



MINNESOTA ACADEMY OF AUDIOLOGY Newsletter

Feature Story

Working with the Tinnitus Population Common Myths Debunked

Natalie Phillips, Au.D.



How would you answer this question, if a “tinnitus patient” came in to your office, and asked: I have tinnitus, what can you do for me?

I usually take a deep breath – sometimes gearing up to let them know what types of management and treatment are out there that can help them, sometimes knowing that I have many more questions for them about their tinnitus, sometimes pausing to hold back the sadness and frustration I feel when a “tinnitus patient” comes in saying that he/she saw another professional and was told that nothing can be done or they just need hearing aids.

Working with tinnitus patients for the past 19 years, I have found some common misconceptions of medical professionals (i.e. Audiologists, Otolaryngologists, and Primary Care Physicians) when it comes to understanding the tinnitus population;

1. There is NO cure and NOTHING can be done for tinnitus.
2. As an Audiologist or Hearing Care Professional, I have device(s) from manufacturers that have tinnitus sounds so I am well-equipped to now help all my patients who have tinnitus.
3. If a patient has tinnitus, they will probably not notice it as much if they wear hearing aids.
4. Tinnitus patients are roughly the same. They have tinnitus and it may be bothering them, therefore, they need help from a professional.

Myth #1: There is NO cure and nothing can be done for tinnitus.

Although I agree there is not necessarily a cure for tinnitus, I take the time to explain what those words mean to my patients. When they hear “there is no cure and you have to learn to live with it”, it allows them to enter into the unknown. They have thoughts that may cover the questions, “What does that mean? Does it mean there was research done and nothing works? Does it mean that no one is working on a cure? Does it mean it will get worse? Does it mean it will stay the same? Does it mean I will have this for the rest of my life?”

cont.

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Tinnitus, cont.

This unknown allows the limbic system to create an emotional association and a meaning attached to the tinnitus which causes tinnitus to linger. If something has no meaning, it tends to exit the subcortical level of the brain and not bother us. Another way to explain those words to my patient is taking the time to discuss how sounds work in the brain from detection to perception and evaluation, and then how the limbic system and autonomic nervous system comes into play giving sounds meaning which engages higher brain activity and allows it to linger. Instead of letting the patient get stuck on the words that “there is no cure”, instead, I explain that there are forms of management to stop the cycle of sounds escalating, thereby NOT engaging the cortical level of the brain, as well as the limbic system and autonomic nervous system, so that the sounds are detected and thereby ignored.

Myth #2: I have devices from manufacturers that can help all of my patients with tinnitus.

I am SO thankful that hearing aid manufacturers and other device manufacturers are focused on the tinnitus patient as it gives us many different options to help our tinnitus patients. However, the KEY word is ALL patients. It gets tricky and therefore I believe we all need to be investigative on the types of devices that are introduced into our field, the way they work, and the success rates to include long-term relief.

The sound therapy methods that I incorporate have led me to eliminate certain hearing aid manufacturers by the ease of use and the way the product operates for my patients’ needs. In addition, just providing tinnitus sounds may help some patients, but I have found that without a protocol in place, providing sounds in either a “masking”

Amplification assists by taking the patient with a hearing loss “out of a quiet situation” and therefore, reduces the awareness of tinnitus.

sense and instructing a patient to “cover their tinnitus” or “set it until you have relief of your tinnitus” is more of a band-aid effect due to the fact that the brain can never ignore something that it cannot detect. In other non-hearing aid and ear-level devices I have investigated, the main goal of the device is to have the patient match the tinnitus sound, or even the hearing loss “notch” and start to listen to this sound to achieve relief.

I strongly believe that to re-train the brain and have a patient desensitize and habituate to their tinnitus, you CANNOT give them the exact sound that they have an aversion to already, but instead, use a sound their limbic system does NOT have an attachment to.

Myth #3: If a patient has tinnitus, they may not notice it as much just by wearing hearing aids/ amplification alone.

Although this may in fact be true for some, may not be the case for all. Most times, a simple tinnitus questionnaire may help weed out these exact patients who have both hearing loss and tinnitus as well as when tinnitus is present, yet not bothersome. Amplification alone can help based on the article by Heller and Bergman in the Annals of Otolaryngology (1953), which indicated two major findings: 1) Normal hearing people can have tinnitus and 2) When put in a quiet environment, your brain can pick up on softer level sounds that may be occurring all the time, but we

don’t notice it during times even with a little noise floor. Amplification assists by taking the patient with a hearing loss “out of a quiet situation” and therefore, reduces the awareness of tinnitus.

Myth #4: Patients with tinnitus are roughly the same and all need help.

While this may be true that they need help, it is important to know that in my 19 years of working with patients who have tinnitus, NO two cases have ever been the same. There are SO many factors that lead to the proper management and treatment of tinnitus. We start our appointments with a consult and thorough evaluation to make sure we are looking at the full picture of what may be going on, including looking at hearing loss and sound sensitivity, as well as a full medical evaluation by an ENT. There are varying degrees of tinnitus, therefore, we also have patients fill out questionnaires at every visit to benchmark any progressions or latency in their therapy. From some of the points above, it is easy to see that some tinnitus patients only need amplification, some need further sound therapy, and some may need an appropriate referral to another medical professional.

Patients with tinnitus are NOT the same and, as an audiologist, I believe we should take the time to look at the whole picture, learn about their situation, and if passionate enough, deliver the appropriate management and therapy available to them OR refer to an audiologist who is able to work with these patients.

Dr. Natalie Phillips is the Senior Audiologist with Advanced Otolaryngology and Audiology in Fort Collins, Colorado.



Coding Corner

Member Question Changes MHCP Rules

Melisa Oblander, Au.D.

Coding and Reimbursement Committee Chair

This month we are continuing to look at the Minnesota Health Care Programs (MHCP) Provider Manual. New updates were posted in mid-June.

Do questions from the membership make a difference? YES!

A question from a member to our Coding and Reimbursement Committee led to a discussion with the Department

of Human Services (DHS) Hearing Aid Policy coordinator. The outcome being that Medical Assistance (MA) will now start to accept the code for Real Ear testing, V5020 also called Conformity Testing. We will not know the rate MA will reimburse for V5020. They will “pay by exception” for several months as they collect data on the amount being assigned. The best thing that audiologists can do now is charge a fair market value,

based on your practice, for Real Ear services using V5020.

Effective June 4, 2018, MHCP covers conformity evaluations. These services may be provided on or after the hearing aid is dispensed. Use HCPCS V5020 – one unit for a monaural aid and two units for a binaural aid. RT and/or LT modifier.

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Message From Your President

You make a living by what you get. You make a life by what you give.

Stephanie Luepke, Au.D.

The Great Minnesota Get-Together is a 12-day fair filled with food, art, animals, and all the wonderful things Minnesota has to offer. This includes the Kare11 Health building, where many fair-goers can receive health screenings. This year, 1,606 hearing screenings were completed by Minnesota Academy of Audiology volunteers! This is a perfect example of supporting a cause that sets Minnesota audiologists apart! Sixty-eight volunteer slots were filled, and professionals supervised 16 students, demonstrating the importance of volunteerism in our Academy!

On behalf of the MAA Board of Directors, I want to recognize the efforts of all the MAA volunteers, specifically, the Audiology Awareness Committee, for their hard work organizing this event. They arranged sponsorships, volunteers, logistics, booth set up, and more. Check out the fun pictures on our MAA Facebook page! We always look forward to volunteering with our distinguished colleagues!

MINNESOTA STATE FAIR MAA STATISTICS!

MINNESOTA STATE FAIR

- * 68 Volunteer spots filled
- * 16 student volunteers
- * 1372 full screenings completed (Sponsor: Midwest Special Instruments)
- * 234 Video Otoscopy (Sponsor: Otometrics/Audiology Systems)
- * 1050 packages of "batteries on a stick": (Sponsor: Resound)
- * 10,000 earplugs! (Sponsor: 3M, Warner Tech, HealthPartners, Park Nicollet)

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Private Practice: Taking the Plunge

By Michael Squires, Au.D.

Picture this. You are a doctoral student finishing your fourth-year externship with graduation only a few months away. Are you thinking about buying a private practice and starting your new career as an owner of a corporation? We were.

Dr. Carlee Squires, my wife and business partner, and I began our new life as practicing audiologists in a world of lawyers, accountants, competitors, and referral sources. It was a whole new experience in the field of audiology, and it was exciting. We were solely responsible for our successes and failures. We worked tirelessly to get our name into the community on the smallest budget possible, and to brand ourselves as the new experts that our patients deserved.

Several months prior to graduation in 2014 we were approached about purchasing a private practice near Carlee's hometown. Against the advice of many, we decided to take the risk and begin our new life as entrepreneurs.

There are many aspects to consider when deciding if private practice ownership is right for you. Few graduate programs adequately prepare students for a career as an entrepreneur. Many professionals urge students to "get their feet wet" before considering the task of practice ownership. While experience is helpful, it is not *necessary* to start a business. We overcame our hesitations and are thankful that we did.

What do you want out of your career? Do you mind putting in long hours if needed? Take time to decide if private practice is for you.

For example, an outgoing practice owner can quickly develop relationships within the community and become known as the area's go-to provider. For example, we are currently working with a local physical therapy practice to create a vestibular clinic for assessment and rehabilitation to be opened within the year. Previously, we were told that vestibular assessment is not lucrative in private practice. This goes to show that with due diligence and motivation, you can create your own path to success.

Another aspect to consider is what resources you realistically have available. Are there physicians with whom you could partner for referrals? Are the population demographics favorable for an audiology clinic? These questions are very important to ask because they will determine how you will run your practice. We practice in an area that's not known high levels of disposable income. However, if proper marketing and business strategies are used there are few reasons why a business should not succeed when the location is well researched before opening a business.

Once you've made your decision to own a private practice, a whole new list of questions must be answered. Will you start from the ground up or will you purchase an existing practice? The conclusions that you reach will help decide the remaining course of your venture. Typically ground-up practices

are less expensive to start, but take more effort to establish your presence in the community. Furthermore, you may be competing with existing practices. Joining as a partner or purchasing an existing practice may be more expensive, but there can be value in purchasing an established patient base and identity. We purchased our practice and requested the former owner write a letter of retirement and introduction of the new owners, which we sent to all existing patients. Patients appreciated the note and it helped the former owner transition out of the practice.

Good financial and legal counsel can help you make decisions regarding the practice. Select an attorney that is experienced with in what you are trying to achieve (i.e., acquisition of private practice, incorporating a new business, etc.). Next, it is important to select a good accountant, who can help you navigate the rough terrain of taxes and bookkeeping. They should be able to teach you how to best keep accurate financial records so that come tax season you have nothing to worry about. Lastly, it is a good idea to select a financial advisor who can help manage life insurance and your retirement plan, which includes investments such as your new practice.

While this is not a comprehensive article on starting a private practice, I hope it generates some questions that motivates students and professionals to consider a career in private practice. In the changing landscape of audiology, it is now more important than ever that private practices remain vibrant and successful.



Student Spotlight

Maureen (Stormont) Cannon

4th year Au.D. Student,
University of Minnesota

Why do you choose to volunteer with MAA?

I volunteer with MAA because it is always a great experience and a good time. What's better than connecting with like-minded people while spreading the word about audiology and giving back to our community?

What has been your favorite memory from graduate school so far?

My favorite memories in graduate school have been celebratory happy hours with

my classmates and our adventures to the AAA Conference!

What is something that you do well?

I'm a great teammate! I really enjoy working with people to achieve a common goal.

If you could give a first-year audiology student any advice what would it be?

Take advantage of opportunities and get involved! Graduate school is the time to invest in experience. Volunteer, observe,

and reach out to audiologists in your community. You won't regret it!

You recently got married—congrats! If you could do anything or go anywhere, what is your dream honeymoon?

Thank you! My dream honeymoon is to do a hut-to-hut hike in the Austrian Alps! There is nothing better than living out of a backpack, panoramic views, and no cell service. We hope to go on some sort of adventure once we both graduate in May 2019.

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Member Spotlight

Melanie Wege, M.A.

Newborn Screening Program Coordinator, Minnesota Department of Health

What brought you to Minnesota?

I'm originally a Wisconsin native, and explored both UW-Madison and University of Minnesota-Twin Cities for graduate school. At that same time, my husband was searching for teaching jobs. A key factor was to find a location close to my potential graduate school. We landed in Minnesota mainly because my husband's job offer, here, had the shortest commute for me. I didn't realize at the time, but because of the rich hearing industry presence in the Twin Cities, my opportunities for possible internships

and career path choices were much broader in Minnesota than they would have been in Wisconsin. It was a great place to begin my career as an audiologist!

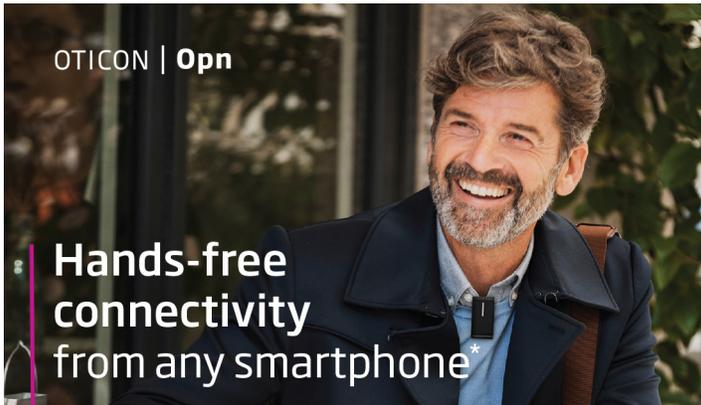
How would you describe your career path, and what has been the most memorable part of your career?

My career path was influenced very early on by two key internship opportunities in pediatric audiology. One with Linda Murrans at Coon Rapids Medical Center, the other providing newborn hearing screening for infants with Vikki Anderson at Hennepin County Medical Center. Both women were incredibly talented pediatric audiologists and wonderful mentors! I was also intrigued with diagnostic ABR during my training program. My husband still laughs about our drives back down to the University of Minnesota after the end of his workday, so he could be a test subject, as I learned different ABR test protocols! Both opportunities served me well, as diagnostic assessments with infants and children is what I ended up loving the most. As universal newborn hearing screening expanded during the early part of my career, I had the opportunity to work with several central Minnesota hospitals guiding the development of their hearing screening programs. That experience helped provide the foundations and network that led to my later career opportunities with MDH-Newborn Screening program.

There are many memorable and rewarding experiences and relationships with other professionals, educators, and families during my career. What stands out most are the kids, their families, and watching them develop into fabulous little people. The amazement that appears on the faces of children and parent when amplification is fit for the first time is priceless! I wish I had thought, back then, to help families capture those moments with photos or video.

What advice do you have for other audiologists?

Explore ways to expand your skillset in ways that extend beyond the field of audiology. It allows you to grow in other areas, and to build mutually rewarding relationships with professionals in other fields that might lead in a new unexpected direction someday.



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Be Happy and Be a Better Audiologist

Kate Teece, Au.D.

Despite our toil and hard work, too many Americans are

dissatisfied at work. We want to live lives of purpose, savor every moment, and change the world! All jobs will have some unpleasant aspects, and at times it is hard to feel like a world-changer when we're churning out the seventh audiogram of the afternoon. Enter Shawn Achor's brilliant little book: *The Happiness Advantage: The Seven Principles that Fuel Success and Performance at Work*¹. This book was recently recommended to me and I found it immediately applicable to our work as audiologists. I hope you'll feel inspired by my interpretation and application of these seven principles. If so, go read the book yourself!

1. Maintain your good social relationships.

Study after study confirms that the more socially connected we are, the healthier we will remain in the long term. This has a direct impact on our work of treating hearing loss, and it is certainly relevant for us as clinicians also. It is not a waste of time to take a few minutes to catch up with your coworkers or to join a book club or meet the neighbors while walking your dog. Audiologists often get the chance to meet a diverse group of people, and these professional connections have the potential to teach us and enrich our social lives. No matter your social style, be sure to nurture this important side of yourself.

2. Remove all the obstacles you can.

Think of a time when moving something

small made a big difference. For example, moving tympanometer tips to a more sensible place resulted in a much smoother patient flow. Another example might be choosing an alternate route to work to avoid Starbucks. (I happen to be sitting in one right now as I type this!) Unfortunately, when we want to improve bad habits, sheer willpower doesn't work very well in many cases. We need to outwit our brains into focusing away from temptations and pitfalls.

3. When overwhelmed, circle around what you can control.

Maybe you are stressed to the breaking point in every aspect of work—your desk is cluttered, your inbox is bursting, you are two weeks behind in billing, and you just don't know how you will ever catch up. You can take a step back, figure out your next step(s), and then regain control of that. Maybe it's a fresh to-do list, an empty work surface, or a focused project. Perhaps you'll determine your bare minimums that need to happen on a regular basis, and you can write a checklist to remind you to follow through. It is easy to become overwhelmed, and it's natural to want to remain in control. Reclaiming focus is possible even at the most basic level.

4. Remember that our greatest pains can be springboards to greater heights.

Painful experiences are very unique and personal, but pain is also universal. We all do struggle at times—grief, loss, illness, and rejection, to name just a few. The question is, how will we respond to pain? Once, I was turned down from a job that I wanted very badly. The news

was tough to swallow, and it took a while to get over, but I found that the sooner I was able to view it as an opportunity to grow, the quicker I could move forward. I could pursue another passion as a result of not getting that job. As Achor says, we don't fall down, we fall up.

5. Look for the “patterns of possibility” like Tetris pieces.

Tetris, of course, is the old, popular video game where interlocking shapes fall from the top of the screen, and the object is to complete rows of squares across the bottom before your playing area fills up. You have to think quickly and adjust the pieces. This is not unlike packing the trunk of your car when going on a road trip. In the same way, we can choose to see the world in a positive light instead of drudgery, stress, and repetition. This is a skill that can be developed by simply paying attention and writing down three good things each day. For me that list includes making patients smile, closing sales, and leaving my work at the office at the end of the day.

6. Wrangle your mindset into a powerful driver for success.

Shawn Achor cites psychologist Amy Wrzesniewski and her work on “work orientations”. She found that employees tend to describe their work as a job, a career, or a calling. The spectrum ranges from working solely to receive a paycheck (job) to working for the meaning it brings to our lives (calling). I can look back over my years in clinical practice and plot where I landed at various points. Where are you right now? If you do not view your work as a calling, what changes could you make,

cont.

Happiness, cont.

either physically or in your mind, to rededicate yourself to the important work set before you?

7. Finally, the Earth revolves around the sun, not the other way around.

A very common belief in America is that the key to happiness is to be successful. Unfortunately, this isn't guaranteed. Plenty of "successful" people are unhappy despite having it all. The Happiness Advantage is the surprising revelation that happy people find professional and personal success more often than unhappy people. Happiness leads to success, not vice versa. This is great news! When we focus on taking care of our mental health and happiness

first, we may find success flowing to us naturally, and we will enjoy life more in the process.

Every day we have incredible opportunities to help children and adults hear better. Certainly, we can feel pressured by external forces and burned out at times—this is commonplace in any profession. More than just a self-help, click-bait list, Shawn Achor's Happiness Advantage tactics can propel us towards happier, more productive lives.

¹Achor, S. (2010). *The Happiness Advantage: The Seven Principles that Fuel Success and Performance at Work*. New York: Crown Business.



Welcome New Members

Students

Samantha Hellman –

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Lauren Howard – howard748@umn.edu

Sarah Kaufman – sschwegman@atsu.edu

Madeline Smith – smit8829@umn.edu

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Life sounds brilliant.



Evaluation of Modern Remote Microphone Technologies

Jace Wolfe, Ph.D.

**Director of Audiology and Research Hearts for Hearing
Oklahoma City, Oklahoma, US**



Introduction

Individuals with hearing loss often struggle to understand speech in the presence of background noise (Bradley & Soto, 2008; Crandell & Smaldino, 2000; Finitzo et al, 2000; Finitzo-Hieber & Tillman, 1978; Jamieson et al, 2004; Wolfe et al., 2013a; 2015). Use of remote microphone technology is the most effective method to improve speech recognition in noise of hearing aid users (Hawkins, 1984; Schafer & Thibodeau, 2004; Wolfe et al., 2009; 2013a; 2013b, 2013c; 2015). **Remote microphone systems** are comprised of a microphone/radio transmitter unit and radio receiver(s). The microphone is worn in close proximity (6 to 8 inches) to the mouth of the talker of interest. The speech signal captured at the microphone is delivered by the transmitter to the receiver(s) by way of **radio frequency (RF) transmission**. Then, the receiver delivers the signal to the hearing aids. Remote microphone systems are likely to provide substantial improvement in speech recognition in noisy and reverberant environments and when the signal of interest originates from more than 3 or 4 feet from the hearing aid user.

A variety of different remote microphone systems are available for hearing aid users. Early remote microphone systems were designed to work with the hearing aids of most manufacturers and accordingly can be described as **universal systems** (although no standard nomenclature exists for labeling modern remote

microphone systems). Typically, the RF receiver of a universal system is coupled to the direct auditory input (DAI) by way of an adapter designed for the hearing aid, and as a result, use of the remote microphone system adds extra hardware to the user's hearing aids. More recently, hearing aid manufacturers have developed remote microphone systems which are designed to work only with the hearing aids of the specific manufacturer and are often referred to as **accessory remote microphone systems**. Although the cost of remote microphone technologies varies across manufacturers, accessory systems are often less expensive (and in some cases considerably so) than universal systems.

Accessory remote microphone systems also differ in design and application across manufacturers. For instance, some accessory systems may be referred to as **truly wireless accessory remote microphone systems**, because the RF signal (which is typically a proprietary digital RF signal transmitted at 900 MHz or 2.4 GHz) is delivered from the transmitter directly to receivers that are integrated within the hearing aids. Truly wireless accessory remote microphone systems do not require the use of additional hardware that is coupled to the hearing aids and may consequently be more comfortable, convenient, and cosmetically appealing for the hearing aid user.

Some hearing aid manufacturers have developed remote microphone accessory systems that use an interface device to

relay the RF signal from the transmitter to the user's hearing aids. In short, Bluetooth RF transmission is typically used to deliver the audio signal of interest from the remote microphone to the interface. Then, the signal received at the interface is delivered to the hearing aids via nearfield magnetic induction. The interface device is usually clipped to the hearing aid wearer's shirt collar or is coupled to a loop that is worn around the neck.

It is possible that the use of the interface device will be perceived as being less comfortable, less convenient, and not as cosmetically appealing when compared to a truly wireless system.

Remote microphone systems also contain a variety of different noise management technologies that are designed to improve speech recognition in noise. For example, remote microphone systems may possess **omni-directional microphones** or **directional microphones**. When a directional microphone is located in close proximity to and oriented toward the talker's mouth, the directional response serves to attenuate surrounding noise more so than the speech of the talker and to consequently provide an improvement in the signal- to-noise ratio (SNR).

Additionally, some remote microphone systems contain gyroscopes and accelerometers in the microphone/transmitter unit allowing for a determination of the orientation of the microphone. When the remote

cont.

Remote Mics, cont.

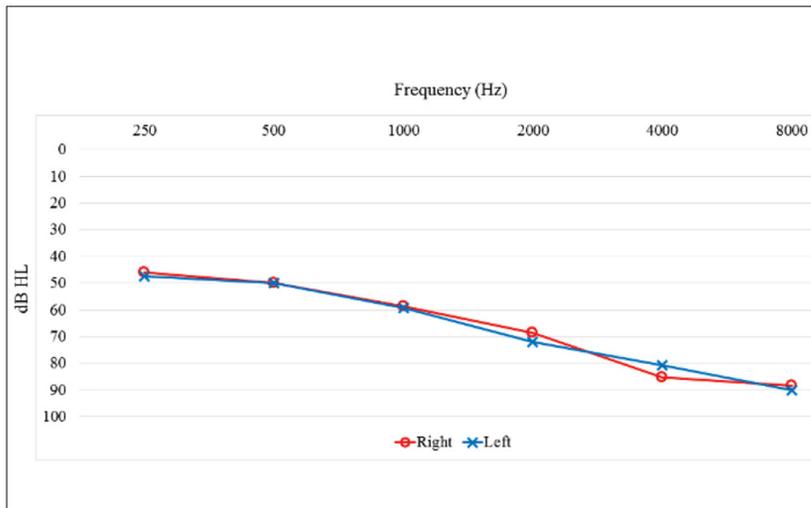


Figure 2

Figure 1

microphone is vertically oriented (i.e., clipped on the talker's collar or worn on a loop around the talker's neck; also known as "teacher mode" or "lapel mode"), the system automatically switches to directional mode in an attempt to focus on the speech from the talker's mouth and attenuate surrounding noise. In contrast, when the remote microphone is oriented in the horizontal plane, as it would if it were lying on a tabletop, the system automatically switches to omnidirectional mode to capture all sounds surrounding the microphone.

Furthermore, remote microphone systems may differ in the gain that is applied to the signal that is transmitted from the remote microphone to the hearing aids. The term "receiver gain" refers to the strength of the signal that is delivered from the remote microphone receiver to the hearing aid. With a **fixed-gain** remote microphone system, the receiver gain remains constant regardless of the ambient noise level. With an **adaptive-gain** remote microphone system, the receiver gain increases as the ambient noise level increases with the objective of improving the SNR.

This white paper describes a study in which speech recognition in quiet and in noise was evaluated in four different

conditions: 1) hearing aids alone, 2) hearing aids with a fixed-gain remote microphone accessory system with an omnidirectional microphone, 3) hearing aids with a fixed-gain remote microphone accessory system with an automatically-activated directional microphone system, 4) hearing aids with an adaptive-gain, universal remote microphone system with an automatically-activated directional microphone system.

Methods

Fifteen adults (18 to 83 years old; mean age = 64.9 years old [standard deviation = 15.4]) with moderate-to-severe hearing loss (unaided four-frequency pure tone average of 40 dB HL or poorer in the better hearing ear) participated in this study (see Figure 1 for the mean audiometric thresholds of the participants in this study). All participants had used binaural hearing aids for at least two years and had an aided CNC word recognition score of at least 50% correct in the binaurally aided condition in quiet (60 dBA presentation level).

All participants used ReSound LiNX2 behind-the-ear hearing aids (binaurally fitted) while participating in the study. For all audiometric frequencies at which the air conduction pure tone hearing

threshold did not exceed 80 dB HL, the output of each hearing aid was matched to the NAL-NL2 prescriptive target (± 5 dB) for a calibrated speech signal presented at 55, 65, and 75 dB SPL as determined by real ear probe microphone verification. Additionally, the real ear aided response obtained to a swept pure tone presented at 85 dB SPL did not exceed prescriptive targets for maximum output level.

Sentence recognition in quiet and in noise was evaluated in each of four different conditions:

1. Hearing aids alone
2. Hearing aids with use of the ReSound Mini Mic, which is a truly wireless accessory remote microphone system that contains a fixed-gain receiver and an omni-directional microphone.
3. Hearing aids with use of the ReSound Multi Mic (see Figure 2), which is a truly wireless accessory remote microphone system that contains a fixed-gain receiver and an adaptive directional microphone that is automatically enabled when worn in the teacher/lapel mode.
4. Hearing aids with use of the Phonak Roger system, which is a universal remote microphone system that contains an adaptive-gain receiver and a transmitter with an adaptive directional microphone that is automatically enabled when worn in the teacher/lapel mode. Specifically, the Phonak Roger Touchscreen

cont.

Remote Mics, *cont.*

remote microphone and Phonak Roger X receivers were used in the “Roger” condition.

Speech recognition in each of the four technology conditions was evaluated in a classroom-type setting (25’3” by 24’8” by 9’ feet; see Figure 3). Speech recognition was evaluated with use of one full list of AzBio sentences (Spahr et al., 2012) per test condition. The AzBio sentences were presented from a loudspeaker located in the front-center of the room, whereas uncorrelated classroom noise (Schafer & Thibodeau, 2006) was presented from four loudspeakers located in the corners of the classroom (30, 150, 210, and 330 degrees azimuth relative to the location of the participant; see Figure 3). For each technology condition, sentence recognition was evaluated in quiet and in noise presented 60, 65, 70, and 75 dBA. In the remote microphone conditions, the remote microphone was positioned 6 inches directly below the cone of the loudspeaker. The level of the AzBio sentences was 85 dBA at the location of the remote microphone and 65 dBA at the location of the participant.

Results

The data were analyzed with a two-factor repeated measures analysis of variance

(RM ANOVA) with the factors of SNR condition (quiet, and noise at 60, 65, 70, and 75 dBA) and technology condition (hearing aid alone, ReSound Mini Mic, ReSound Multi Mic, and Phonak Roger). Mean speech recognition results across the SNR and technology conditions are shown in Figure 4. The RM ANOVA identified statistically significant differences across SNR ($p < .01$) and technology ($p < .01$) conditions as well as a statistically significant interaction between the SNR and technology conditions ($p < .01$).

Post-hoc analyses conducted with the Tukey-Kramer Multiple Comparisons test identified the following findings:

1. Use of each remote microphone system provided better speech recognition in quiet and in noise relative to the hearing aid alone condition.
2. At moderate to high noise levels (60-75 dBA), the remote microphone systems with directional microphones (i.e., ReSound Multi Mic and Phonak Roger) provided better speech recognition in noise than the remote microphone system with an omnidirectional microphone (ReSound Mini Mic).

3. At higher competing noise levels (70 and 75 dBA), use of an adaptive-gain remote microphone system provided better speech recognition than what was obtained with use of a fixed-gain remote microphone system.

Discussion

The results of this study provide evidence of the substantial benefit provided by use of remote microphone technology. Use of each of the remote microphone systems resulted in a trend toward an improvement in sentence recognition in quiet relative to the hearing aid alone condition. In noise, use of a remote microphone system provided improvement in speech recognition of up to almost 70 percentage points compared to use of hearing aids alone. Inclusion of a directional microphone in the remote microphone system attenuates surrounding noise resulting in an improvement in the SNR and a consequent improvement in speech recognition in noise, particularly at moderate to high noise levels (i.e., 65 to 70 dBA).

At higher noise levels (i.e., 70-75 dBA), the provision of adaptive increases in receiver gain provides an improvement

cont.

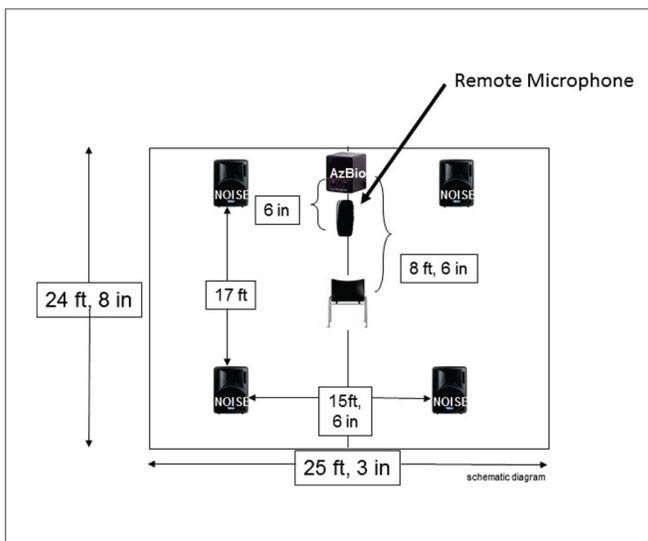


Figure 3

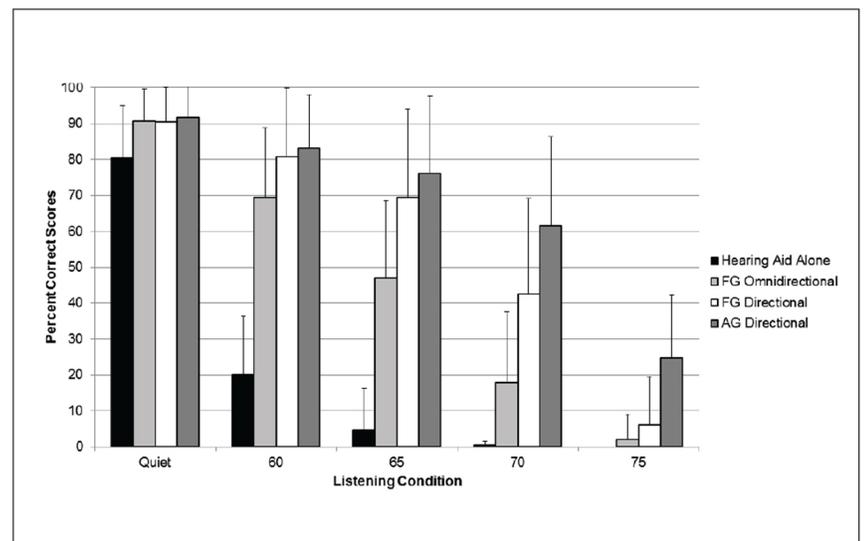


Figure 4

Remote Mics, *cont.*

in speech recognition (typically almost 20 percentage points compared to a fixed-gain receiver). Of note, the Roger X receiver (or any universal remote microphone receiver that contains a 3-prong Europort plug) may be directly connected to the Europort socket of the ReSound Multi Mic. This solution may be beneficial for children who are using ReSound hearing aids and are educated in a classroom in which a universal remote microphone system is already in use. Connecting the universal receiver to the ReSound Multi Mic allows the child to have access to the signal being broadcast by the universal remote microphone system, and only one universal receiver is required for delivery of the remote microphone signal to both hearing aids of a binaural user by way of the Multi Mic to the integrated RF receivers. A previous ReSound white paper described an investigation in which electroacoustic measurements suggested preservation of the adaptive gain benefits of the Roger system when the Roger X receiver was coupled to the Multi Mic (Quilter and Wright, 2017).

However, it is important to note that there have been no studies examining speech recognition obtained with the use of adaptive-gain RF receivers coupled directly to hearing aids versus an adaptive-gain receiver coupled to the Multi Mic.

Several factors influence the selection of a remote microphone system that best meets the needs of each hearing aid user. For instance, hearing aid users may select a remote microphone system based on financial cost. Accessory remote microphone systems are typically less expensive than universal remote microphone systems and will often serve as an excellent option for persons who cannot afford the relatively higher cost that is often associated with wireless universal remote microphone systems.

Accessory remote microphone systems with automatically-enabled directional microphones may be of particular interest to many hearing aid users given the relatively good speech recognition in noise that may be obtained at a relatively affordable cost.

Additionally, some hearing aid wearers may not wish to connect an RF receiver to their hearing aids. The coupling of a radio receiver to an adapter that connects to the DAI of the hearing aid adds extra bulk and weight to the hearing aid. For the bilaterally fit hearing aid wearer, it would be necessary to have a receiver and adaptor on each hearing aid in order to receive the signal – and benefit – in both ears. Furthermore, some hearing aid wearers may prefer the cosmetics of a hearing aid that contains an RF receiver that is integrated within the hearing aid rather than coupling a universal receiver to their hearing aid.

Remote microphone systems with directional microphones and adaptive-gain receivers may be the ideal solution for persons who require optimal improvement in the SNR in order to understand speech in moderate- to high-level noise. Also, remote microphone systems with directional microphones and adaptive-gain receivers are likely to be ideal for persons who frequently communicate in environments with high-level noise (70-75 dBA). The clinician should work with the hearing aid wearer (and his/her family) to evaluate the cost/benefit relationship of various remote microphone systems with the objective of determining the remote microphone system that best meets the needs of each individual.

Of note, the clinician should also consider other practical features that may influence the benefit the user will receive from remote microphone technology. For example, some remote microphone systems may be

simpler to operate than others. The clinician should ensure that the user (and his/her caregiver if the user is a child) are comfortable operating the remote microphone system that is recommended for the user. Ideally, the clinician should plan to spend ample time with the user discussing proper care, use, and maintenance of the remote microphone system.

Moreover, the clinician should consider whether the user will be able to manually activate the remote microphone system or if automatic-activation is ideal. In particular, children are unlikely to consistently press a button on their hearing aids or on a remote control to activate the remote microphone system during times in which a signal of interest is present at the remote microphone. Remote microphone systems that automatically enable when the remote microphone is active are likely to be preferred for infants and young children who cannot manually operate their hearing aids. However, the child's caregiver (e.g., parent, teacher, etc.) must be cognizant of the need to mute the remote microphone when the child is listening to other signals of interest (e.g., a child working in a small group in a classroom while his/her teacher works with another small group). The availability of a remote microphone that contains a display screen or that may be wirelessly connected to a smartphone or tablet via an app is likely to be beneficial, because information regarding the function of the remote microphone system may be provided to the hearing aid user and/or his/her caregivers (e.g., the remote microphone is enabled/disabled, the user is outside the range of the remote microphone, etc.).

Finally, it is strongly recommended that clinicians should select a remote microphone system that allows for the connection of the remote microphone

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Remote Mics, cont.

transmitter to consumer electronics such as a classroom smartboard, a computer, a television, etc. This greatly expands the scope of the benefit of the remote microphone system beyond listening to talkers in difficult listening situations.

Conclusions

1. Remote microphone systems provides substantial improvement in speech recognition over hearing aids alone.
2. Several factors must be considered when selecting the ideal remote microphone system for each individual.
3. Remote microphone systems with directional microphones provide better speech recognition in noise than remote microphone systems with omni-directional microphones.
4. Remote microphones systems with adaptive-gain receivers provide better speech recognition in high level noise than remote microphone systems with fixed-gain receivers.
5. Many hearing aid wearers may appreciate the financial cost, comfort, ease of use, and the aesthetics of truly wireless accessory remote microphone systems.
6. The clinician should ensure that the hearing aid user (and his/her caregivers if the user is a child) are sufficiently informed to correctly use the remote microphone system in daily listening situations. The use of remote microphone systems that contain display screens or that may be connected to smartphones or tablets via an app may be beneficial, because information pertaining to appropriate function of the system may be communicated to the hearing aid user and his/her caregivers. Additionally, clinicians should consider providing children with remote microphone systems that may be easily coupled to consumer electronics (e.g., tablets, computers, smartboards, etc.).

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