By Kate Carney

WIRED FOR SOUND

From cochlear implants to language training, the Bill Wilkerson Center offers help and hope to the 10 percent of Americans with hearing problems.

One evening not long ago, Bob Geldreich was wandering around his Franklin, Tenn., home, determined to track down the source of an unfamiliar noise. "It was a scratchy sound I had never heard before," he remembers. "I knew it wasn't the dogs, and I knew it wasn't the TV. I looked all over the house and finally found our kitten playing with a piece of paper."

Then there was the day Bob learned to tell the difference between the ticking of the grandfather clock and the sound made by the computer keyboard. And the day his wife, Beverly, discovered that automobile turn signals make their own clicking sound. And the day Beverly started hearing music and discovered her mother in another room playing the piano—something she had never heard before.

And the memorable day the couple accidentally pulled into a fire lane at the grocery store and learned just how loud a siren can be.

Bob, 58, and Beverly, 56, have been married 35 years, but it wasn't until Aug. 1, 2005, that they heard each other's voices for the first time. That was the day their cochlear implants were turned on. Since then the Geldreichs, who both had been unable to hear since infancy, have been exploring a whole new world of sound, voices and music.

Bob and Beverly Geldreich never heard each other's voices until they'd been married more than three decades.

NEIL BRAKE

A cochlear implant is an electronic device that is surgically placed in the cochlea—the part of the inner ear that, in typical hearing, picks up sound vibrations and transmits the signals to the auditory nerve. In many people who have hearing loss, part or all of the cochlea is damaged and no longer transmits those signals naturally. The cochlear implant is essentially an artificial cochlea that converts outside sounds to electronic signals and transmits them directly to the nerve of hearing and the brain.

Vanderbilt otolaryngology surgeon Dr. David Haynes performed the Geldreichs' surgeries on the same day. Implanting a husband and wife on the same day was a first for him. "They're both doing very well," Haynes says. "They can hear in what we consider a normal range now, and their speech is much more understandable."

Haynes is part of a much larger team of physicians, audiologists, teachers, speech-language pathologists and researchers working to find new treatments for hearing loss at the Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences. The center comprises Vanderbilt's Department of Otolaryngology and Department of Hearing and Speech Sciences. Vanderbilt's audiology program is ranked No. 1 in the nation, and its speech-language pathology training program is ranked No. 6 in the latest graduate school rankings by *U.S. News and World Report* magazine. The Department of Hearing and Speech Sciences boasts one of the largest faculties and staffs in the country, numbering more than 100.

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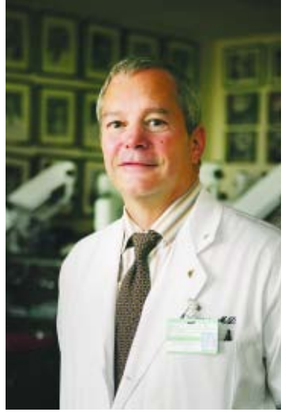
>
> — Dr. David Haynes, otolaryngology surgeon



DANIEL DUBOIS

For people who have been deaf from birth or infancy like the Geldreichs, the road to hearing well with a cochlear implant can be lengthy. Small children who receive implants are young enough to learn hearing and speech on an almost typical schedule, and the plasticity of their brain development helps them soak up language like a sponge. Adults who lost their hearing as adults are also ahead of the game; they have a memory of sound and an existing knowledge of speech sounds to work with. But adults who have been without any useful hearing for 40 or 50 years must work very hard to decipher and put meaning to the new sounds they are hearing.

Although the Geldreichs could hear sounds as soon as they were hooked up, they say it took six to nine months to get to the point where they understood immediately what the sounds were. At first, the sheer quantity and variety of sounds could be overwhelming. Now they can make the distinction between the organ and hand bells at church, they hear birds and their pets, and they can hear the voices of their children and each other.

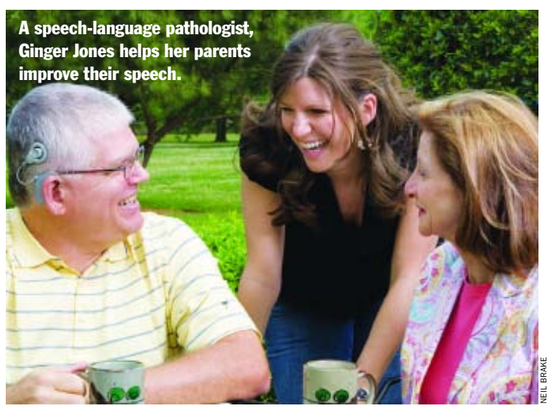
Being able to hear so well does have its drawbacks. Bob says he can't hear the TV when Beverly is using the blow dryer. Beverly argues with him about the volume. And they still have difficulty localizing sound. Recently, they spent two or three days trying to find a humming noise only to discover they had left the vent fan on over the stove.

The Geldreichs are developing more understandable speech, which is exciting to them and their family. Their daughter, Ginger Jones, is a speech-language pathologist at the Bill Wilkerson Center who specializes in speech and language development in individuals with hearing loss. Her parents received formal speech therapy for a while after they were implanted, and Jones has worked informally with them since that time.

"My dad has made the most improvement," says Jones. "Both my parents developed very good spoken-language skills as children, but my mom's speech was always easier for unfamiliar listeners to understand. Having the implant has motivated my dad to work hard on making his speech more intelligible."

Bob is a part-time personal assistant to a man who is both deaf and blind. They communicate by signing into each other's hands. Beverly stays busy with home, family and Jazzercise (she says she enjoys being able to hear the music now), and they both are active in the local chapter of Hearing Loss America. "A couple of friends in Hearing Loss America had received implants and loved them, so we decided to try it," she remembers. "What would I tell others who were thinking about implants? I'd tell them to go for it."

Bob Geldreich has come full circle. He was one of the first children with hearing loss to receive speech therapy at the Bill Wilkerson Center in the 1950s. He remembers hours of speech therapy there with other children, passing headphones and microphones around the table.



A speech-language pathologist, Ginger Jones helps her parents improve their speech.

NEIL BRAKE

Better Implants, Safer Surgery

The Bill Wilkerson Center came into being in 1956 (see sidebar "Who Was Bill Wilkerson?"), but not until 1997, when it lacked the physical and fiscal resources to provide for needed growth, did the center merge with its longtime neighbor, Vanderbilt University Medical Center.

Despite one name and one big organizational chart, Bill Wilkerson's programs were fragmented geographically, housed in several buildings around campus until 2005, when the center moved into 139,000 square feet of space on five floors of a $61 million, nine-story building adjacent to Vanderbilt Hospital. Space in the new Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences is designed to encourage interdisciplinary collaboration and research in all of the speech, language and hearing sciences, and otolaryngology specialties. It has been hailed as the first of its kind in the world to create space where medical and therapeutic intervention are used in partnership to treat communication disorders.

The center handles more than 50,000 patient visits a year, treating people challenged by the entire range of communication-related and otolaryngological diseases and disorders like deafness, autism, head and neck cancer, accidental brain injury, vocal disorders, sinus diseases, speech and language delays, balance disorders, and other debilitating conditions of the head, neck, ear, nose and throat.

Hearing loss is the third most prevalent health problem in the United States, with more than 10 percent of the population having some hearing problem. New developments in cochlear implants are enlarging the demographic of people who can be implanted. "We used to tell people they could only get an implant if they had no hearing at all," says Haynes. "Now we're considering people who may still have some hearing but aren't getting any benefit from hearing aids. Anyone of any age who is not doing well with a hearing aid could be considered a candidate for an implant." As technology improves, speech processing in the implant improves and users get better results.

On the horizon are implants that have a shorter electrode array so that surgeons are able to create better hearing—but also preserve hearing that is left. Currently, the electrode array on a cochlear implant is long enough to obliterate all the "nerve endings" of the hair cells of the inner ear. If all the hair cells are nonfunctioning, this isn't a problem. But if some of the lower frequencies are still viable, a shorter electrode array will enable hearing in the higher frequencies that no longer work and leave natural hearing in the lower frequencies. This new technology may again increase the number of people who are good candidates for the device.

Researcher Dr. Rob Labadie, assistant professor of otolaryngology, is trying to create a way to make cochlear implants less invasive and more appealing by developing image-guided techniques for ear surgery. Surgeons have been using scans and markers in other types of surgery for years, but commercially available systems aren't accurate enough for the complicated and delicate area around the ear. Because of the close proximity of vital systems—auditory and facial nerves, vascular structures—accuracy in ear surgery must be within a millimeter, a level that standard image-guided techniques can't achieve.

"The key," says Labadie, "is linking the patient to the X-ray with immobile markers [on the body]. Stick-on markers don't work because skin moves too much for the accuracy level we need." Labadie and colleagues have developed a marker system that attaches to patients via a dental bite block—similar to an athletic mouth guard.

"Mounting the marker system on the dental guard allows placement of the markers surrounding the ears, which allows accuracy to be within a millimeter," he says. Trained in both engineering and medicine, Labadie is also exploring the idea of using computer-guided robotics to assist in ear surgeries. "If we can make these techniques available in rural areas

Who Was Bill Wilkerson?

The Bill Wilkerson Center has been around 51 years. That's more than twice as long as its namesake, who died in 1945 at age 19.

The son of Wesley Wilkerson, a Nashville eye, ear, nose and throat doctor, Bill loved history and archaeology. He knew the location of Civil War trench lines around Nashville, and where Native American tribes had lived and traveled. Many days found him riding horseback through Lealand Hills, south of Nashville, collecting musket balls, mini cannon balls and arrowheads. For Christmas when Bill was 16, his parents gave him a folding shovel, one he could carry on his horse to dig for relics.

In 1943, when he was 17, Bill volunteered for the Civil Air Patrol. He graduated from Hillsboro High and took a few classes at Vanderbilt. He enlisted in the Army and volunteered to be a forward observer in the largest ground battle of World War II, the Battle of the Bulge. Bill Wilkerson was one of more than 19,000 American men to die between Dec. 16, 1944, and Jan. 28, 1945.

"Mother and Daddy would not speak of Bill after he died. It was devastating to them," Bill's sister Nancy Fawn Wilkerson Diehl remembered in a 2002 interview with the *Vanderbilt Reporter*.

Since the 1930s, Dr. Wesley Wilkerson had lobbied and pushed for a center for hearing and speech sciences. When it finally came to fruition, the board surprised Wilkerson by voting unanimously to name the center after Bill.

When ground was broken on the original building a few blocks east of the Vanderbilt campus in May 1956, Wesley used the folding shovel that had belonged to his son.

In 1997 the Bill Wilkerson Center merged with Vanderbilt University Medical Center and became the Vanderbilt Department of Hearing and Speech Sciences. Partnered with the Department of Otolaryngology, the combined departments are now known as the Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences.

When ground was broken for a new state-of-the-art building to house the center on the Medical Center campus in December 2002, Bill's sisters, Jane Wilkerson Yount and Nancy Fawn, dug that same spade into a pile of sand.

— CLINTON COLMENARES

Oral Tradition

At the Mama Lere Hearing School, most of the 30 or so preschoolers were born with little or no hearing. Half have cochlear implants, and the other half wear traditional hearing aids. About a third have multiple disabilities. But all are learning to talk and listen without using sign language, and a few of the 5-year-olds are beginning to read.

Housed in the Bill Wilkerson Center, the Mama Lere Hearing School is part of the National Center for Childhood Deafness and Family Communication (NCCDFC), which was started at the Bill Wilkerson Center about three years ago with the idea that the center would renew its historic commitment to helping children with hearing loss become oral communicators.

The school works to develop spoken language and help children communicate independently and effectively. It is the only option in Middle Tennessee for preschool children with hearing loss to receive intensive training in spoken language.

Preschoolers at Mama Lere tune up for Morning Music.

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Walls and ceilings at the school are acoustically treated, and doors create a seal so that background noise is lessened. Even the children's playground was carefully planned: The slides are made of coated metal instead of plastic so that children with cochlear implants do not risk creating a static charge that could damage the implant.

The Mama Lere Hearing School is a direct descendant of the Mama Lere Parent Teaching Home that was established by the Bill Wilkerson Center in 1972. It was named for Mrs. Valere Potter—called "Mama Lere" by her children and grandchildren—whose foundation provided funding.

Like the original, the new school is family oriented. "Our philosophy is that parents are their child's best teacher," says Tamala Bradham, director of the school.

Music plays an integral role in the children's advancement. "It helps us get the wiggles out and our listening ears on," says Bradham. "Teachers, audiologists—sometimes even the surgeons who performed the cochlear implant surgery—come help us dance, clap and sing along." All sorts of guest artists have attended "Morning Music," and the children have been introduced to everything from Native American flute tunes to classical instruments.

Children also spend the day on learning activities, vocabulary and concept development, one-on-one time with speech pathologists, and pre-reading skills. They also have self-directed time when they are encouraged to play and interact.

The children at Mama Lere are part of the first generation of children with hearing loss who are growing up with such good technological and therapeutic intervention that learning to talk is the most natural communication option for many of them. Last fall many of the previous year's kindergarteners headed off to first grade ready to listen and learn with the rest of the class.

or developing countries where specialists are rare, we hope to improve the safety of the techniques and allow surgeons with less training to do more sophisticated surgeries."

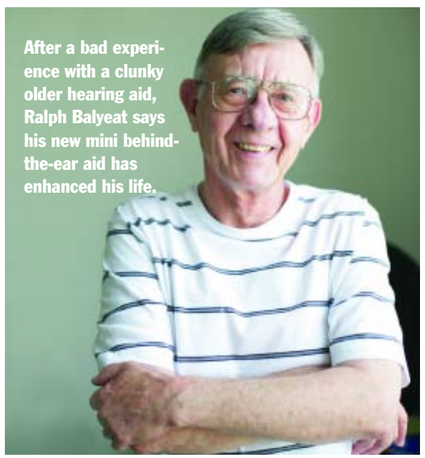
Using an image-guided directional device, Labadie is working on developing a less-invasive cochlear implant surgery that avoids the mastoidectomy (a surgical procedure to remove an infected portion of the bone behind the ear) and possibly general anesthesia. He is leading a multisite investigation with teams from the University of North Carolina-Chapel Hill, the University of Texas Southwestern Medical Center, and Case Western Reserve University. "We hope to decrease operative time from two or three hours to 15 minutes," says Labadie. "If we can perform the surgery under local anesthesia, we can test the cochlear implant before we close the incision. That gives us the option of adjusting where the implant lies within the cochlea in order to get better overall sound perception from the implant."

Hunting, Harleys and Hearing Loss

Typical hearing loss begins in the higher frequencies as we age and the ears accumulate years of exposure to noise. The cochlea can recover from one exposure to loud noise, but after multiple exposures the hair cells start to deteriorate and hearing becomes less acute.

Generally, the first frequencies lost are in the upper ranges. Although a person may not notice he can't hear a watch tick anymore, he might start noticing when he can't hear the soft, high speech sounds like "s," "th" and "sh"—when words like "fishing" and "sipping" become indistinguishable.

Ralph Balyeat, now 71, grew up in Ohio and Michigan, hunting and riding a Harley for fun. "Between the two," he says, "my hearing was probably pretty bad by the time I hit high school.



After a bad experience with a clunky older hearing aid, Ralph Balyeat says his new mini behind-the-ear aid has enhanced his life.

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"You first accuse people of mumbling," he adds. "Then you fuss because the minister drops words on the ends of sentences. It's always something or someone else—they play the background music too loud. Then you finally realize you need some help."

Balyeat's hearing loss was more moderate than the Geldreichs'; he didn't need a cochlear implant. But his experience with a hearing aid a decade ago had not been successful. He has a small ear canal that causes problems with an in-the-ear fitting.

Last summer he visited the Bill Wilkerson Center and tried one of the new open-ear fittings so as not to block the canal and maximize the hearing he still has. "The old hearing aid was huge," Balyeat says. "But the new one is very small."

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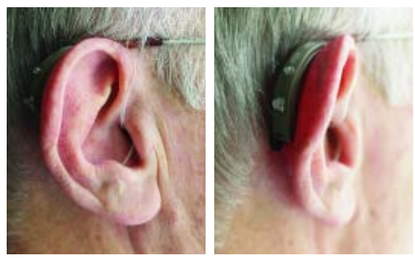

"I tell people these are high-tech Band-Aids for their ears," says Dr. Bill Dickinson, assistant professor of hearing and speech sciences and director of the hearing aid dispensary. "We're not fixing the ears, but we're fixing the lifestyle of the person the ears belong to."

2006 was one of the largest hearing-aid growth years ever, and patients at Vanderbilt far exceeded the national rate for hearing aid purchases. The newest type is a mini behind-the-ear aid with an open-ear fitting. The high-performing technology fits behind the ear with only a tiny, clear tube and an ear bud extending into the ear canal. Open fittings like this do not plug the ear canal, which allows any residual natural hearing to keep functioning.

The technology includes automatic or adaptive microphones that can analyze the sound environment and adjust its processing to fit. Stored in the hearing aid is a database of hundreds of different acoustical environments to choose from, and some hearing aids have programs that will evolve as it "learns" the user's typical environments and preferences.

And audiologists like Dickinson are becoming more exact with hearing-aid fitting. "With software, we can create a prescription to match the hearing loss and then measure whether that prescription is being met at the eardrum."

Balyeat uses some of the adaptable functions occasionally, particularly in noisy restaurants, but for the most part he lets the hearing aid do its job. "It's a big help in terms of conversation with your spouse," he says. "There are not as many misunderstandings. You pick up more of what your grandchildren say, especially if they are young or have soft voices, because that's the hearing you lose first. It definitely enhances my life."

One floor above the audiology clinic, in the Dan Maddox Hearing Aid Research Lab, researcher Todd Ricketts works to keep up with rapidly changing technology. "Engineers are building new technology into microprocessors and releasing it before researchers can fully evaluate it," says Ricketts, associate professor of hearing and speech sciences. "By the time we get a fairly complete picture on one circuit, it's been replaced by new technology."

One question heard over and over again in the clinics and research labs at the Vanderbilt Bill Wilkerson Center is, "How does this work in the real world with real people?" Real people like the Geldreichs and Ralph Balyeat are examples of how research, technology and hands-on treatment work together to make radical improvements in quality of life for individuals with hearing loss. So as technology continues to improve, more and more people will have an opportunity to take advantage of Beverly Geldreich's advice to "go for it." ▼