AMERICAN HEARING RESEARCH FOUNDATION
SOUNDINGS NEWSLETTER

Chairman's Update

Season's Greetings from all of us at the American Hearing Research Foundation! Thank you for supporting our mission to fund innovative research into hearing and balance disorders. This year we saw a 45% increase in the number of applications. Among the many promising studies, 10 were chosen for 2018 funding. We are excited about the work of these researchers, as well as projects of our own – which include a website update and a video with PBS to raise awareness about Meniere's disease.

Sometimes I appreciate being reminded why this work is so important. I'm moved by Laura Burton's frustration and anxiety as she dealt with sudden hearing loss (p. 2), and Tom Sager's wonder at hearing regained (p. 6). AHRF wants to find answers for the more than 48 million Americans who have hearing and balance problems.

I invite you to partner with us – whether through a one-time contribution or as part of your legacy for the future. You truly can make a difference.

Sincerely,

Richard G. Muench, Chairman Board of Directors

AHRF to Fund 10 Projects in 2018

The American Hearing Research Foundation will fund 10 studies in 2018, for a total of $195,050. Grant recipients will examine diverse topics including how middle-aged subjects understand speech in noise, afferent synapses of cochlear outer hair cells, and the genetic basis of familial Meniere's disease. See page two (2) for a list of recipients.

An estimated one-third of people over 65, and half of those over 85, have some hearing loss in the United States.
- National Institutes for Health

Congratulations to 2018 AHRF Grant Recipients!

- **Jessy Alexander, PhD**; State University of New York at Buffalo; *Complement, hearing loss and lupus*
- **Karl Doerfer, MD**; Medical College of Wisconsin; *Development of In-House Genetic Screening for Pediatric Hearing Loss*
- **Michael M. Ebeid, MBBCh, MS, PhD**; University of Nebraska; *Mechanism of FGF signaling in regulating mouse cochlear progenitor proliferation*
- **Anna Lysakowski, PhD**; University of Illinois at Chicago; *Understanding genetic heterogeneity in familial Meniere's Disease*
- **David C. Martinelli, PhD**; University of Connecticut; *Determination of the Auditory Function of the Outer Hair Cell Afferent Synapses in the Mammalian Cochlea*
- **Tobias Overath, PhD, Josh Stohl, PhD, Leslie Collins, PhD, Michael Murias, PhD**; Duke University; *Optimizing cochlear implant sound processor configurations via neural response properties to improve speech comprehension*
- **Enrique Perez, MD, MBA**; University of Miami; *High-resolution contrast-enhanced microendoscopy in cholesteatoma surgery: safety, efficacy and feasibility*
- **Isabelle Schrauwen, PhD**; Baylor College of Medicine; *Identification of genes for non-syndromic rare congenital inner ear malformations in children*
- **Erika Skoe, PhD, Jennifer Tufts, PhD**; University of Connecticut; *Biological indices of noise exposure in the clinically-normal ear*
- **Spencer B. Smith, PhD, AuD**; Northwestern University; *Investigating the Relationship between Binaural Hearing and Speech-in-Noise Performance in Middle-Aged Listeners*

Sudden Hearing Loss - "It was life changing."

Four years ago, I was getting ready to return home after a wedding when suddenly I had a total loss of hearing in my left ear. I worried that the airplane pressure would make things worse. It was a Sunday, and there was no place to go for treatment, so I got on the plane.

At home, I saw a doctor. He said to come back in two weeks. I couldn't stand it, so five days later I walked into an ENT's office. The ENT diagnosed "sudden hearing loss" (which I didn't even know was a "thing"). He injected my ear with steroids. But it was too late to be effective. I was told that if I had been diagnosed and treated right away, most of my hearing in that ear could have been saved.

I'm a real estate agent, and for a while I thought I couldn't work. Now I lack depth perception because I can't triangulate sounds. The tinnitus is so loud, and unfortunately hearing aids make it worse. It's affected everyone around me. I can't have things too loud. On Facebook, I've found people dealing with this all over the world.

I used to explain my hearing loss to people I dealt with. But I don't want people to know anymore. At first people kind of made fun of it – like it wasn't a big deal. But it was big – it was life changing.

Laura Burton; Everett, Washington

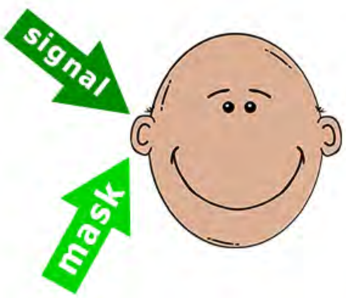
"Modulation Interference in Listeners with Cochlear Implants"

By Monita Chatterjee, PhD – 2017 AHRF grant recipient
Boys Town National Research Hospital in Omaha, Nebraska

The sound level in our everyday environment can vary quite a bit – the quiet peace of a reflective morning, the roar of traffic as we get around town, the muted ambience of a productive work environment, the louder talk and laughter of many voices at a relaxed happy hour after work. Hearing each other becomes more difficult as the background sounds increase in level and "mask" out the target (the voice we want to listen to). Masking – the ability of one sound to swamp the target sound – increases when the masker and the target sounds are more similar in their audio frequency content.

As this overlap between the masker and target frequency bands increases, the neurons responding to the two also overlap more and the neural responses to the two become less distinct in the brain. This makes it harder for us to separate perceptually the target voice of interest from the background sound.

In recent years, aside from the level of the background sound and the audio-frequency overlap between the background sound and the target, a new factor has emerged as a player in this field: the temporal envelope of the masker and the target. The temporal envelope refers to the relatively slow fluctuations (modulations) in the level of natural sounds such as speech. These fluctuations can be as slow as syllabic-rate (the rise and fall of syllables within a word, occurring at about 4 Hz) or much faster, occurring at the rate at which the vocal folds vibrate (hundreds of Hz). As it turns out, these slower fluctuations carry a great deal of meaningful information in speech perception. Also, the temporal envelope of the background noise can interfere with the temporal envelope of the target speech, adding a new dimension to masking. Thus, if the background sound has temporal fluctuations that are more similar to those of our target sound, then it becomes harder for us to tell them apart. Traffic noise, for instance, has many fluctuations, and those can interfere a lot with any target sound we are trying to hear. This kind of masking is known as "modulation masking" or "modulation interference".



How, then, do we manage to hear each other in noise? It seems that the auditory system has an assortment of mechanisms with which to overcome background noise. Collectively, these mechanisms are known as "perceptual stream segregation" or "perceptual organization," by which the brain "sorts" different sources of sound into separate, distinct categories and is able to attend to individual sources at will. For instance, one way we can try to overcome masking in general is by listening for the talker's voice pitch, which is a powerful ally in background noise. Another way is by listening for differences in rises and falls of sounds to separate out their sources (onset or offset asynchronies).

Unfortunately, for those with hearing loss who wear cochlear implants, stream segregation, and therefore listening in noise, can be quite difficult. The poor transmission of voice pitch information by the device is one factor. Another is the overall poor representation of individual frequency components of sounds, which makes

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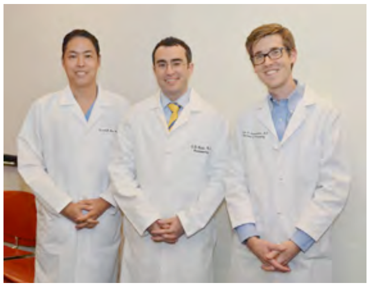
PROGRESS REPORT

Elliot D. Kozin, MD
Aaron K. Remenschneider, MD, MPH
Daniel J. Lee, MD
Massachusetts Eye and Ear Infirmary
Harvard Medical School, Boston, Massachusetts

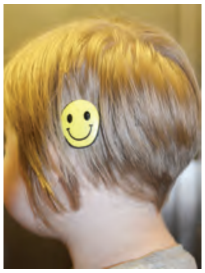


Pictured, left to right: Daniel Lee, Elliot Kozin, Aaron Remenschneider

The study "Application of diffusion tensor imaging to evaluate central auditory pathways in patients with congenital deafness" by Kozin, Remeschneider, and Lee was funded by a 2017 AHRF grant.

Dr. Kozin explains: Sensorineural hearing loss is the most common congenital disability, with about three out of every 1,000 children in the United States born deaf or hard of hearing. Children with hearing loss can face significant challenges in psycho-social well-being, quality of life, and economic independence. Auditory neuroprosthetics, such as the cochlear implant (CI) and auditory brainstem implant (ABI), have revolutionized the management of pediatric hearing loss with improved audiometric and quality of life outcomes.

Despite standard imaging of the temporal bone, it can still be challenging to determine if a pediatric patient with hearing loss has a cochlear nerve - and as a result, whether the child should receive a CI or an ABI. Computed tomography and magnetic resonance imaging provide mostly structural anatomic information, but do not deliver information about auditory pathway function. At the Massachusetts Eye and Ear Infirmary (MEEI), we are pioneering new ways to visualize the functional aspects of the auditory pathway to better treat pediatric patients with hearing loss. New imaging techniques, such as diffusion tensor imaging (DTI), provide insight into the function and strength of the auditory pathway. In this AHRF-funded study, we are focusing on DTI measures of the cochlear nerve, which transmits sound information from the cochlea to the brain.



Using DTI techniques, we can now visualize the cochlear nerve and brainstem in ways that previously have only been possible using histologic techniques in cadaveric specimens. Given high-resolution DTI imaging in modern MRI scanners, we are gaining new insight into the peripheral and central auditory pathways in pediatric patients with hearing loss. In the near future, DTI scans may become a major part of the evaluation of pediatric hearing loss, and ultimately help clinicians and families determine optimal treatment options.

"Modulation Interference in Listeners with Cochlear Implants"

(continued from page 3)

the target and masker sounds blend much more than in normal hearing. A third factor – and the focus of our AHRF-funded project – is that in cochlear implants, hearing the temporal envelope of speech is critical for speech recognition. Thus, modulation masking, in which the temporal envelope of the target becomes masked by the temporal envelope of the background noise, has the potential to be an even more powerful source of interference in cochlear implant users than in normally-hearing listeners.

We have two new discoveries to report to date. One completed study (manuscript submitted for publication) reports on the finding that modulation masking/interference persists in cochlear implant users even after the background noise has been turned off, and remains for at least 100 ms (a tenth of a second). This means that

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RESEARCHER PROFILE

Frances Meredith, PhD
University of Colorado Denver

Dr. Meredith's study "Identification and Modulation of Na+ Currents in Vestibular Afferent Terminals" was funded by a 2017 AHRF grant.

Dr. Meredith explains: Sensory cells in the inner ear communicate with vestibular neurons that carry messages about head movement to the brain. This is how your body stays balanced and knows if you're falling. These messages are in the form of electrical impulses - action potentials - generated by sodium and potassium ions moving through ion channels located in the membranes of sensory cells and neurons. I study the specific channels that allow sodium ions to enter the neuron and generate action potentials. We are finding out more about the sodium channels that signal fast head movements such as those experienced during a fall. Knowing what these channels are and how they work will help us find therapies to alleviate symptoms associated with balance disorders.

How did you come to the fields of neuroscience and otolaryngology?

I was born in Johannesburg, South Africa. I did my undergraduate and MS degrees at the University of the Witwatersrand in Johannesburg.

I took a neuroscience class during the final year of my undergraduate degree. This soon became the most enjoyable, fascinating and intriguing course I had ever taken. I developed a strong interest in how sensory systems process information and eventually chose to study the vestibular system. It is a hidden sense – we are mostly unaware of our vestibular system and take it for granted. But when it malfunctions, the consequences can be devastating. Dizziness and vertigo are highly debilitating and yet not much is known about how our vestibular sense works.

What's the best part of your work?

It's the excitement I feel when I perform an experiment successfully and obtain new and interesting data. I enjoy sharing ideas and gaining insight and inspiration from my colleagues, including Katherine Rennie who has been my graduate and postdoc advisor.

"Modulation Interference in Listeners with Cochlear Implants"

(continued from page 4)

the temporal envelope of the target may be less discernible to the listener if it was preceded by a background noise. Thus, modulation masking/interference not only influences concurrent target speech, but also interferes with future target speech. In a second project (still ongoing), we are finding that modulation masking can occur across ears in cochlear implant listeners who are bilaterally implanted. Thus, a temporal envelope on a masker in one channel on the right cochlear implant can interfere with the temporal envelope of a target sound in the left side. This is remarkable, and could alter both the perceived location of the target and its identification by the listener. We are excited about these findings and are seeking new sources of funding to support ongoing work in this area, as the more we know about mechanisms of interference by background noise, the better we will be able to mitigate its effects.

Partner with Us!

General Fund. You can support the vital work of hearing and balance innovations by donating online at www.American-Hearing.org. Or mail your contribution in the enclosed postage-paid envelope. If you wish, you can designate your gift to honor someone dear to you.

Support Meniere's Disease Research. Over three years ago, the Foundation joined forces with Katie Mertz, founder of *"run because."* As her mother dealt with the debilitating effects of Meniere's disease, Katie embarked on a grassroots effort to raise awareness and research funding for this illness by aiming to run 51 half-marathons – one in each state plus DC – by age 50. She completed race #19 in Arkansas this past November, and has raised over $27,000 to date. You can support follow Katie's efforts – and support her cause at www.facebook.com/runbecause.

Helping Future Generations. Will you work with us to find hearing and balance solutions for generations to come? When you remember AHRF through a gift in your will, known as a bequest, you can ensure these cutting-edge research projects continue.

You can choose to leave a specified sum of money or a percentage of your estate. Other forms of planned giving include securities, life insurance policies, or retirement plans. A qualified financial planner can guide your decision and help you consider tax consequences.

Combined Federal Campaign. The American Hearing Research Foundation is a designated charity for the Combined Federal Campaign (CFC) – the largest workplace giving campaign in the world that raises more than $265 million each year. AHRF is on the CFC National List, number 10571.

Hearing Regained - "I remember it like it was yesterday."

I was one of the earliest people to have the stapes operation pioneered by AHRF founders Eugene Delacki and George Shambaugh. I had severe otosclerosis - total calicification of the inner ear bones. I was deaf in both ears, with about 80% hearing loss. I had been wearing hearing aids in both ears since my freshman year in high school, and they were becoming less effective. When I was a college freshman in the early 1960s, Dr. Derlacki performed the then-experimental stapes surgery on my right ear.

I was awake during the procedure, so they could test hearing and determine placement of the prosthesis. They gave me a mild sedative and washed the ear canal with something ice cold. Dr. Derlacki removed the calcified bone and connected the new prosthesis. Even though it was 55 years ago, I remember it like it was yesterday: hearing the sound of the fan in the operating room.

I regained about 90% of my hearing in my right ear. I went on to become a dentist, and served in the military. When I go hunting, I wear ear protection because the prosthesis isn't able to absorb that kind of sound.

Dr. Derlacki was a wonderful physician. My will directs that my remains go to Northwestern University for study. I'm hoping someone will be interested in my ears!

Dr. Tom Sager; Green Bay, Wisconsin

Thank You to Our Donors

This list reflects donations received from June 23, 2017 through December 14, 2017.

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General Funds sustain the core programs central to the Foundation's mission. Donations to the General Fund also can be restricted to use for research into certain areas such as Meniere's disease. There are several levels from which to choose:

- Chairman's Circle $5,000 and above
- Research Champion $1,000 to $4,999
- Research Supporter $100 to $999
- Friends of the Foundation $99 or under

The Foundation also appreciates the support of the following organizations:

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American Hearing Research Foundation

A nonprofit foundation dedicated to funding significant research in hearing and balance disorders, and helping to educate the public about these disorders.

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