing, but two implants are demonstrably better than one, Shafiro observes.

"There's a big benefit that comes with that second implant. The individual knows where sounds are coming from, can hear multiple people talking, localize the speaker, understand noisy situations," he says. However, the benefits of getting the first implant are much more obvious than those of getting a second implant, which makes insurance companies reluctant to pay for the second one.

Even the experience of normal hearing is subjective. Some people love the sound of trilling birds while others find the same sound annoying, Shafiro notes. "A lot of it depends on how you interpret the world around you," he says.

Gaining understanding in how we understand each other

Shafiro was born in Odessa, Ukraine, and grew up there and in Russia. He was a nurse during his service in the then-Soviet army, and came to the United States with his parents at the age of 21 right before the breakup of the Union of Soviet Socialist Republics.

"Many fields of study were open to me here that wouldn't have been in the Soviet Union," he says. He wanted to apply the medical aspects of his nursing training, but he also wanted to stretch beyond it.

He earned a bachelor's degree in psychology from New York University and received his PhD, in speech and hearing sciences, from the City University of New York. "Studying speech and hearing seemed like a fascinating intersection of medicine and the theoretical questions of how we process information and understand one another," he says.

Provided by Rush University Medical Center