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Winter 2014

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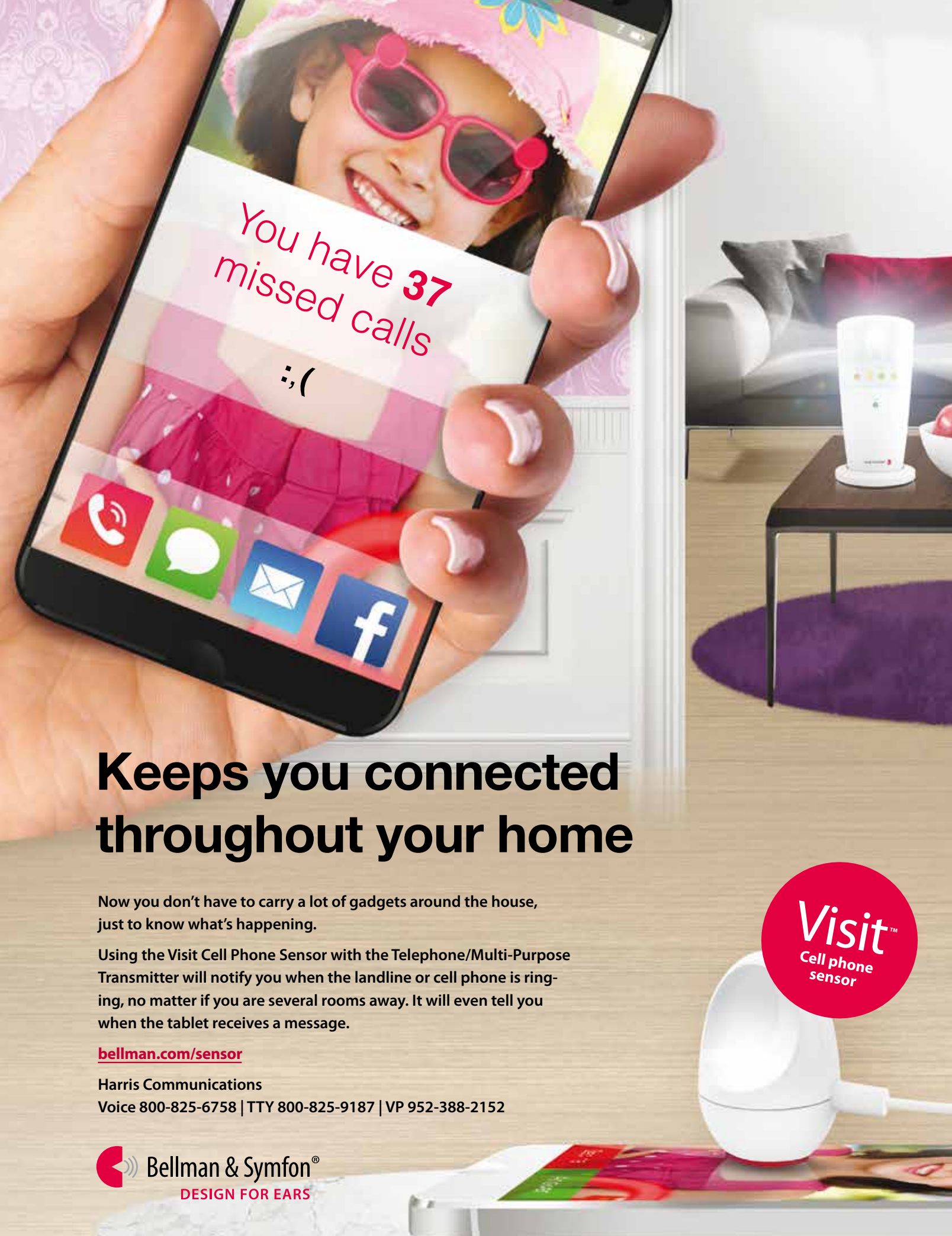
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Hearing Health

VOL. 30, NO. 1, WINTER 2014

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HEARING HEALTH TIMELINE

Since 1958, Hearing Health Foundation has been the leader in preventing hearing loss and in funding research into advanced treatments. Now we are close to developing the first genuine cure for hearing loss and tinnitus by regenerating the damaged inner ear hair cells that make hearing possible. Help us making hearing loss a thing of the past at hhf.org/donate.

1958
Collette Ramsey Baker founded Deafness Research Foundation to help further research and improve treatments for the millions of Americans with hearing loss.

1960
Creation of the National Temporal Bone Banks Program, to collect and study the human temporal bone. In 1992 the registry was taken over by the National Institute on Deafness and Other Communication Disorders (NIDCD).

1961
Honored Georg von Békésy with an achievement award in New York City, where he learned he had won the Nobel Prize in Physiology or Medicine

1972
Began funding research on cochlear implants. This remains a primary area of research funding, with later grants exploring single channel versus multichannel implants, speech perception among cochlear implant users, and implants for children.

1977
Funded research in outer ear hair cell motility that led to a new method for measuring the health of a newborn's ear.

1985
Started funding research to understand how sensory cells transmit sound from the world to the brain, and began funding tinnitus research.

1987
Funded research that discovered spontaneous regeneration of hair cells in chickens, thus igniting the field of hair cell regeneration in humans.

1990s
Advocacy for Universal Newborn Hearing Screening legislation increased testing from 5 percent to 97 percent of newborns by 2007.

2002
Acquired Hearing Health magazine, the ultimate consumer resource on hearing.

2008
In celebration of our 50th anniversary, rang the opening bell at the New York Stock Exchange.

2010
Launched Safe and Sound prevention program to prevent noise-induced hearing loss.

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2011
Hearing Health Foundation became the new name for Deafness Research Foundation.

HRP Hearing Restoration Project

Launched the Hearing Restoration Project to develop the first real cure for certain types of acquired hearing loss.

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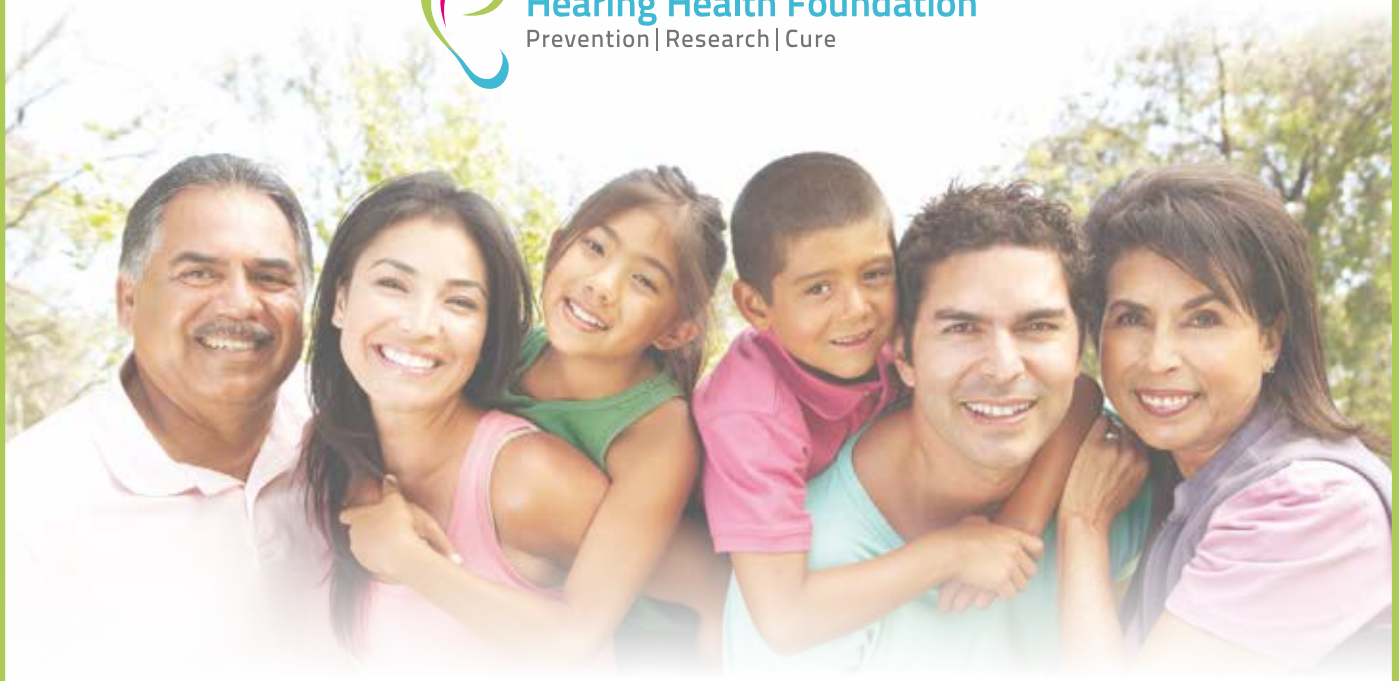

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NEWS

HRP consortium scientists met in Seattle in November.

3 Days, 14 Scientists, 1 Goal

The annual meeting of the Hearing Restoration Project (HRP) consortium took place in Seattle from November 10 to 12. Participants discussed progress of their research toward a cure for hearing loss and tinnitus.

The weekend started with a team-building visit to two of Seattle's iconic attractions: Chihuly Glass Museum and the Space Needle. The group took in a colorful array of glass sculptures at the museum, followed by a 360-degree view of Seattle. The group then enjoyed a relaxed dinner together before the real work of the meeting commenced.

Early Monday morning, each group of researchers began presenting their progress on the five funded HRP projects. (See "What Will It Take to Seal the Deal?" on page 16 for details about the fifth project.) Each group presented their initial findings on the genomics of mouse, chicken, and zebrafish studies. This work helps us learn how these animals are capable of inner ear hair cell regeneration in order to identify ways to translate this to humans. Each member of the consortium contributed to the discussion on how we can compare this cross-species data, something that would not be possible without the collaborative design of the HRP.

The progress reports led to a discussion of how to update the HRP's Strategic Research Plan to reflect what we have learned through the first year and a half of funding these HRP projects. Stay tuned for updates at hhf.org and in a future issue of this magazine.

Basch Earns an HHF Award

HHF is proud to announce the second annual Strial Atrophy/Development Award granted to Martin Basch, Ph.D., of Baylor College of Medicine in Houston. Basch's project, "The Development of Biomarkers to Study Strial Development and Degeneration," has the aims of understanding the development of the stria vascularis and applying this knowledge toward the regeneration and/or repair of damaged stria vascularis in cases of congenital defects or age-related hearing loss.

Basch received his Ph.D. in developmental biology at the California Institute of Technology. He worked as a postdoctoral fellow with Andy Groves, Ph.D., at Baylor College of Medicine, and Neil Segil, Ph.D., at House Research Institute. He is currently an instructor in Groves's lab.

Westone Partners With HHF for a Cure

In a program launched in fall 2013, Westone Audio is donating a portion of every sale of its Westone Audio products to HHF throughout 2014.

"We are extremely excited to partner with Hearing Health Foundation and help support its efforts in hearing research, hearing protection, and a search for a cure for hearing loss," says John F. Lowrey, the vice president of the Colorado-based company's audio division. The partnership includes an initial gift plus a portion of every Westone Audio sale.

"Westone Audio is committed to delivering the best audio and protection available to customers, and we want to support HHF's efforts to find a cure for those who have already experienced hearing loss," Lowrey adds.

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1. Hehrmann P, Fredelake S, Hamacher V, Dyballa K-H, Büchner A. Improved Speech Intelligibility with Cochlear Implants Using State-of-the-Art Noise Reduction Algorithms. Speech Communication; Proceedings of the 10th ITG Symposium, 09/2012.

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A MUSIC-FRIENDLY STRATEGY FOR IMPLANT USERS

Cochlear implants (CIs), while an incredible aid for understanding speech, are only a moderate help to music lovers. Though CI users can usually differentiate between octaves, discerning adjacent musical notes is more challenging. University of Washington (UW) researchers are working to fix this.

In the July 2013 edition of IEEE Transactions on Neural Systems and Rehabilitation Engineering, the scientists say that they have devised a harmonic-based algorithm for processing signals that helped the eight CI users in their study perceive differences between musical instruments. This new processing method can help CI users better enjoy music through the ability to detect pitch and timbre in songs.

"Right now, cochlear implant subjects do well when it's quiet and there is a single person talking, but with music, noisy rooms, or multiple people talking, it's difficult to hear," says lead researcher Les Atlas, Ph.D. "We are on the way to solving the issue with music."

Atlas worked with Jay Rubinstein, M.D., a physician at the UW Medical Center and Seattle Children's Hospital and the director of the Virginia Merrill Bloedel Hearing Research Center. Both have musical backgrounds. Atlas designed guitar amplifiers for rock musicians before becoming an electrical engineering professor. A musician since age 5, Rubinstein plays several instruments and became interested in neuroscience to discover why minor chords sound sad. His brother Jon helped invent the Apple iPod.

The researchers say more work is needed to fine-tune the signal processing and make it compatible with CIs already on the market.

HEARING HEADLINES

HEARING LOSS RISK FOR OVERWEIGHT WOMEN

Here's yet another reason to make regular physical activity a priority: A high body mass index (BMI) is linked with an increased risk of hearing loss. A 20-year study of nearly 70,000 women found that when controlling for other factors such as age, smoking, diabetes, and high blood pressure, the greater the BMI and waist size, the greater the chance of hearing loss. Boston's Brigham & Women's Hospital scientists published the results in the December 2013 issue of The American Journal of Medicine.

The good news? Walking just four hours a week cut the hearing loss risk. The study authors theorize that being overweight constricts blood flow including to the inner ear, and that moderate exercise helps counteract that effect. The research echoes the results of a Laryngoscope report in June 2013 that found a link between childhood obesity and hearing loss (see "Hearing Headlines," Fall 2013, at hhf.org).

HOW LITTLE ONES LEARN TO TALK

There is a lot of commonality in how infants across cultures acquire their native languages. Now, a study shows striking differences, too. The study, which was published in the September 23 issue of Language Acquisition: A Journal of Developmental Linguistics, looked at how Korean infants learn new nouns and verbs.

In "noun friendly" languages such as English, infants focus on objects, typically marked by nouns. In "verb friendly" languages such as Korean, infants focus more on actions and relations, typically marked by verbs.

Previous research showed English-learning 24-month-old children did better learning verbs when nouns were included. But Korean toddlers learned verbs better without the nouns present—mirroring how spoken Korean is structured.

"This means that like early speech and music perception, the structure of what infants passively hear influences how they actively learn," says Sandra Waxman, Ph.D., a psychology professor at Northwestern University in Illinois and the senior author of the study.

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A Sense of Structure

A son's hearing loss, while a shock to the family, helps pave a path to structure, routine, and success.

By Cynthia Andrade

MY SON, JAN MARCOS, WAS born in 1992. As a baby he was fascinated by music and loved his little piano keyboard toy, resting his ear on its speaker. Quiet and observant, he would stare with his big green eyes while you talked, without even blinking.

At the time when he was supposed to say a few words, around age 1, he would mimic and point to things he wanted. We thought he was just lazy, or a late talker.

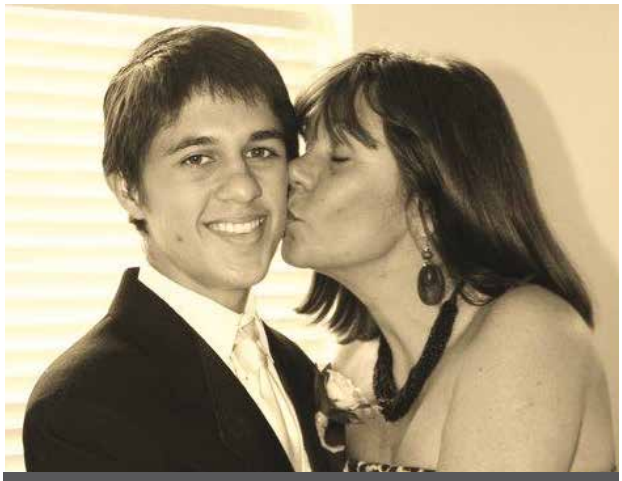
When he was about 2, a friend called out a question to Jan about lunch, but Jan didn't pay attention and kept walking away. My friend asked me very tactfully and politely whether we had checked his hearing.

I started to pay more attention to Jan's responses. Once while he was crying for me in his crib, I stood at his bedroom door and spoke to calm him down; he didn't know I was there. That's when I realized my friend was right: There was something wrong with Jan's hearing.

My husband Enrique and I brought him to see a specialist. Jan got hearing tests and an MRI of his ears, and we navigated the questions that come with that first visit. We said that we have no hearing loss history in either family; during pregnancy I did not fall, drink, or become exposed to loud noises; Jan had no high fevers within the first two years of life, etc., etc., etc.

Then the doctor sat us down and very routinely explained the test results. "Your son has moderate to severe sensorineural hearing loss and needs to wear hearing aids," he calmly said. "His hearing may stay the same or may decrease in the future, we cannot tell."

It was just like that: no preparation for bad news, no hints about the cause—only this news. It put us in shock. We had dozens of questions: Why did it happen? What did we do, or not do? What about his future?



The writer has been inspired by her son Jan Marcos.

Then we learned hearing aids cost thousands of dollars, a sum we did not have and that we had to borrow since our health insurance did not cover hearing aids.

After managing to get the hearing aids into Jan's ears, we had to make sure he would not take them out, lose them, or get them wet.

We also discovered a whole new world of hearing and speech issues. He started a free program at school as well as private speech therapy. Jan was not yet 3 years old.

All these resources meant a very routine, schematized life, with rules and times for each task, but with lots and lots of love from all. From the start Jan was eager and willing to learn, and he went on to earn straight A's in school and a scholarship for college. He is very structured at everything he does, even to this day.

As a teen, Jan began to wonder about the cause for his hearing loss. We still have no explanations. But he has never been embarrassed about his hearing aids; he even had me get blue and red ear molds so they would look cooler.

After all these years his hearing has not changed and his speech is completely normal. All we can hope for is that his hearing stays the way it is and that a cure for hearing loss can be found in the future. Using genetic testing, we are trying to find out if his future children will have hearing issues.

Now 20, Jan works and studies full-time and bought a car with his own savings. To us he is an inspiration, striving to be as successful as he can, even with a disability. Not everyone can handle this situation as well as he does, which deserves admiration and respect. I hope our story can help give hope and strength to others facing unexpected obstacles. Love is our secret medicine… and of course, hearing aids!

Cynthia Andrade lives with her family in Boca Raton, Fla.

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PEDIATRICS

A Closer Look

After years of treating hearing loss, a clinician becomes a researcher to discover that the brain's ability to process speech can deteriorate with age—and that auditory training can help slow the effect.

By Samira Anderson, Au.D., Ph.D.

As a clinical audiologist for 26 years, I enjoyed helping people improve the quality of their lives through better hearing with the use of hearing aids. At the same time, I also felt frustrated when my patients continued to have trouble hearing in challenging listening situations, such as in noisy backgrounds, even with hearing aids with advanced technology.

What has been especially puzzling is that two people with identical hearing tests may report quite different listening experiences in the same environments while wearing the same hearing aid technology. These observations led me to question what happens to speech after it has been processed by hearing aids, and whether the brain's processing of speech is degraded in some individuals, especially as they age.

For these reasons, I left my clinical practice in Minnesota to pursue a Ph.D. at Northwestern University in Illinois. I worked toward my doctorate at Northwestern's Auditory

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Neuroscience Laboratory, which is overseen by Nina Kraus, Ph.D. While there, my focus was on examining how the brain processes sound in individuals who have difficulty understanding speech in noise, such as older adults or people who have hearing loss.

I use electrophysiology, a noninvasive measure that records electrical activity of the auditory cortex and brainstem in response to sound through electrodes placed on top of the head, on the forehead, and on the earlobes.

Compared with younger adults, in older adults the brain processes sound more slowly and with more degraded, variable responses.

One of my key findings is that neural timing is disrupted in older adults. The brain processes sound more slowly and responses are degraded and more variable than they are in younger adults.

These results, which we published in The Journal of Neuroscience in October 2012, are consistent with behavioral studies in the lab of Sandra Gordon-Salant, Ph.D., at the University of Maryland, who has also found that older adults have poorer processing of timing cues compared with younger adults. Timing is critically important for understanding speech in noise; therefore, disrupted neural timing may be one of the factors underlying the older adult's difficulty in challenging listening situations.

Although it is important to identify potential causes for difficulty understanding speech, it is even more important to develop strategies for overcoming these difficulties. While at Northwestern, I also conducted a study to evaluate the effects of auditory training on neural timing in older adults. Our results were published in the Proceedings of the National Academy of Sciences in March 2013.

I used the Brain Fitness program, developed by Posit Science Corporation, which is an adaptive listening and memory software training program that can be used on a personal computer. The training consists of six modules that require listening to speech that is stretched or compressed as needed for the individual listener. The listening exercises are combined with increasing demands on memory, so that the listener needs to recall longer strings of words or sentences.

The 35 participants in this study, whose average age was 63 years old, used this program one hour daily, five days a week for eight weeks, for a total of 40 hours. Before the training, the participants were tested using electrophysiologic responses to speech and behavioral tests of speech-in-noise perception, memory, and speed of processing. Eighteen people, or about half of the participants, had mild to moderate hearing loss and did not wear hearing aids. The tests were repeated after the completion of training.

Many of the participants observed that they could hear better after the training, and that speech was clearer in noisy backgrounds. Electrophysiologic testing indicated that neural timing was improved, especially in response to speech in noise. In addition, behavioral testing showed improvements in speech-in-noise perception, memory, and speed of processing.

These results are exciting, as they demonstrate that the brain can continue to change and improve into older adulthood and that hearing deficits associated with aging can be at least partially reversed with training.

Many questions are yet to be answered. It is important to identify how much training is needed to maintain these gains after the initial 40 weeks is completed. In addition, this training was not performed in individuals who wear hearing aids, so one important step is to combine the use of auditory training with hearing aid use.

Most recently, we discovered that neural responses to moderately loud or loud sounds in older adults with hearing loss are actually bigger than the responses in those with normal hearing. Auditory training actually reduces the amplitude of the response so that those with hearing loss are more similar to those with normal hearing. We think that the bigger neural response to loudness fluctuations in speech is making the details of speech, such as the consonants, harder to hear. It may explain why people with hearing loss often say that speech is loud but not clear.

We will be exploring issues like these in more depth and hope the results we discover can continue to help older adults with hearing loss.

Samira Anderson, Au.D., Ph.D., is continuing her research into the benefits of auditory training as an assistant professor in the Department of Hearing and Speech Sciences at the University of Maryland.

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What Will It Take to Seal the Deal?

Hearing Restoration Project scientists have identified mammalian inner ear hair cells that take the first steps toward regeneration—and then mysteriously stop. Here's how they will figure out why.

By Andy Groves, Ph.D.

This is the fifth article in a series about current projects under way in the Hearing Restoration Project. This piece explains "Transcriptional profiling of purified supporting cells from control and damaged adult mouse utricles, with and without inactivation of Notch signaling," the project of HRP consortium members Andy Groves, Ph.D., Baylor College of Medicine; Neil Segil, Ph.D., University of Southern California; and Jennifer Stone, Ph.D., University of Washington. We sincerely thank Dr. Groves for contributing this story to the magazine.

In previous Hearing Health articles in this series about the Hearing Restoration Project (HRP), we have discussed the problem of hair cell regeneration—that in mammals, hair cells, the highly sensitive sound detectors of the inner ear, are unable to grow back after damage to the ear. As a result, hearing loss in humans is progressive and permanent.

However, although humans and other mammals cannot replace their lost hair cells, this is not true for other vertebrates. It has been known for more than 25 years that birds, frogs, and fish can regenerate their

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hair cells naturally. A bird that has been deafened is able to grow back almost its entire complement of hair cells and hear again almost perfectly in a matter of weeks. However, mammals apparently lost the ability to regenerate hair cells at some point over the past 300 million years.

How are birds able to regenerate their hair cells? Every bird hair cell is surrounded by four to eight supporting cells to form a repeating mosaic pattern. The death of a bird hair cell somehow triggers one of its neighboring supporting cells to divide to give two "daughter cells." One of the daughter cells then turns into a hair cell, and this process of division followed by transformation into a hair cell restores the normal mosaic of hair cells and supporting cells.

Regeneration of this type happens normally in some parts of our bodies; for example, we lose and replace about 10 billion cells every day from the lining of our digestive system. However, although humans and other mammals also have supporting cells surrounding their hair cells, there is almost no regeneration of hair cells after damage in our inner ears.

Some of the HRP-supported research has focused on the cochleae of newborn mice, which have a capacity for hair cell regeneration, albeit a rather limited one that disappears before mice start to hear at about 14 days after birth. Some HRP consortium scientists are trying to understand the genetic changes that occur in the cochlea during this very brief time period.

More recently, the lab of HRP member Jennifer Stone, Ph.D., at the University of Washington, has made an exciting discovery in another part of the inner ear called the utricle. The utricle also contains hair cells like the cochlea, but it uses them to detect gravity rather than sound.

Can the inner ear utricle teach us about the signals that drive regeneration?

Dr. Stone and her colleagues have pioneered the technique of isolating the utricle from an adult mouse and growing it in a dish in the lab. Since the adult cochlea is too delicate to isolate and grow in a dish, this technique is the only one that allows experimental access to hair cells and supporting cells in adult mammals.

The lab found that within a few days after hair cells are killed in the utricle, the surrounding supporting cells take the very first genetic steps to activate the program to make hair cells—but then they stop before the hair cells actually form. It is as though the supporting cells have received a signal to regenerate new hair cells, but they cannot "seal the deal" and complete the regeneration program.

This situation is very different from the cochlea, where absolutely no hair cell regeneration steps occur in adults. Can we therefore use the utricle to learn more about the signals that drive regeneration?

In an attempt to identify factors that can push supporting cells over this roadblock, Dr. Stone turned to drug inhibitors of the Notch signaling pathway. In our report "What Stops the Inner Ear From Regenerating?" (in the Fall 2013 issue of Hearing Health, available at hhf.org), we discussed how Notch signaling is an evolutionarily ancient form of cell communication that is frequently used to create mosaic patterns of different cell types, such as the mosaic repeating pattern of hair cells and supporting cells in the inner ear.

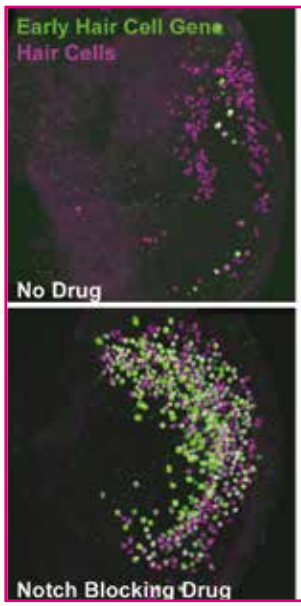
HRP Hearing Restoration Project

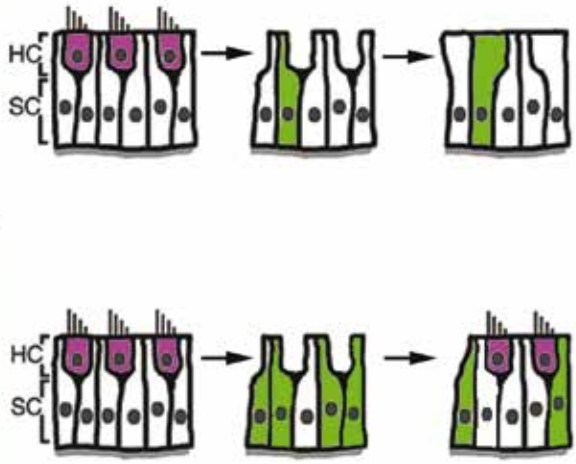
The groundbreaking Hearing Restoration Project brings together new focus, new science, and new hope for a cure for hearing loss. The project is based on the discovery funded by Hearing Health Foundation that birds can regenerate the hair cells necessary for hearing when those cells become damaged; humans can't. But recent discoveries in stem cell research and gene mapping may make it possible to trigger hair cell regrowth in humans.

Today, more than a dozen laboratories in the U.S., Canada, and the U.K. are working on ways to translate to humans what we already know about hair cell regeneration in chickens. One approach is to stimulate existing stem-like cells in the human inner ear to regenerate hair cells, by delivering molecules that stimulate new hair cell production. Studies in animals that spontaneously regenerate hair cells, such as birds and fish, are unveiling important molecules needed to reach this goal.

A second approach is to transplant stem-like cells into the damaged ear that can give rise to new hair cells. Different labs are working on different pieces of this puzzle: some are working on gene therapies, some are working on stem cell therapies, and others are working on possible ways to integrate both approaches.

When these labs are successful at solving the puzzle of regeneration, there will be—for the first time ever—a biologic cure for hearing loss. Hearing Health Foundation is at the center of this important work.





The lab of Jennifer Stone, Ph.D., has developed a way of growing the adult mouse utricle in culture. The top far left panel shows an adult utricle in which most of the hair cells (depicted in purple) have been killed with drugs. A few supporting cells (SC) have begun to turn on early hair cells genes (green), but they cannot fully convert into hair cells (HC). This is schematized in the illustration on the immediate left.

The bottom far left panel shows a similar mouse utricle, but this time grown with a drug that blocks Notch signaling. Many more supporting cells have turned on early hair cell genes (green), and many of these cells have gone on to convert into hair cells.

A Grand Passion

MUSIC ISSUE

A pianist and Hearing Health Foundation board member explains why the Hearing Restoration Project is important to her—and to everyone with hearing loss.

By Nancy M. Williams

For years, I tried to consider my hearing loss as little as possible. I never dreamed there would be a cure for hearing loss and tinnitus. Now as a board member of Hearing Health Foundation (HHF), I am part of a team working toward a cure. This new role has forced me to confront the societal stigma around hearing loss and, even more deeply, my own denial.

In kindergarten, after I sang "Three Blind Mice" too loudly on the big rag rug in our classroom, I was diagnosed with a high-frequency hearing loss. My parents, worried about the social stigma, refused the recommended hearing aid, a decision that boomeranged when I reached middle school. "You can't hear secrets," complained a girl with green eyeliner at lunchtime. "Don't sit with us anymore."

I was devastated. My parents broke down and had me fitted with an aid, a behind-the-ear model, bulky by today's standards.

My parents had acted with the best of intentions in a society that tolerated hearing loss even less than ours does today. Yet the incident in the lunchroom stayed with me for a long time. To compensate, I rarely admitted to anyone that I had a hearing loss. By some tacit pact, my closest friends, who knew about my loss, rarely mentioned it. The shame I felt in the lunchroom had mildewed within.

Once I was fitted with that first aid, however, I never stopped wearing it. Over the years I upgraded to two aids, then two digital aids, until I arrived at a high-performance, six-setting pair of aids that included a special music setting. As a passionate amateur pianist, I felt it was only natural that two of the settings be for music—one for practice, the other for performance. Although my hearing aids were on the cutting edge of technology, I still consigned thoughts about my loss to a remote, secluded part of my mind.

Then, in the fall of 2011, a friend asked me to cover a research symposium hosted by HHF. I attended as a member of the press, but as I rode the elevator up to the symposium, I felt no wiser than my little self on that big rag rug in kindergarten. I felt tumult at the prospect of walking into a roomful of people with hearing loss. I pictured people with ear trumpets,

ILLUSTRATION (TOP) COURTESY OF JENNIFER STONE, PH.D.; PHOTO (RIGHT) COURTESY OF NANCY M. WILLIAMS

In this scheme, supporting cells make a protein on their cell surfaces. This is the Notch receptor. Hair cells make proteins on their cell surfaces that bind to the Notch receptor, like a key fitting into a lock. Binding to the Notch receptor is believed to actively block supporting cells from turning into hair cells.

Dr. Stone and her team found that if they killed hair cells in the utricle, but then used drugs to block Notch signaling, they saw small but significant numbers of true hair cells appearing in their experiments. These results suggest that the Notch pathway may be one of the signals that holds regeneration back in the adult mammal.

Neil Segil, Ph.D., and I have teamed up with Dr. Stone and her lab to identify other players that may block regeneration in the utricle. Using Dr. Stone's culture system, our three labs will use next-generation DNA sequencing technology to identify genes that are switched on in supporting cells of the utricle as they attempt to transform themselves into hair cells after damage—but ultimately fail. We will then see what genes are switched on or off when drugs that block the Notch pathway are used to finally complete the process and drive supporting cells to produce hair cells.

These experiments are still at a very early stage, but we hope this approach will complement other work by members of the HRP consortium that are looking at similar processes in the cochlea.

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as cranky as deaf Beethoven, yelling, "WHAT?" The truth was, I had bought into society's depiction of people with hearing loss; I was reluctant to confront the part of me I usually tried to deny.

Five minutes into the reception, my fear morphed into elation that didn't dissipate the entire night. I met professionals with hearing loss, parents of young children with hearing loss, well-regarded doctors who treat hearing loss, and most importantly, some of the scientists who are part of the Hearing Restoration Project (HRP). The mildew within—the shame I felt for my hearing loss—began to dry up and disappear.

In volunteering with the foundation, I learned more about the HRP consortium of scientists, who, contrary to the tradition of competing against one another and racing to be the first to publish their findings, had agreed to work together. I admired the scientists' approach and joined the foundation's board.

Now I am in the hands of the HRP. Since my loss was first diagnosed, the curve of my hearing has been slipping downward on the audiological charts. Now, in the conversational frequencies, my hearing is no longer normal—in fact it has slipped past a mild loss to moderate, and is sloping down to severe in the high frequencies. Sometimes I worry about the sounds that someday I might miss: the treasured voices of my husband and children and the sweet chimes and deep rumbles of my piano.

I need the HRP to succeed. We need the HRP to succeed—people with hearing loss and tinnitus of all ages and backgrounds and beliefs and professions need the HRP to succeed. This is true especially of children, some of whom—despite all the progress our society has made, signified by colorful "look at me" aids and cochlear bling—may still be shunned in the lunchroom.

Although it is off to a very promising start (see Dr. Groves's accompanying story), the HRP is still in its early days. The scientists need additional funding in order to create momentum with their research and establish a cycle that will lead to success. Abolishing the stigma around hearing loss goes hand in hand with securing funding.

I hope you'll join me in advancing both of these causes, by talking candidly and passionately about your or your loved one's hearing loss, and by donating whatever you can, no matter how small, to the HRP. I had never dreamed there might be a cure for hearing loss, but now I have hope.

Nancy M. Williams, who serves on HHF's board of directors, is the founding editor of Grand Piano Passion, an online magazine for musicians with hearing loss. To learn more, see grandpianopassion.com.

MUSIC ISSUE

The Sounds of Music

Hearing aids help you hear speech better in background noise, but what if that "noise" is music? Here's how you can make adjustments.

By Barbara Jenkins, Au.D., BCABA

One of my patients, Gene, recently recounted this story: "I was at the symphony last week, as we have season tickets, and I enjoy fine music. I found myself able to hear the nuances of the music more clearly than I had in years. Instead of hearing the music as one entity, I was able to hear the flutes, the clarinet, and all the other instruments more distinctly.

"My wife looked over at me and asked what was wrong, concerned about the wide-eyed look I had on my face. 'Wrong? You mean what's right,' I said to her. 'I hadn't realized how sweet music could be.'"

I had just fit Gene with new, higher-fidelity hearing aids and, on a whim, asked him if he enjoyed listening to music. Since he said he did, we spent extra time customizing a music program.

Hearing aids have been developed to maximize clarity of speech understanding, but to do this they must reduce non-speech sounds—which are the very elements that enhance musical or environmental sounds. Even though you may hear music better with your hearing aids than without them, most speech enhancement programs by necessity end up distorting music.

Some hearing aids have the capacity to utilize additional, dedicated programs for music, an option that will help you hear music more richly; in fact, most newer hearing aids have a dedicated music program built into them. Ask your hearing healthcare professional to activate it for you, so that you can switch it on whenever you want. These music programs automatically utilize some of the programming changes we will discuss below, but by fine-tuning them even further, you will be able to enjoy music as fully as possible.

The degree to which your hearing aids can be adjusted for music is predicated on the type and severity of your

PHOTO CREDIT: @ISTOCKPHOTO.COM/LIANGPV

hearing loss, the type of music you listen to, and the technology of the hearing aid you select. Each auditory system is unique, so confer with your specialist to see which recommendations will work for you.

First, Thorough Testing

The first step is to make sure you have the most complete audiometric evaluation possible. This includes the following tests:

Additional frequencies: In addition to testing the standard frequencies, ask your provider to test the 125, 750, 1,500, 3,000, 6,000, 9,000, and 10,000 Hz (hertz) frequencies. (Note that equipment limitations or your hearing loss may not allow for testing at all frequencies.)

Speech-in-noise testing: This will help measure your ability to hear vocals with instrumentals.

Supra-threshold measurements: These readings, including UCL (Uncomfortable Level) and MCL (Most Comfortable Level), will assure that the music stays within your comfort range. Without these tests, music may sound too sharp or even painful to you.

Tympanometry and bone conduction tests: A middle ear dysfunction alters sound waves differently than inner ear problems, affecting music as well as speech. These tests assess the middle ear.

Ear canal resonance: It's important to capture information on the volume, size, and resonance characteristics of your ear canal using a system of tiny microphones and speakers. The process, called Real Ear Measurement, shows exactly what level of each frequency is actually reaching your eardrum.

Music selection: Some people prefer to sing along with golden oldies, others enjoy a solo pianist. Inherently, the spectral characteristics of each type of music differ greatly. Speech enhancement and noise reduction are two aspects of hearing aid processing that can either work in concert with or counter each other. Let your professional know what type of music you enjoy so that your music program is adjusted appropriately.

Vocals: Adjust speech enhancement and disengage noise reduction. You want to be able to understand the lyrics as clearly as possible.

Instrumentals: Disengage speech enhancement as well as noise reduction. These settings may compress or muffle the harmonics of the instruments.

Hearing Aid Features for Music

Some of the following features are preprogrammed into the music programs of newer hearing aids, but not all of them work the same or have the same flexibility. Consider these features before your next hearing aid purchase, and research at least two different manufacturers before you buy your next device.

Frequency range: Until recently, most hearing aids were not able to provide much amplification in frequencies higher than 3,000 Hz very effectively. This prevented hearing aids from amplifying the f, s, and th sounds well, and made it almost impossible for someone with high-frequency hearing loss to hear harmonics clearly. In the last few years, hearing aids have improved so that some are capable of amplifying up to 8,000 Hz or more. This will help you not only understand lyrics more clearly but also hear some of the finer aspects of music that you may not have heard in years. If you have low-frequency loss, don't forget to adjust the bass sounds as well.

Channel fidelity: Just as a graphic equalizer helps adjust sounds at specific frequencies, your hearing aid has channels to help match the frequencies of sound. The more channels, the more precisely the hearing aid can accurately reproduce the sound. What pixels are to photography, channels are to hearing aids.

Phonak includes up to 20 channels in its premium hearing aids, Siemens includes up to 48. Most other manufacturers have up to 16. If you just listen to music on the radio now and then, you may not notice the difference. However, if you can identify the finer nuances of music, the difference may be quite apparent.

Feedback technology: Feedback is the whistling emitted when the sound being produced by the hearing aid hits the microphone and gets re-amplified. To eliminate this irritant, manufacturers have devised feedback cancellation technology. This is very helpful in day-to-day communication, but turn off the feedback canceler so that it doesn't inadvertently distort the music.

"Sound smoothing": This setting reduces sudden sounds (clanking dishes, dropped keys, etc.). While this feature works well in restaurants, it can reduce the unique subtleties and crescendos in your selection. Disengage it for music.

Compression: Compression technology, which helps to keep sound within your comfort range, may muffle music. Your hearing provider should be able to minimize compression to preserve the crispness and clarity of music. This is where the UCLs mentioned earlier are important. You should be able to hear as much musical range as possible without going outside your comfort level.

Optimizing your hearing aids for music will take at least one or two visits, as there is a definite art to the process. Just as a person with normal hearing adjusts the stereo equalizer differently according to personal taste,

each person with a hearing loss will need adjustments based not only on their hearing loss but also on their personal preferences. The nuances of music appreciation are personal, so be patient—the rewards are worth it.

Work, But Worth It

Work with your hearing professional to design a program to help you enjoy music more fully. Remember, music may never sound the same as it did when you had perfect hearing (the sound is still being processed through a damaged ear), and the limitations of your hearing loss or hearing aid may preclude the use of all of these options.

If I had not asked Gene about music, he would not have realized that the sounds of the symphony could be so clear. I'm thankful to Gene for helping me remember that birds chirping, bells chiming, and music playing can all enhance quality of life.

Staff writer Barbara Jenkins, Au.D., BCABA, is Colorado's first board-certified doctor of audiology. She has more than 25 years of hospital and clinical experience in treating patients with hearing loss. Jenkins serves as Colorado's professional state commissioner for the deaf and hearing impaired, and was awarded the 2010 Leo Doerfler Award for Clinical Excellence by the Academy of Doctors of Audiology. For more information, see advancedaudiology.info.

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Musicians Making Melodies

A group bringing together amateur musicians proves that hearing loss is no barrier to understanding harmonies.

By Wendy Cheng

Many parents hope to instill a love for playing music and provide music lessons to their young children. As we grow into adults, we play music because we want to create the music we love to hear, or simply to relieve the stresses of everyday life. Some individuals even play music for a living.

And yet, until very recently, hearing device manufacturers have not looked at hearing device design from the viewpoint of someone deeply involved in music performance. For example, many musicians who wear digital hearing aids or cochlear implants complain of poor sound quality for music listening and music performance from their devices, and also about the lack of hearing healthcare professionals knowledgeable about musical acoustics to program hearing devices for the demands of playing in various ensemble groups.

Ten years ago, I wrote a story in Hearing Health about setting up a new group for adult musicians to discuss the audiological barriers and psychosocial issues surrounding the art of making music with a hearing loss. The group is called Association of Adult Musicians With Hearing Loss. In the beginning we were a pretty small group, maybe fewer than a hundred individuals. Since writing that story, more musicians, hearing providers, and musical educators have become aware of our organization. We hold concerts for one another in hearing-accessible venues in the Washington, D.C. and New York City areas. We even produced a CD anthology titled "Hear This!" featuring music by members of the group.

Our book, "Making Music With a Hearing Loss: Strategies and Stories," came out in 2011, and we have held Web conferences on the topics of making music with hearing aids or with cochlear implants. We also ran handbell-ringing workshops for musicians with hearing loss. People with hearing loss rarely have an opportunity to play in an ensemble (due to limitations not only of the musician's hearing ability but also the type of music and assistive technology), so these workshops gave them the opportunity to develop ensemble skills.

We're looking forward to the next 10 years of helping fellow musicians with hearing loss through technology, social media, and other methods. Our hope is not only to bring musicians together to share tips and information but also to work to change attitudinal barriers to what musicians with hearing loss can accomplish.

Wendy Cheng is the founder and president of the Association of Adult Musicians with Hearing Loss (aamhl.org). Diagnosed with hearing loss in childhood, she has studied piano, violin, and viola, participates in her church's handbell choir, and is now studying music theory. She lives with her two daughters, who are string players, in Maryland.

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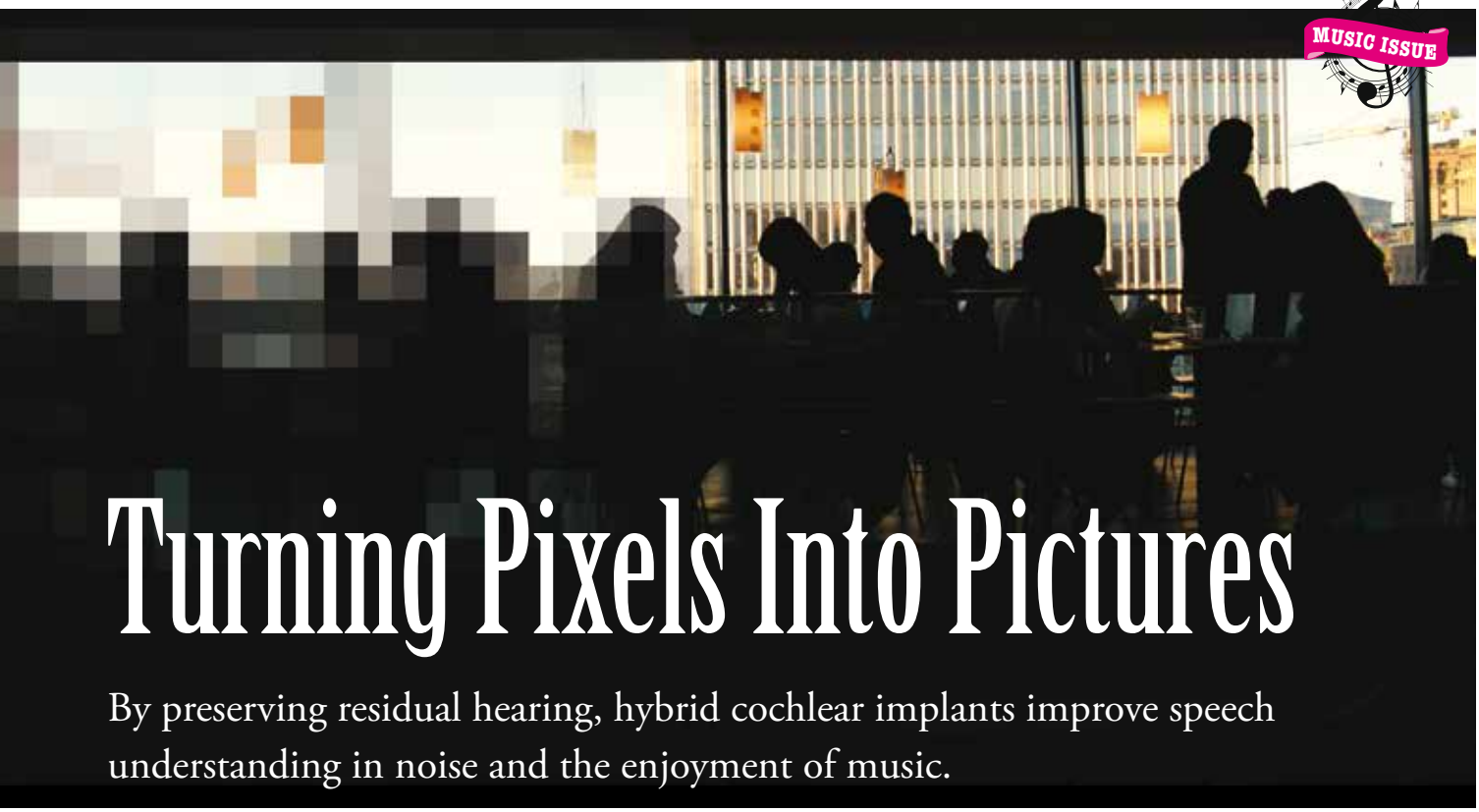

MUSIC ISSUE

Turning Pixels Into Pictures

By preserving residual hearing, hybrid cochlear implants improve speech understanding in noise and the enjoyment of music.

By Lina A.J. Reiss, Ph.D., and Christopher W. Turner, Ph.D.

For decades, cochlear implants have been a safe, effective means of restoring hearing in people with severe to profound hearing loss in both ears. But cochlear implants (CIs) did carry a risk—that of damaging residual hearing.

Initially devised in 1999, a new kind of cochlear implant, called the hybrid CI, was designed for people who still have some hearing, with the goal of preserving it. The term "hybrid" comes from the combination of electric stimulation, via the implant, and acoustic stimulation, from residual hearing. (The hybrid model is also known an electro-acoustic stimulation.)

The hybrid CI helps people with high-frequency hearing loss while retaining their natural, residual hearing in the low frequencies. A high-frequency hearing loss, like that common in age-related hearing loss, makes consonants difficult to discern. The hybrid CI provides high-frequency information electrically and restores consonant perception. The residual low-frequency acoustic hearing helps "round out" the artificial hearing provided by the CI, and together this gives the user a fuller hearing experience.

A Matter of Pitch

From the early single-channel CI to the highly successful multi-channel CIs today, there have been many advances in CI design, and a broader candidacy criteria. The multichannel implant has resulted in large improvements in speech recognition due to new sound processing strategies, with speech perception approaching 85 to 90 percent accurate for the most successful users.

But understanding speech in background noise can pose a problem for traditional CI users, since the various sound sources and talkers all sound very much the same to the user. Traditional CI users also have difficulty with recognizing voices and musical melodies. Voices have specific frequencies, or pitches, and picking out a woman's higher-pitched voice among lower-pitched male voices (or vice versa) is easier to do than picking out a lower-pitched voice from among many lower-pitched voices.

By the same token, music is comprised of multiple pitches. Although a CI user usually can differentiate among octaves, discerning adjacent musical notes is more challenging. (Recently, University of Washington researchers devised a harmonic-based algorithm for processing signals that allowed CI users in their study to perceive differences among musical instruments; see "Hearing Headlines," page 10.)

Difficulties with speech in noise and music are all due to the poor frequency resolution of the CI, which has only 12 to 22 electrodes, compared with the thousands of individual sensory hair cells in a normal ear, or even in an ear with mild to moderate hearing loss.

In addition, since electrical stimulation tends to spread

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out in the conductive cochlear fluid, each electrode often stimulates a broad area of nerve fibers, so that even the best scenario is only eight to 10 usable channels.

Listening through a CI is like hearing sound as a highly pixelated image, as in early digital cameras. A face might be recognizable as a face, but may not be distinguishable from other faces.

Similarly for speech perception, when presented in a quiet background speech does not require a lot of fine detail to understand. But without those fine details it is difficult to distinguish one person's voice from other voices in a crowd.

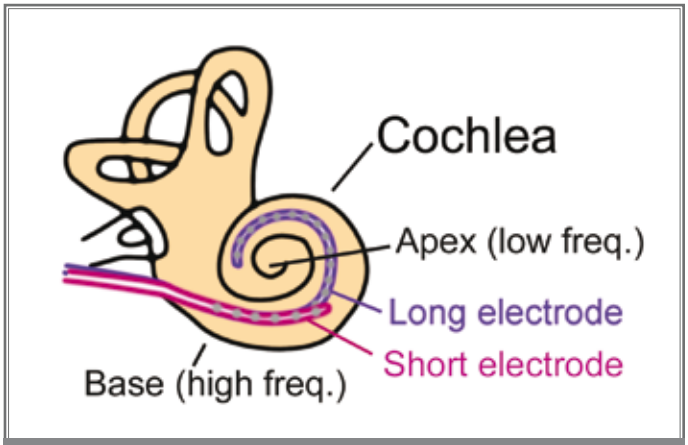
Why the Hybrid?

The hybrid CI was originally developed for individuals with enough low-frequency hearing to disqualify them from getting CIs, but who obtained little benefit from hearing aids due to profound high-frequency hearing loss.

Initially, the hybrid electrode array was much shorter and thinner than the traditional array, with just six electrodes over 10 millimeters (mm) instead of 12 to 22 electrodes over 16 mm to 30 mm, and at half the diameter. (See illustration below.) This "short-electrode" array was developed and tested in the first patients in 1999 at the University of Iowa in collaboration with Cochlear Corporation. Or, the implant can be a regular implant inserted only partway into the cochlea, as another group in Germany did in collaboration with MED-EL in 1999.

The shorter length, or shorter insertion, stimulates the basal region of the cochlea, where high frequency hearing is enabled. The apex of the cochlea, in the inner region, accounts for pitch hearing ability and low-frequency hearing. In the hybrid this area is not touched, in order to preserve that hearing.

The shorter electrode also enables relative ease of insertion into the cochlea before it begins its spiraling turns, minimizing the potential surgical trauma to cochlear tissue that can lead to hearing loss.



This illustration shows the difference in placement between a traditional long electrode and the hybrid's short electrode.

In the first clinical trial of hybrid CIs, which started in 2000, hybrid CI users could understand speech in much more adverse background noise compared with traditional full-length CI users, with as much as a 12 decibel (dB) advantage in signal-to-noise ratio. To illustrate how dramatic this benefit is, directional microphones typically only provide about a 3 dB advantage. Musical melody recognition was also much higher, at 85 percent correct for hybrid CI users compared with 25 percent correct for regular CI users, according to 2006 research.

The hybrid allows the combination of high- and low-frequency hearing. The electrical stimulation of the high frequencies in the base of the cochlea improves the discernment of consonants, boosting the availability of speech cues, while the residual low-frequency hearing in the apex fills out the vowels and provides pitch information, for better hearing in noise. And, if needed, a hearing aid can still be used in the same ear to amplify the acoustic hearing.

The hybrid essentially combines the best of both worlds: the greater sensitivity of the cochlear implant for the profoundly deaf high frequencies, and the better frequency resolution of the residual acoustic hearing for the low frequencies (even if impaired). This is like combining a pixilated image with a blurry image: The brain is able to extract and combine the best information from each source so that performance is better with the two combined than with either alone.

In addition, surgeons have developed "soft surgery" techniques to further minimize tissue trauma. This consists of either carefully drilling the hole at a slow speed in the cochlea, or using the cochlea's existing round window opening for electrode insertion. The electrode is inserted slowly to decrease insertion forces and reduce fluid loss from the cochlea.

The shorter electrode and improved surgical techniques has meant residual hearing has been preserved within 10 dB in 60 to 70 percent of hybrid CI patients, according to a 2009 study.

Preserving Residual Hearing

With any implantation, the risk of residual hearing loss remains. Scientists have been trying to determine why. One important finding in clinical trials is that the majority of hearing loss is delayed by several months after the implantation surgery. This implies that surgical trauma is not the major factor, and that other factors such

as an inflammatory response to the electrode array or even electrical stimulation can lead to delayed hearing loss.

In our laboratory, we tested the hypothesis that electrical stimulation combined with acoustic stimulation leads to hearing loss in guinea pigs with CIs. These animals were implanted with CIs and electrically stimulated daily for 10 weeks. After 10 weeks, we found that stimulated animals were more likely to have low-frequency hearing loss of greater than 10 dB than controls that were implanted but non-stimulated. This suggests that electrical stimulation, or more likely electrical stimulation combined with acoustic stimulation, can affect hearing.

One possibility that we are now investigating is whether this combined stimulation can lead to overstimulation of the hair cell synapses—similar to the hearing loss that occurs after prolonged exposure to loud noise. It may be that we need to develop new guidelines for safe limits of hybrid stimulation.

Alternatively, new treatments such as antioxidant-based therapies may be options for preserving residual hearing, such as those for preventing noise-induced hearing loss.

More recently, researchers have found that using a hearing aid in the ear opposite a traditional CI also improves speech perception in noise and melody recognition. This suggests that even people with more severe hearing loss can benefit from wearing a hearing aid together with their implant.

Implant companies are already changing electrode designs for all implants and encouraging surgeons to use soft surgery techniques to improve hearing preservation for all CI users. A 2011 study found outcomes to be significantly improved with the CI when acoustic hearing was preserved, even if the acoustic hearing was not used. This suggests that minimizing damage to residual structures is important for maximizing nerve survival and the ability of the implant to provide focused, effective stimulation of surviving neurons.

Another factor to consider, especially in children, is the potential for future regeneration technologies to be applied when residual structures are preserved, using the new shorter electrodes. It may be possible that preserving residual hearing becomes a factor for successful hair cell regeneration. (For more about hair cell regeneration, see the Hearing Restoration Project update, "What Will It Take to Seal the Deal?" by Andy Groves, Ph.D., page 16.)

With these changes and additional research, the goal is to make residual hearing and structure preservation a standard rather than an option in cochlear implantation.

Lina A.J. Reiss, Ph.D., is an assistant professor in the Department of Otolaryngology–Head and Neck Surgery at Oregon Health and Science University and an HHF 2012 and 2013 Emerging Research Grant recipient.

Christopher W. Turner, Ph.D., is a professor in the Departments of Communication Sciences and Disorders and Otolaryngology–Head and Neck Surgery at the University of Iowa. Together with Bruce Gantz, M.D., also at the University of Iowa, Turner has been involved from the beginning in the development, assessment, and optimization of the original short-electrode array, with more than 20 publications on the hybrid electrode since 2003. Turner is a former HHF Emerging Research Grant recipient.

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Current Limitations, Future Improvements

Because the shorter electrode's location in the base of the cochlea stimulates only high-frequency regions, only those with residual low-frequency hearing can benefit from the hybrid CI. Additionally, because of the reliance on residual acoustic hearing, current criteria require a stable hearing loss that is not growing worse over time. This is a particular issue in children, whose hearing may not yet be stabilized.

There is also a 30 percent risk of losing some of this beneficial residual low-frequency acoustic hearing after the implantation surgery. A complete loss of acoustic hearing would negate the hybrid benefit, especially if the electrode array is too short to stimulate the low-frequency region of the cochlea.

Recently, to prevent this scenario, implant companies have increased the hybrid implant length. The slightly longer 16 mm to 20 mm length (up from 10 mm) allows it to accommodate electrical stimulation and function like a traditional CI, if low-frequency acoustic hearing is lost.

This new version is currently in clinical trials and in November 2013 received preliminary FDA approval. In addition, several laboratories are investigating how to decrease hearing loss due to surgical trauma or even electrical stimulation.

—L.R. and C.T.

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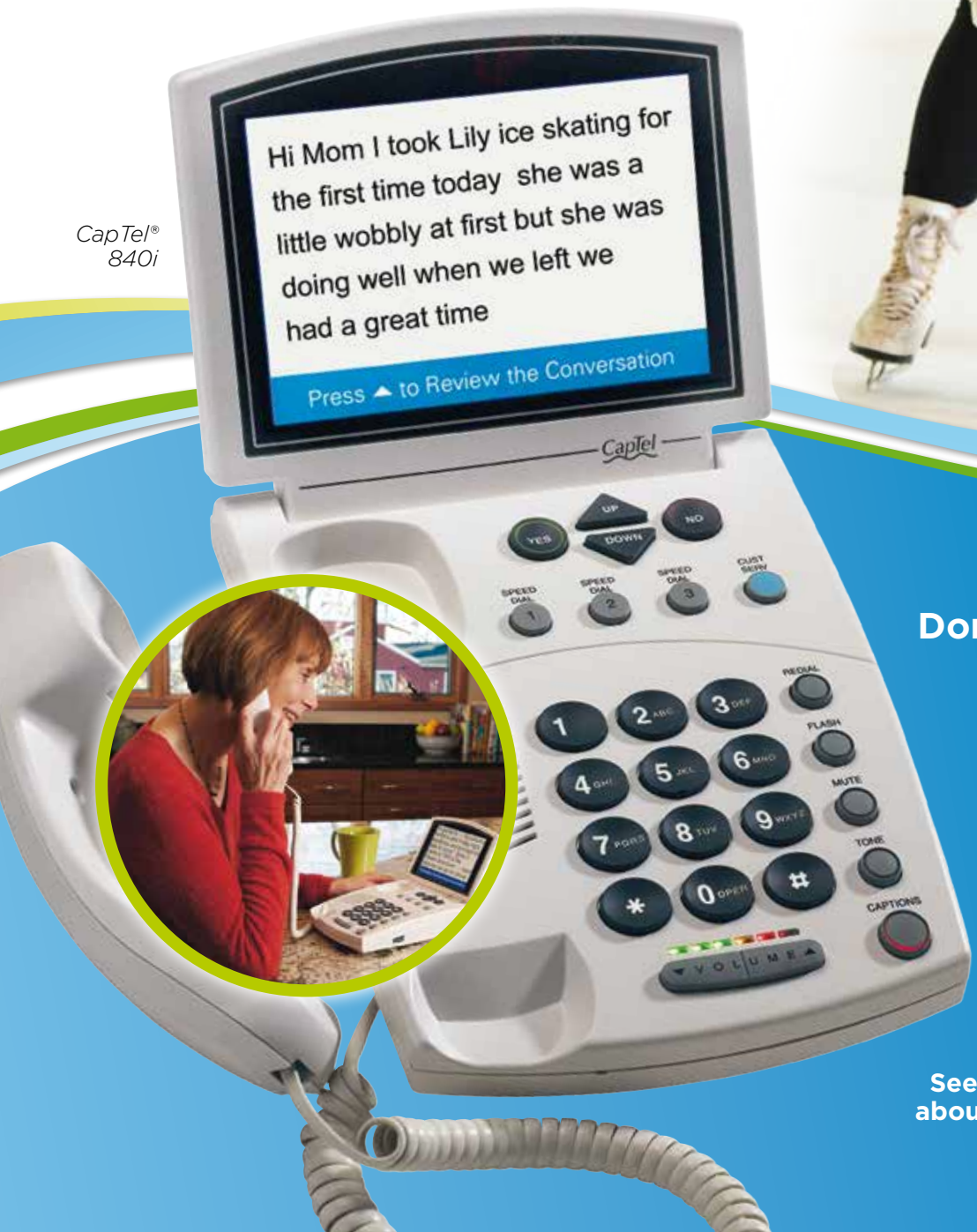

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A Growing Market

Hearing healthcare is a burgeoning market, ripe for start-up companies with innovative approaches and targeted products.

By Elizabeth Stump

Nearly 50 million Americans are affected by hearing loss. As the population ages, financial analysts predict an increasing demand for hearing devices. In addition, there is a growing market for such devices among younger generations, as teens and young adults who routinely use ear buds at unsafe volumes put their hearing at risk. According to 2010 research published in the Journal of the American Medical Association, one in five American adolescents ages 12 to 19 has a hearing loss.

Aware of the health needs and business opportunities associated with these trends, several start-up technology companies have developed targeted approaches to hearing loss. Here are some to watch.

AUDICUS

Patrick Freuler became interested in the hearing aid industry when two family members needed hearing aids. After working as a healthcare investor in Europe, he launched a website to provide lower-cost hearing aids. "Our online retail model allows us to pass up to 70 percent in price savings directly on to the end user," Freuler says.

Only a quarter of Americans who have a hearing loss actually own a hearing aid, Freuler says. In large part this is due to the cost of hearing aids (often thousands of dollars each), which is typically not covered by health insurance. Freuler also hopes to appeal to young consumers by branding its products as fashionable consumer electronics devices.

Based in Hoboken, N.J., Audicus believes in the provision of quality care by audiologists and hearing healthcare professionals, and the company says it has audiologists on staff. It offers phone support as well as a money-back guarantee. Currently its U.S.- and German-made products include a behind-the-ear (BTE) model, a completely-in-the-canal (CIC) model, and a personal sound amplifier (PSA) worn in the ear. (audicus.com)

E-VIEW CONNECTIONS

Lloyd Roin is the only member of his immediate family who does not have a hearing loss. The managing partner and cofounder of E-View, Roin says his company and the smartphone app Engage were created to keep people with hearing loss informed and connected through Deaf-friendly emergency alerts and video-text messages in sign language.

The Engage app (free and available for the iPhone, Android, and Blackberry platforms) provides location-specific content based on the GPS coordinates of the subscribing member and text messaging targeted to members' specific needs. For example, a hurricane emergency alert is sent only to those in the affected region. E-View, which is based in Des Plaines, Ill., also tailors news and event content to a location.

The 20-second videos arrive on the subscriber's mobile device as a video text message, eliminating the need to open a browser window to watch the video, Roin says.

PHOTO CREDIT: @ISTOCKPHOTO.COM/BARISONAL (TOP)

Clickable links are embedded in the messages, and each subscriber receives about 22 videos a month based on their location. Next up: messages for iPads and other tablets that won't require a cell phone number. (eviewconnections.com and engagebyeview.com)

OTOJOY

Thomas Kaufmann, the founder and CEO of Otojoy, says his company's focus is on hearing loop systems. "Even with the most advanced hearing aids, people frequently struggle with difficult listening environments," he says. "But with an installed hearing loop system, a hearing aid user receives crystal-clear sound straight into their ears at the push of a button." (Hearing aids must have telecoils, or T-coils, and must be turned to pick up sound from loop systems.)

Otojoy launched a public awareness campaign called Let's Loop Santa Barbara, where the startup is based. In the past year, more than 20 loops have been installed in Santa Barbara County as well as nearby Los Angeles. "Hearing loop systems need to be specifically engineered and customized to each venue, which is a big part of our work," says Kaufmann, who is hiring additional staff with the goal of installing systems throughout California.

Otojoy is also working on portable loop systems. One is a looped clipboard and a separate microphone. A waiter or heathcare worker hands the clipboard to a person using a hearing aid and speaks into the microphone. The speech signal is picked up by the clipboard and delivered into the listener's ear via the hearing aid's telecoil.

The company is also producing a portable receiver for people whose hearing aids are not compatible with public loop systems. "Currently, portable receivers are larger sized black boxes with a lanyard to hang around your neck," Kaufmann says. "Our device will be more inconspicuous." (otojoy.com)

SONO

While still in its initial fundraising stage, this company is taking a novel approach to dampening ambient noise. A sensor on a glass window pane takes in loud noises from outside, such as the sounds of traffic or construction, and cancels specific frequencies to render them less irritating. By turning a knob you can filter out sounds you don't want to hear and only hear those you do, such as birdsong.

The Sono sensor uses the same technology concept that mini desktop speakers for your iPhone (or other MP3) use to detect vibrations through flat surfaces. It also benefits from advances in digital sound processing that allow for precise canceling of specific sounds. The device, which was a finalist in an industrial design contest in the U.K., also hopes to partially recharge itself through electromagnetic signals in the air, such as a wireless Internet signal. Industrial designer Rudolf Stefanich got the idea for the device while in an office conference room whose glass doors failed to block outside noise. He is working to raise funds to bring Sono to production. Keep an eye out for announcements.

Staff writer Elizabeth Stump is the former editor-in-chief of the Hearing Loss Association of America's Manhattan chapter newsletter.

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From left: The Audicus aJive personal sound amplifier; a prototype of the Sono sound-reduction device; and the Engage app.

Workplace noise can be hazardous to your hearing health, but efforts are under way to protect you.

By Kathi Mestayer

If you're sitting someplace quiet while reading this, consider yourself lucky. There's a reason why "peace" is so often associated with "quiet." Being surrounded by noise is stressful, even for short periods. But what recourse is there for people who work in noisy restaurants, factories, airports, and construction sites?

Consider the workers in a U.S. Post Office distribution center only 100 feet from a train track where Bay Area Rapid Transit (BART) trains line up to cross San Francisco Bay. "Because it's close to one of the busiest BART stations, a train goes by every three to four minutes," says Ethan Salter, an acoustician with Charles M. Salter and Associates, a San Francisco acoustical consulting firm. "We put a microphone over the edge of the building, and the sound level was between 80 and 90 decibels (dBA) on the side of the building facing the tracks."

The windows facing the tracks were single-paned, with metal frames, so they didn't help much, especially when open for fresh air. "The dBA levels inside the building were almost at 70," Salter says. "It was definitely loud enough to make it difficult to communicate by phone, or even face-to-face, and it was extremely disruptive."

Salter worked with the Post Office staff to evaluate the alternatives in terms of cost, aesthetics, and constructability. "We finally retrofitted the facility with double-paned windows that have a layer of plastic in between the two panes of glass," he says. "You can still hear the trains, but now it is quiet enough to have a phone conversation."

Definitions and Measurements

Who defines workplace noise? For regulatory purposes, the Occupational Safety and Health Administration (OSHA) sets limits in the U.S. for workforce noise exposure. The limit, a maximum allowable time period of exposure for a given decibel level, is currently eight continuous hours at 90 dBA.

The National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention, sets its own best practices standard based on evaluating current research. NIOSH's recommended standard is lower than OSHA's: 85 dBA for eight hours, with an exchange rate of 3 dBA.

Decibels (dB) are the standard units for measuring

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sound pressure, but they are not the best for measuring how it affects human beings. Instead, the measure of preference is what's known as the "A-weighted sound pressure level," abbreviated as dBA, which mirrors, as closely as possible, the frequencies we hear.

According to Richard Peppin, the president of Engineers for Change, a nonprofit acoustics and vibrations consulting firm in Rockville, Md., "Some low frequencies just don't sound as loud to us as high frequencies, so we use dBAs for virtually all of the situations where we're measuring what humans hear."

All decibels are measured on logarithmic scales. So a relatively small increase (3 dBA) equals a doubling of the sound pressure being measured. Another 3 dBA increase will double the sound pressure yet again. As a result, NIOSH's recommended "exchange rate" of 3 dBA means that for each 3 dBA increase in sound, the maximum time a worker can be exposed to it should be cut in half.

Turning It Down

There's no doubt that workplace noise can damage hearing. Worse, it can sneak up on you. "The most common cause of hearing damage in the workplace is continuous-type, or steady-state, sound," says audiologist Mark Stephenson, Ph.D., the lead researcher for NIOSH's noise and hearing loss program. "It's insidious. It's like sunburn—everyone has gotten a sunburn, but nobody goes outside intending to get one. We don't perceive the damage while it's being done."

"Steady-state sound can cause fatigue of stereocilia [hair cells] in the cochlea, which is temporary, or death of those cells, apoptosis, which is permanent," he adds.

Diagnosing noise-induced hearing loss (NIHL) is tricky, because there is no single characteristic that conclusively identifies it as noise-related. "Often, the audiogram of a person with NIHL will have a 'notch' in it, or a relatively narrow frequency range, where hearing is damaged," says physicist and acoustician William Murphy, Ph.D., the leader of the Hearing Loss Prevention Team at NIOSH. "But if there's any doubt, an audiologist will take a detailed case history and possibly do additional tests to make the diagnosis."

In addition to damage from steady-state workplace noise, sounds like gunfire and explosions can cause physical damage, such as ruptured eardrums and inner- and middle-ear damage, according to NIOSH. Depending on the duration and volume of the sound, damage can be temporary or permanent.

Turning down the volume at the source is the best, first option for hearing protection. There are three other common approaches to mitigating noise, Peppin says. The first, absorption, is the addition of porous materials such as acoustical panels, tiles, and floors to reduce reflection and, therefore, reverberation.

Another approach is to use sound insulation to reduce transmission of noise using dense materials, such as concrete and thick or double-paned windows in the building, and earplugs in your ears.

Third, sound damping reduces the sound's resonance. It turns the sound's vibration energy into heat using materials like rubber or visco-elastic coating on surfaces such as walls and doors.

Hearing Conservation

In addition to setting time and decibel exposure limits, OSHA requires a Hearing Conservation Program if workers in noisy environments, such as in the manufacturing and service sectors, are exposed to 85 dBA for eight hours in a row.

According to OSHA's website, conservation programs require noise level monitoring, free annual hearing exams, hearing protection, and training. They must also evaluate the adequacy of hearing protectors.

Alcoa, the international aluminum company, uses "Quiet Dose" technology for some employees. It tracks employees' daily noise dosage using microphones mounted inside protective earplugs or earmuffs. "The units vibrate and have a warning light when the wearer gets to 50 percent of the daily maximum dose," says Chris Dixon-Ernst, an industrial hygienist and audiologist at the company.

Alcoa trains workers to be aware of noise dangers and hearing protection, and it conducts audiograms after eight continuous hours of exposure to 82 dBA. "It's not a question of potential harm—we know that noise damages hearing above certain levels," Dixon-Ernst says. "We also measure and collect data on noise levels in our production settings worldwide, which include mining, refining, smelting, and manufacturing."

Evaluating Workplaces

At the request of workers or companies, NIOSH will evaluate workplaces for noise and make recommendations for reducing sound. It has visited restaurants, offshore oil drilling rigs, and automobile factories, among others. "Power tools and industrial operations are likely to generate hazardous levels of noise," says NIOSH's Murphy. "Recent measurements in nightclubs found levels of 93 to 110 dBA for the disc jockeys."

When protective gear (such as earplugs and earmuffs)

is needed, making sure workers use it correctly and consistently is critical. "The fit of the gear has a big impact on performance," Murphy says. NIOSH and other companies have developed instrumentation that measures how well a hearing protector fits an individual wearer.

"If it doesn't fit properly, it will not protect you from noise," he adds. "With one person, we had to try three different styles of earplug before we got the right fit."

Alcoa's Dixon-Ernst adds that it is also important to get the right level of attenuation, or sound reduction. More is not necessarily better, she says.

In Search of Silence.

While organizations like NIOSH, OSHA, the National Hearing Conservation Association, and the Acoustical Society of America are working to protect hearing, it's a big job, and noise is everywhere.

"You don't have to work in a noisy space to feel the pressure," says Salter, the acoustician. "The increase in mixed-use neighborhoods and urban redevelopment means that the music from a high-energy aerobics class at 5 a.m. could be your alarm clock. Or you might find yourself next to a nightclub that turns on its subwoofers

No Pain, No

AT A FITNESS CLASS recently, a Hearing Health Foundation staff member was stunned by how loud the music seemed to be. She did what anyone who works in the field of hearing health would do: She measured the sound using a decibel app on her smartphone. The National Institute for Occupational Safety and Health (NIOSH) says that, at 100 dBA, exposures of more than 15 minutes can damage hearing. (The unit dBA measures sound levels as perceived by humans.)

The HHF staffer says that at her gym, "It was 105 decibels once and 115 decibels the second time, during class with music on and the instructor giving direction." She now consistently wears earplugs, but few others in the class do.

Unless you work in a gym, most people don't spend a lot of time in them. The noise mainly comes from sound systems or boom boxes that we voluntarily turn up or down (as opposed to noise from traffic, for example). Plus, we know it's there and can prepare in advance by bringing hearing protection. So what's the problem?

It depends on who you ask. An Australian study found that 85 percent of the instructors in gyms and workout facilities that they interviewed found loud music motivating. About 20 percent of clients found it stressful.

And what about the instructors' hearing? A 2009 study of indoor bike class instructors in Brazil measured dBA levels of 74 to 101 dBA. Although the decibel level fluctuates during classes, remember that NIOSH recommends limiting exposure at 100 dBA to a total of 15 minutes over a period of eight hours.

"Physical education professionals working with indoor bike classes are under high levels of sound pressure during their classes," the Brazil study concluded. "This physical agent has been related to several health problems and should therefore be more controlled."

What's more, studies have also shown that people who wear ear buds to listen to their own music while working out will turn them up to drown out the gym's music. A 2009 Canadian study showed that people who use earbuds while working out in noisy situations tend to turn the volume up higher than those who are not exercising—often to dangerous levels.

Even workout spaces that don't play music can cause issues. Athletic facilities sometimes have very high reverberation, causing sound waves to bounce back and forth, up and

PHOTO CREDIT: @ISTOCKPHOTO.COM/KZENON

just when you're going to sleep." In New York City, noise complaints routinely rank as the top reason for calls to the city's nonemergency 311 hotline.

Advocate for yourself and your coworkers to turn down the volume. Someday soon, peace and quiet may be a commodity that we all seek out, the way we have learned to search for a little shade in the blazing sun.

Staff writer Kathi Mestayer serves on advisory boards for the Virginia Department for the Deaf and Hard of Hearing and the Greater Richmond, Va., chapter of the Hearing Loss Association of America.

This is second of two articles about workplace noise. Part one, "Office Space," talks about optimizing workplace environments if you have a hearing loss. It appeared in the Fall 2013 issue and is available at hhf.org.

Read the blog post about steps a busy Berkeley, Calif., restaurant has taken to manage noise levels at hhf.org/blog.

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Gain? Going to the gym should not mean risking your hearing.

down, echoing over metal, glass, and concrete surfaces and structures.

If we're working out alone, or don't need to hear the teacher, trainer, or other class members, maybe it's not such a big problem. But when we do need to hear and be heard, the echoes get in the way, even when they're not at ear-damaging volume.

And if you happen to be a neighbor who shares a wall, floor, or ceiling with the gym, the noise and vibrations can invade your space and sense of privacy.

Acousticians like Richard Peppin, the president of Engineers for Change, a nonprofit acoustics and vibrations consulting firm in Rockville, Md., call this transfer of sound from one space to another "transmission loss"—the sound energy is lost through the shared surfaces.

Building codes, such as the International Building Code (Section 1207), have been adopted in some states, but not all. And Section 1207 only applies if the affected space is residential and adjacent to the noise source.

Smartphone apps that measure sound levels are readily available, although the quality of the microphones limits their accuracy. I tested a smartphone app (AudioTools) against a Quest Model 2900 Sound Level Meter (professional device) to see how well the smartphone and Quest dBA readings match.

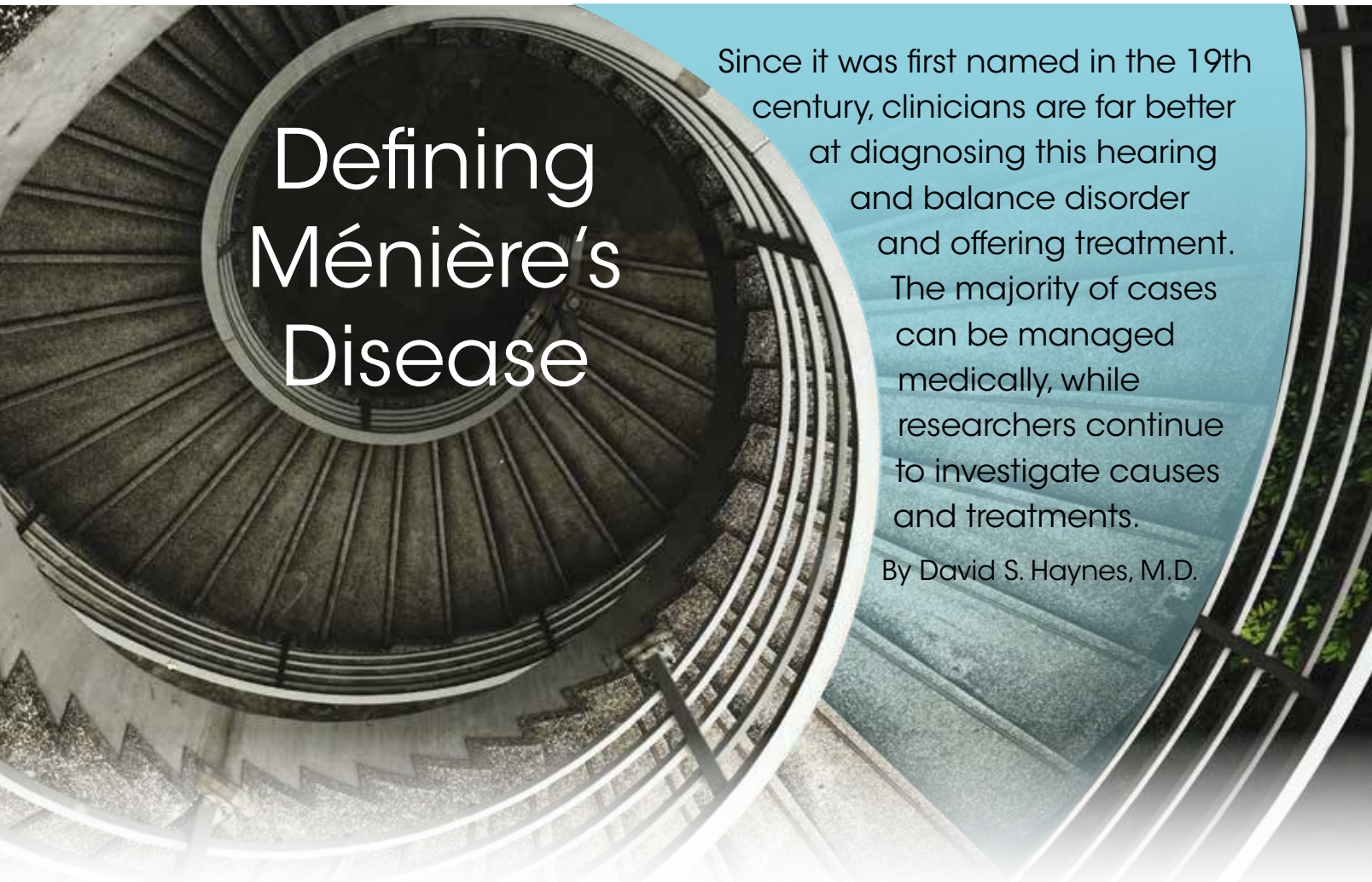
The test site was a local community recreational center. In the huge, hard-surfaced pool area, five lanes were filled with a swim team practicing, and an aquatic aerobic class was in progress at the opposite end, with the boom box on. The Quest sound meter gave me levels between 74 and 78 dBA, with 78 nearest the boom box. The AudioTools smartphone app read about 4 dBA lower, across the board.

Remember that decibel increases are magnified: 80 dBA is twice as loud as 77 dBA—the sound energy doubles with each 3 dBA increase. So while 4 dBA doesn't seem like much on a linear scale, it's a big difference in dBA terms.

That said, you can still use decibel apps to get a general reading and as evidence to bring to the workout instructor or the gym manager.

Wear earplugs, ideally those with a customized fit, such as from Etymotic, HearPlugz, HearTech, Killnoise, Mack's, and Westone. Some gyms, such as Flywheel, do offer ear plugs to their guests.

Part of being physically fit is protecting your hearing. Don't get drowned out by the noise, and speak up. —*K.M.*



Defining Ménière's Disease

Since it was first named in the 19th century, clinicians are far better at diagnosing this hearing and balance disorder and offering treatment. The majority of cases can be managed medically, while researchers continue to investigate causes and treatments.

By David S. Haynes, M.D.

Chaired by David S. Haynes, M.D., Hearing Health Foundation's Council of Medical Trustees (CMT) consists of otologic and neurotologic physicians and surgeons who advise the foundation's staff and the board of directors on medically related issues. This article is one of several that the CMT will be contributing to Hearing Health magazine and hhf.org on hearing and balance disorders.

What is Ménière's disease?

In 1861 Prosper Ménière described the group of symptoms for the disease that now bears his name. These symptoms include fluctuating hearing loss, episodic vertigo, a sensation of ear fullness, and tinnitus. The underlying etiology identified for this inner ear disorder is felt to be endolymphatic hydrops (fluid buildup in the inner ear) and was confirmed via temporal bone histology in 1938.

Many disorders have similar symptoms to Ménière's disease. As a result, the American Academy of Otolaryngology–Head and Neck Surgery attempted to define the condition in 1985, further refining it in 1995. The 1995 diagnosis for *probable* Ménière's disease includes one definitive episode of vertigo and audiometrically documented hearing loss, as well as tinnitus and fullness in the affected ear. *Definite* Ménière's disease is classified when there are two or more definitive spontaneous episodes of vertigo (20 minutes or longer), hearing loss, tinnitus, and aural fullness in the affected ear. Dizziness can appear after a period of tinnitus or muffled hearing. They may appear so suddenly that sometimes the person loses balance and falls.

As more knowledge of Ménière's and other vestibular disorders emerges, many patients who were once considered to have Ménière's are now diagnosed as having other disorders. For example, many patients who, in the past 20 years were diagnosed with Ménière's disease due to episodic vertigo, hearing loss, and ear symptoms, are now more successfully diagnosed with disorders that have similar symptoms as Ménière's, such as superior semicircular canal dehiscence, vestibular migraine, and benign positional vertigo.

Having an experienced doctor who understands the conditions that can present with similar symptoms is essential. Because of the challenges in accurately diagnosing Ménière's, the diagnosis can sometimes occur by process of elimination.

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How common is Ménière's disease?

About 615,000 people in the U.S. have Ménière's, according to the National Institute on Deafness and Other Communication Disorders (NIDCD). About 45,000 new cases are diagnosed annually. It most commonly affects people between the ages of 40 and 60, but it can affect people of all ages.

What causes Ménière's disease?

The physical cause of Ménière's is a buildup of endolymph fluid inside the inner ear. This excess fluid (beyond the normal fluid that exists in the inner ear) affects balance and hearing.

The cause of the fluid buildup is not definitively understood. Some researchers believe it is related to the same blood vessel constrictions that can lead to migraine headaches; others say it may be due to an autoimmune condition, a viral infection, an allergic reaction, or head trauma. Ménière's appears to have a hereditary component, so there may be a gene mutation connected to the regulation of endolymph fluid.

How is Ménière's disease treated?

Many treatment options have been proposed in patients with Ménière's disease. It is difficult to determine the effectiveness of these therapies given the variable degree of symptoms and the variable natural history of recovery between patients. Many treatments that were in favor a few years ago have now fallen out of favor with clinicians as new treatments develop or as others are proven to be ineffective. As a result, the treatment options for patients with Ménière's disease remain a work in progress.

There are two main treatment types: those that stabilize the inner ear at a functional level, and those that shut down the function of the inner ear.

A helpful analogy for these two types of treatments is to think of an airplane with an engine on each wing. The plane flies better with both engines functioning in sync. But if one engine continuously starts and stops, activates and deactivates, it is better to have that particular engine stabilized either at a functional level, or be turned off.

Here is a review of treatments, ranging from the most to least conservative.

Medical therapy is directed at treating the underlying disorder and controlling the symptoms. The primary method of treating the underlying hydrops is to implement a low-sodium diet and diuretics to reduce fluid retention and, as a result, inner ear fluid pressure. A variety of vestibular suppressants, ranging from antihistamines to benzodiazepines, are utilized to control patients' acute symptoms. Most patients are well controlled on medical therapy and require no surgical intervention. Similar to patients with lumbar back pain, most patients can be managed with nonoperative therapy, with surgical intervention being reserved for the worst cases. Approximately 85 percent of Ménière's disease patients are treated medically.

One of the earliest interventions, which is being offered to patients more frequently, is **intratympanic steroids.** A steroid solution is placed directly into the middle ear, allowing for passive perfusion into the inner ear via the round window. Intratympanic steroids are often offered to patients with episodic vertigo, sensorineural hearing loss, and other classic symptoms of Ménière's disease that do not respond well to medical management. Like any treatment for Ménière's disease, intratympanic steroids have variable effects among patients. They are increasing in popularity due to their low risk and easy administration in the doctor's office. Many patients often prefer intratympanic steroids on a frequent basis as opposed to taking daily diuretics and/or sedating vestibular suppressants intermittently. Intratympanic steroids are associated with fewer side effects than systemic steroids.

The **Meniett Device** was approved by the Food and Drug Administration in 1999 and requires a tympanostomy tube to be placed in the ear drum. A self-administered pressure device, the Meniett is inserted into the ear canal and applies intermittent, alternating air pressure pulses to the middle ear in order to reduce fluid pressure causing dizziness. While having early promise as a conservative treatment option, it is now used less and less frequently due to other treatment modalities.

Although **endolymphatic sac surgery** is done in the operating room under general anesthesia, it remains classified as a conservative procedure because it retains the function of the inner ear. By decompressing the endolymphatic sac, there is a chance to decompress the functional component of the inner ear, reducing symptoms. This procedure generally has a success rate of around 50 percent. (Generally, an outpatient procedure for the most symptomatic patients—the worst 15 percent—that has the capacity to improve symptoms at a rate of 50 percent is perceived as a good option.)

The next option is **intratympanic gentamicin.** Gentamicin is an antibiotic with a known side effect of hearing loss and a capacity to destroy the vestibular

system. It is delivered specifically to the middle ear with the intent to reduce the function of the vestibular system in that ear. It is titrated so that hearing can be preserved while vestibular function is reduced or eliminated.

A **vestibular nerve section** requires surgically opening the skull. The balance portion of the 8th (auditory-vestibular) nerve is cut, sparing the hearing portion. It is now rarely performed due to the advent of intratympanic steroids and gentamicin therapy.

Labyrinthectomy remains a viable option for patients. It is a surgical removal of the inner ear. It is done through a relatively straightforward mastoid operation and is definitive in eliminating vestibular function. Labyrinthectomy remains the gold standard for treating Ménière's disease in patients with poor hearing. It too, however, is generally used only after other treatment options have failed and a definitive option is needed.

What is the treatment outlook?

Treatment for Ménière's disease remains elusive. Most treatment options today begin with routine medical management. If this fails or side effects are significant, targeting the affected ear with therapy is the next consideration. The improved diagnostic skills of clinicians, who are better able to identify other inner ear diseases, has reduced in general the number of patients being diagnosed with Ménière's disease. Most centers adopt a conservative treatment, withholding surgical intervention for more severe cases.

What research is being funded?

The NIDCD is supporting Ménière's research, as is

Ménière's *and the Promise of a Cure*

When Pat Collins was 6, he was diagnosed with hearing loss in his right ear, but it did not hold him back. He was always a good student, and he grew up to be a competitive athlete and even an accomplished singer.

But when Collins was 39, he suddenly lost hearing in his other ear, and he feared his world would change dramatically.

That was in 2001, and Collins and his family, who live in New Jersey, had just welcomed a new baby into their home. What should have been a time of joy was filled with anxiety. "I didn't know if I'd still be able to support my family or if I'd ever hear my little boy's voice," he says.

His doctor was optimistic. After a steroid treatment, he recovered much of his hearing in the left ear. Life went back to normal—until a few months later when he suddenly lost his hearing again.

"I bent over to retrieve papers from my briefcase—then all at once, all the sound became extremely distorted," says Collins, who was formally diagnosed with Ménière's. While he does not have the severe vertigo that can come with the condition, he does have episodes of mild dizziness, distorted hearing, fullness in the ear, and tinnitus.

Collins was advised to follow a low-sodium diet and avoid stress. "Dealing with my Ménière's—well, it's frustrating. To tell me I can't push myself is really an adjustment."

He set out to learn as much about hearing loss as possible. As a result, Collins is closely watching the efforts of HHF's Hearing Restoration Project (HRP) to cure hearing loss and tinnitus. "No other nonprofit is doing more to restore hearing," he says. "It could mean very big changes in my life and the lives of millions."

(Please see details about the HRP's latest work on page 16.)

Pat Collins and his family believe a cure for hearing loss can cure his Ménière's.

PHOTOS COURTESY OF PAT COLLINS (LEFT) AND DANA WHITE (RIGHT)

HHF. Two 2013 Emerging Research Grant scientists are investigating the condition. Peihan Orestes, Ph.D., of the University of California, Los Angeles, is testing the effect of gentamicin use on the contralateral (least affected) ear to stabilize vestibular function in patients with Ménière's disease, and whether the contralateral ear can be retrained to help normalize vestibular function.

Ian Swinburne, Ph.D., of Harvard Medical School, is studying how the endolymphatic duct and sac stabilize the inner ear's fluid environment in an effort to identify ways to restore or elevate this function to mitigate or cure Ménière's disease.

David S. Haynes, M.D., FACS, is the vice chair, the chief academic officer, and a professor in the Departments of Otolaryngology, Hearing and Speech Sciences, and Neurosurgery, and the director of the Division of Otology and Neurotology; the program director of the Neurotology Fellowship; the director of Cochlear Implant Program; and a co-director of the Skull Base Center, all at the Vanderbilt University Medical Center. Haynes is also the medical director for Hearing Health Foundation.

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A Boxer Says His Ménière's Is Beaten

A German orthopedic treatment is expensive, exclusive, and not approved by the FDA. Dana White says its off-label use helped him.

By Elizabeth Stump

Dana White is the president of the Ultimate Fighting Championship (UFC), a mixed martial arts organization. But for decades, he waged a private battle with Ménière's.

Last spring, White made headlines when he said his Ménière's had been cured in Germany using the Regenokine Injection System (also known as Orthokine). Peter Wehling, Prof. Dr. Med., developed the treatment for back pain.

It involves removing some of the patient's blood, incubating the blood at a raised temperature, running the blood through a centrifuge to isolate anti-inflammatory proteins, and then injecting the solution back into the patient. Heating the blood increases the concentration of anti-inflammatory proteins. When reintroduced into the body, they act as a "natural" anti-inflammatory drug.

Reached in Düsseldorf, where he oversees the Center for Molecular Orthopedics, Wehling says he must emphasize that Regenokine is for orthopedic conditions. He says randomized, double-blind trials verified its use for osteoarthritis and spine disease, as reported in the journals BioDrugs (2007) and Osteoarthritis and Cartilage (2008).

"The use of this procedure for other indications such as Ménière's is a so-called off-label use, which we do not want to promote actively, as there are no double-blind studies for this indication," Wehling says. Regenokine is also not approved by the U.S. Food and Drug Administration (FDA).

White has been outspoken about his success using it. He traces his Ménière's to a street fight two decades ago. With the attacks worsening over the years, eventually lasting up to 10 hours, he was officially diagnosed in 2012.

"I'm a tough guy but nothing ever shut me down so completely like Ménière's," he says. "I had to lie down during attacks in a dark and quiet room, shutting my eyes and not moving an inch, because the vertigo and ringing in my ears was so extreme."

White tried restrictive diets, steroid injections, and a stent surgery, but the attacks continued. In 2012 he stopped working and traveling. "I was so depressed, thinking the rest of my life would be like this," he says.

Then pro baseball player Alex Rodriguez (A-Rod) recommended Regenokine, which he used on his knee.

"The doctor in Germany sees people only on referral, but A-Rod got me in," says White, who was evaluated and paid $10,000 for two shots several months apart.

His Ménière's symptoms disappeared. "I am living a normal life again, with no symptoms or side effects," he says. "I am finally back to working full-time and traveling, going to the gym, and spending time with my kids."

Staff writer Elizabeth Stump is the former editor-in-chief of the Hearing Loss Association of America's Manhattan chapter newsletter.

MUSIC ISSUE

The Legendary Les Paul

The music and innovations of guitar great Les Paul forever changed the course of music history. Now, his foundation is working with Hearing Health Foundation to forever change the field of hearing health.

By Andrea Delbanco

A total of 36 gold records in the 1950s was just the icing on the cake for rock legend Les Paul. Together with his wife, Mary Ford, he took the music world by storm. But Paul was more than a performer; he was also an innovator. His solid-body electric guitar, the Gibson Les Paul, became the instrument of choice for countless future greats. Paul's pioneering production methods included multitrack recording, close miking, and reverb. His electric sound revolutionized American pop music.

For decades, Paul lived with a hearing loss and suffered from tinnitus. It didn't stop him from making music, though. In addition to supporting music education, engineering, and innovation, Paul turned his talents to medical research. He was working on creating an advanced hearing aid device when he died in 2009, at age 94. The guitar great, who grew up in Waukesha, Wisconsin, was a multifaceted man. Here, friends and family members share their recollections about Paul, in their own words.

Michael Braunstein is the executor of Paul's will and runs the Les Paul Foundation.

"Les was part of my family. I was the third generation of Braunsteins to work with Les. When Les was looking for a business manager in

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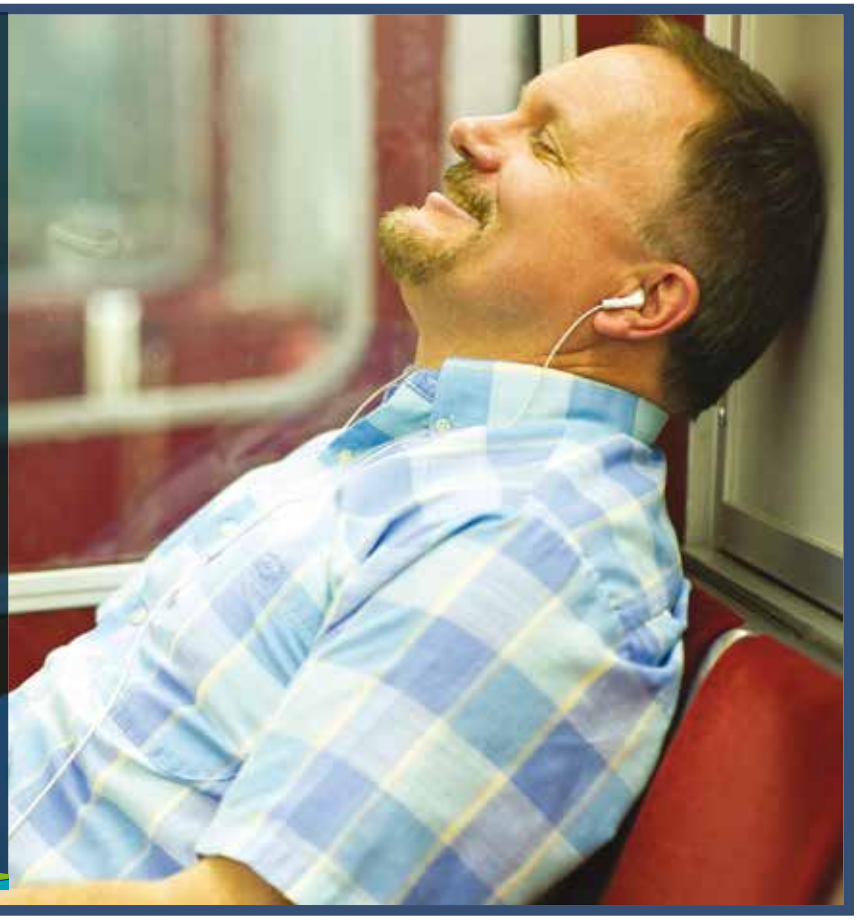

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In addition to his 36 gold records in the 1950s, Les Paul revolutionized music production and invented such methods as multitrack recording, close miking, and reverb.

the late 1940s, he sought out my grandfather because he represented one of Les's guitar heroes, Andrés Segovia [the Spanish classical guitarist who died in 1987].

I was blessed to get to work with Les for the last 19 years of his life, which included many great events like his 90th birthday concert at Carnegie Hall and projects like the Les Paul documentary 'Chasing Sound,' as well as his biography, 'Les Paul In His Own Words.'

The thing that stood out to me the most about Les was how much he enjoyed interacting with people. He would always take the time, especially when signing autographs, to ask questions about the individual's interests in music or anything else.

One of Les's greatest frustrations in life was his impaired hearing and the low quality of hearing aids. As a man whose entire life was about sound, healthy hearing was of paramount importance, which is why one focus of his foundation is on a cure for hearing loss. ”

Sue Baker is the program director for the Les Paul Foundation.

“I became good friends with Les Paul for the last 10 years of his life. During long hours of conversations, I learned that the guitar god went way past the inventor and gold-record performer most people knew. Although I'm less sure why he chose to grow our friendship, I certainly know why I valued the relationship. I observed a man who sat on top of the world but made time for those around him. Unlike most of us, challenges were not time for self-pity. He viewed them as opportunities to learn.

I was amazed to learn about the many physical challenges that threatened to end Les's ability to play his beloved guitar. Unlike many of us, he declared that each challenge merely provided him an opportunity to teach himself a new way to play.

After his near-death car accident in 1948, Les's torso and right arm were in a cast that precluded him from holding a guitar. Determined to work with his situation, Les recruited a friend to help him modify a guitar stand to hold his instrument so that he could play.

Les spent his life chasing the perfect sound, so losing hearing in both ears was a tremendous blow. He spent his last years, when he was in his 90s, searching for a better hearing aid. That is, except for every Monday night, when he performed two shows at New York's Iridium Jazz Club. And he did that until just a few months before he passed on.

Les decided what he wanted and kept working toward that goal, no matter how long or how many attempts it took, until he reached it. I learned a lot about life from my friend, and it is my privilege to share Les Paul's stories and legacy through his foundation. ”

Chris Lentz is the director of media archives for the Les Paul Foundation.

“Les was always bothered by background noise and the frequency response of hearing aids, as well as their fit and feedback. We were always cleaning the hearing aid's earwax traps. We would sit around for hours adjusting his aids. He had tried every brand and was unhappy with all of them since they basically used the same components, so he kept trying to build a better hearing aid, even into his 90s. ”

PHOTOS COURTESY OF THE LES PAUL FOUNDATION (TOP) AND LOU PALLO (RIGHT)

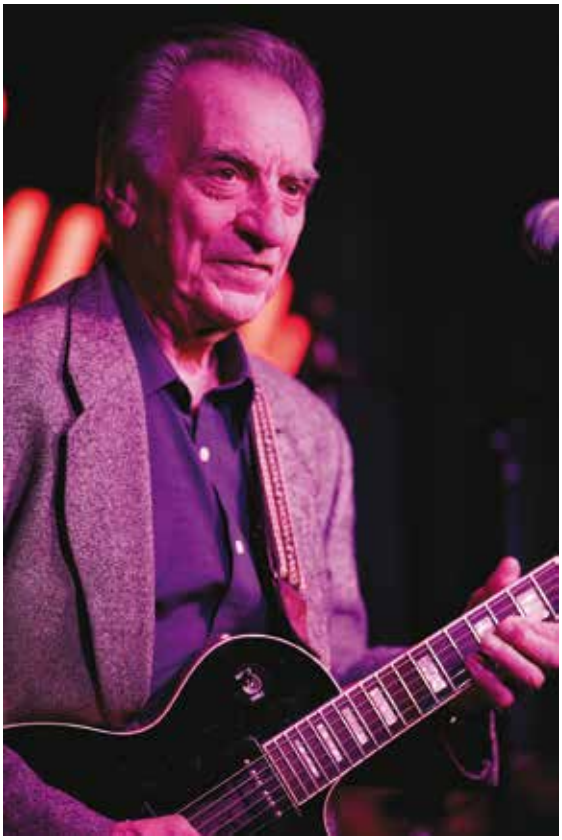
The Les Paul Foundation and Hearing Health Foundation (HHF) are teaming up to prevent and to cure hearing loss and tinnitus which affects 50 million Americans and 360 million people worldwide. One of the most common causes of both is frequent exposure to loud sounds. As a result, many musicians, sound engineers, and others who work in the music industry are affected. Guitar great Les Paul, a man who meant so much to the world of music, also lived with a hearing loss and was determined to find a cure. Today, through the Les Paul Foundation, Paul's desire to find a cure for musicians and people around the world who have tinnitus and hearing loss continues.

Through his foundation's support of HHF's Hearing Restoration Project, an international research consortium of top researchers, we have the opportunity to cure hearing loss and tinnitus within a decade. But we need the help of the music industry to make it happen. Together, the Les Paul Foundation and HHF launched the Les Paul Ambassadors program in 2013 to promote awareness of the prevention of tinnitus and hearing loss; of the prevalence and warning signs of tinnitus and hearing loss; and of a cure possible through the Hearing Restoration Project.

The Les Paul Ambassadors are musicians and music industry professionals who support HHF's goal of curing hearing loss and tinnitus and want to share their experiences for the benefit of others.

The Les Paul Ambassadors

Our first Ambassador is the legendary Lou Pallo, a guitar hero in his own right and the leader of the Les Paul Trio. Here, Pallo, 79, who lives in Wanaque, N.J., shares his memories of Les Paul.



"When I was 14 years old, I took guitar lessons. My idol and hero was Les Paul. I purchased all of his records, a total of 78 discs, and played them over and over. I could not believe the sound and arrangements he produced. Every guitar player tried to copy Les Paul but could not reproduce his sound and arrangements. He was the best.

In 1963 I played in Greenwood Lake, New York, when I met Les for the first time. We exchanged phone numbers. Of course I called him the next day and wound up at his house that day jamming with him. Les was retired at that time, but I could see he missed playing in small venues. He would come to every gig I performed and bring his guitar and sit in with me.

Les and I became very close friends. We then performed small concerts in New Jersey, and it was an honor for me to be onstage with my best friend and my guitar hero.

Over the years Les's arthritis in his hands would bother him. He would use three of his fingers and still played well. When his hearing problems began [likely from working in the music industry and, possibly, from getting cuffed on the ear], Les tried many hearing aids but was never completely satisfied with them. He worked with a few people who made the aids to try to improve the highs and the lows of their decibel range, which he believed were 'not up to par.' If he lived a little longer, I think he would have achieved that goal. He knew sound, and that was what he was striving for in hearing aids.

He was the best."

Andrea Delbanco is the senior editor of this magazine.

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Straight Talk About Assistive Listening Devices

By George Khal

Assistive listening devices (ALDs) help people with hearing loss communicate. As a person with severe bilateral hearing loss and 30-plus years of experience using, testing, advising, and selling ALDs, I hope to present unbiased information on the many options available to help you make the right choice for your needs.

There are two major categories of ALDs: **Listening Devices** and **Alerting Devices**. Listening Devices use text or amplified sound to help you hear in the classroom, on group tours, during phone or in-person conversations, and while watching TV. Alerting Devices use vibrations or flashing lights when a baby cries, the doorbell rings, the alarm clock buzzes, or a smoke detector sounds. In this way, ALDs provide independence and peace of mind.

ALDs can be used at home, work, and school, and in public places. The Americans With Disabilities Act requires public venues to accommodate people with hearing loss. For example, movie theaters must provide hearing assistance.

An important built-in component of most hearing aids and cochlear implants is the telecoil, or T-coil. Think of this as a second microphone/receiver in your aid or implant. The T-coil receives electromagnetic sound waves via the use of an induction loop. These loops generate electromagnetic soundwaves and deliver them directly into the T-coil of your aid. A national effort is currently under way to promote audio loops and T-coil use. (Learn more at hearingloop.org.)

> With a wide range of options, ALDs provide independence and peace of mind.

If you are thinking of upgrading your hearing device, make sure it has a T-coil. Some of the newer, smaller hearing aids that sit completely in the ear canal do not have T-coils, although with advances in technology this may change.

Types of ALDs

Here is an overview of the different categories of assistive devices. Look for more details about these devices in future columns.

Induction (audio) loop systems are used in homes, schools, offices, theaters, train stations, and airports. They transmit sound electromagnetically to the T-coil in hearing aids, via a wire circling the room. The range is limited to within the perimeter of the wire. A **neck loop device** is worn around the neck and plugs into an MP3 player, smartphone, or computer.

Personal amplifiers are used for close-range, one-on-one communication. They can also be used for TV or at the dinner table. The microphone and the amplifier are a single piece of equipment.

Personal FM systems are used like personal amplifiers but are wireless, transmitting sound via radio waves. This means the microphone could be as far as 150 feet from the personal receiver. Personal FM systems can be used in a classroom or larger meetings, where the person speaking wears the microphone. **Large FM systems** are used in auditoriums, places of worship, and with tour guides. The microphone/transmitter is plugged into the sound system of the facility; you wear a personal receiver with headphones or a neck loop. The range is about 500 feet.

Television infrared systems are for watching TV or listening to music at home, delivering sound via infrared rays. The range is limited to within the perimeter of the room. Some new models transmit via FM waves, which allow you to hear the show outside the room. **Large infrared systems** are used in movie theaters and courtrooms.

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Vibrating alarm clocks use strong bed shakers and, sometimes, flashing lights. Battery-powered models are placed directly under the pillow.

Visual/tactile home alerting systems use lights and vibrations to alert you to the phone or doorbell ringing, a baby's cry, the presence of smoke or carbon monoxide, severe weather, or an intruder at a window.

Phone Options

Amplified telephones are used to increase volume up to 60 decibels and adjust tone for clarity.

Captioned telephones allow the user to read what the caller says, and they also transmit voice (unlike TTYs below). An Internet connection is required to connect to the free, real-time captioning service.

Cell phones can send text messages, but how well you can hear conversation will depend on the M (microphone) and T (telecoil) ratings. A cell phone rated M4/T4, the maximum rating for each category, is likely to work best with your hearing device. (See "Cell Phones Decoded," Spring 2013, at hearinghealthmag.com.)

TTYs (teletypewriters) are phones on which the conversation is typed using a small keyboard.

Videophones With Free Video Relay Service (VRS) are used to conduct conversations between a person with hearing loss and a person with normal hearing. VRS translates sign language via a video screen.

Voice carry over (VCO) phones are similar to captioned telephones, but an Internet connection is not required. Users dial 711 to connect to the free Telecommunications Relay Service for captioning.

With this new column, I hope to be able to help you or your loved one with hearing loss get the most out of your assistive devices. In addition to writing about ALDs, I will also be discussing state programs that offer free devices, how to shop for ALDs, and what to consider in terms of reliability and pricing. Stay tuned!

George Khal was the founder of Sound Clarity, an international retail company for assistive devices; he served as its president from 2000 to 2010. With a severe bilateral hearing loss, Khal was the Hearing Loss Association of America's chapter coordinator for Iowa and chaired its national convention in Cedar Rapids in 1992.

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Hearing Health Foundation is a national nonprofit organization with a mission to prevent and cure hearing loss and tinnitus through groundbreaking research.

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GUIDESTAR Exchange SILVER PARTICIPANT

Veronica Calhoun (top right) and Kimberly Rossignol Montini (bottom right), who live in New York City, ran the ING New York City Marathon on November 3, 2013, to raise funds to find a cure for hearing loss and tinnitus. Calhoun shares:

My 4-year-old daughter was born with severe hearing loss. It was a complete surprise. But since I had met Kim, an amazing woman with hearing loss, I saw firsthand that hearing loss doesn't prevent you from doing anything. I thought of her immediately when Marlowe was diagnosed with hearing loss, and I knew my baby would be just fine.

Running the NYC Marathon was a dream goal, but one that seemed laughable for someone who had never run more than a 5K race. The training was tough. Some days I just didn't want to do it, but I dragged myself out of bed because I had made a commitment to HHF. I would never have been able to make it through training if I hadn't made that promise.

Together we raised over $11,000. Some of the donations came through a corporate match from The Macquarie Foundation. Kim raised $3,800 through multiple Facebook posts and emails to friends. The race was so much fun. It was a huge rush. I trained alone, so the actual marathon felt like a giant party by comparison. I think I was grinning from ear to ear, high-fiving the crowds for the first half. At the finish line I tearfully hugged the guy who put the medal around my neck. I was just a happy puddle.

I believe that a cure for hearing loss is a reasonable and attainable goal in the near future. It's not a cause that gets the kind of funding it deserves, so I'm not going to sit and wait for someone else to raise the money to keep the science going. It's too important to me to stop now—I'm just getting started.

Rossignol Montini adds:

I have a moderate to profound hearing loss, so it was a no-brainer to help "my people" and also participate in an iconic event in the greatest city in the world. I had never raised money like this in any capacity. Fundraising for a great cause gave me extra motivation to keep going during the marathon. It felt amazing to be a part of it.

What are fun, creative ways to fundraise for HHF? Find out at hhf.org/fundraise and help us cure hearing loss and tinnitus.

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Questions to Ask When Getting Hearing Aids for the First Time

By Courtney M. Campbell, Au.D.

For the average first-time hearing aid user, choosing a hearing aid can be a daunting task. There are different styles, technology levels, and manufacturers to pick from, and there are several things you should ask yourself and your hearing healthcare professional to help you make an informed decision.

First and foremost in informing the decision-making process is your hearing loss. It is essential to have a comprehensive hearing test completed by a hearing professional before even thinking about hearing aids. The severity and configuration of your hearing loss is as individual as you are, and it will often dictate the style of the hearing aid (such as behind-the-ear, in-the-ear, etc.) that will be best for you.

Another factor to consider when choosing the style of hearing aid is your level of dexterity. The smaller the hearing aid, the smaller the battery, and this can make changing batteries a challenge for people who have problems with their hands or fingers. Vision issues can also affect your choice. Ask your provider why a certain hearing aid style is being recommended to you.

> Brand matters less than the type and technology.

Hearing aids come in a wide variety of technology levels, and the technology inside a hearing aid will often correlate with price. Not surprisingly, the most advanced hearing aid technology will be the most expensive, so consider your day-to-day listening environments. Do you go to restaurants or parties frequently? Are you a professional musician? Do you primarily stay at home and watch television?

If you are very active and exposed to varied listening environments, you will have much greater success using a high-end technology hearing aid with features like advanced noise reduction. A person who is primarily in quiet places will do well with basic hearing aid technology.

Be honest with yourself about daily hearing challenges. You may end up disappointed if you opt for very basic hearing aid technology and find it does not perform well in your everyday routine. And for many people, cost will be a major determinant; weigh what you can afford with the level of technology you need.

One question I am often asked is, "Which manufacturer or brand of hearing aids is best?" Most hearing providers work with several hearing aid manufacturers, but some practices specialize in a certain brand.

In my opinion, style and technology tend to be more important than the name brand of the hearing aid, but there are certainly some exceptions to this. Some hearing aid brands are more moisture- and dust-resistant than others, so if you plan on wearing the hearing aids in diverse environments this may be a very important feature.

Other main differences among the manufacturers are aesthetics and manual function. Some brands have manual controls (e.g., volume) directly on the hearing aids, and others will require you to add an accessory (e.g., a remote control) to access those features.

Your hearing provider may have a personal preference due to past experiences with previous patients or the manufacturer's customer service. If your hearing professional recommends a certain brand of hearing aid, ask why, and make sure you understand the reasoning.

Lastly, there is color: Hearing aids come in an array of choices. This is certainly the least important factor when deciding among hearing aids, but picking a color you like is a nice way to make the hearing aids "yours." Most people choose a color to match their hair, but I always try to convince patients to get their favorite color—my hearing aids are pink!

An audiologist at A&A Hearing Group in Chevy Chase, Md., Courtney M. Campbell, Au.D., received her undergraduate and doctorate degrees from the University at Buffalo in New York. She has a hearing loss and has been wearing hearing aids for over a decade.

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Hearing Health Foundation aims to educate Americans about safe listening levels and how to prevent noise-induced hearing loss. Nearly 50 million Americans, including 1 in 5 teenagers, suffer from hearing loss.

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How Loud Is Too Loud?

Sound level is measured in decibels (dB). As the number of decibels increases, so does the risk of harm to hearing, as shown in the guide below.

140-165 Firecracker, shotgun firing

140 Jet taking off

120 Ambulance siren, thunderclap

110 Jackhammer, rock concert, symphony orchestra

Regular exposure of more than 1 minute at or above 110 decibels risks permanent hearing loss.

105 MP3 players at maximum volume

No more than 15 minutes of unprotected exposure at or above 100 decibels is recommended.

95 Subway platform

85 Heavy city traffic, school cafeteria

Prolonged exposure to any noise at or above 85 decibels can cause gradual hearing loss.

75 Dishwasher

70 Hair dryer, vacuum

60 Normal conversation

40 Refrigerator

30 Whisper

0 Smallest sound a person with normal hearing can detect.

NAME:

Sarah Poissant, Ph.D.
University of Massachusetts Amherst

BIO:

Poissant is an associate professor in the Department of Communication Disorders at the University of Massachusetts Amherst. After graduating from the University of Vermont, Poissant received her Master's and Ph.D. from the University of Connecticut. She is a 2013 Hearing Health Foundation (HHF) grant recipient and is also partially funded by the HHF Centurions.

IN HER WORDS:

Maximizing auditory speech perception for listeners with hearing loss is the focus of my research. I am particularly interested in working with children and cochlear implant recipients of all ages and in more fully understanding how the characteristics of real-world listening environments impact their speech understanding abilities.

We will examine the impact of total communication on the auditory perception of speech. My hope is that our work will lead to a more complete understanding of how sign language and speech interact with each other. We are particularly interested in learning whether or not manual signs can actually enhance the understanding of spoken language.

I have always loved science, and I became interested in the fields of audiology and hearing science as an undergraduate. As a child the first experiment I ever did was to tape the handle of the spray nozzle down. I hadn't fully thought through the consequences—my mom getting very wet when she turned on the faucet. In an undergraduate psychology class, we surveyed our peers about their soda preferences while serving them cups filled with RC Cola but labeled Coke or Pepsi. The majority identified the cup labeled with their favorite soda's name as being the one that tasted the best. The power of branding!

My uncle, who was a plant and soil scientist, had an accident that resulted in permanent, unilateral hearing loss. He got his first hearing aid around the time I was an undergraduate studying communication disorders. Growing up in Rutland, Vermont, I have always been close with my family. We are lucky enough to be able to get four generations together on many happy occasions.

I love to cook, read, take pictures, and—much to everyone's surprise, including my own—I have become a runner. I think a big part of why I like to run is that I've met some really great people along the way. I also like the fact that most all of the local races I participate in raise funds for good causes.

Given the translational nature of my research, I work with actual patients in my lab, reminding me of my previous work as an audiologist in clinics and a hospital. It is always actual patients, and the struggles they face as a result of their hearing loss, who drive my research questions and encourage me to continue to search for way to improve speech understanding for listeners with hearing loss.

—Andrea Delbanco, Senior Editor

PHOTO COURTESY OF SARAH POISSANT, PH.D.

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