American Auditory Society Scientific and Technology Meeting
March 2-4, 2017

PODIUM PRESENTATIONS: Thursday, March 2, 2017

PODIUM SESSION I: COCHLEAR IMPLANTS AND OUTCOME MEASURES: JOHN NIPARKO SESSION

Podium Paper I.A.

Neural Correlates of Phonetic Categorization in Adult Cochlear Implant Listeners

Sharon Miller, PhD; Samantha Munzer; Jessica Graham, BA, University Of Louisville, Louisville, KY
Yang Zhang, PhD, University of Louisville, Minneapolis, Minnesota

Auditory event-related potentials (ERPs) can shed light on the neural mechanisms underlying speech and language outcomes in cochlear implant (CI) listeners. The mismatch negativity (MMN) component of the ERP response reflects pre-attentive sensory discrimination, making it a potentially useful clinical measure of accurate phonetic categorization, a skill known to support language and word learning. The present study used ERPs and a double oddball paradigm to examine whether the MMN could serve as a neural marker of phonetic categorization in individual adult CI users. The double oddball paradigm uses two distinct deviants from across and within phonetic categories to elicit MMN responses. Behavioral phoneme identification and discrimination and word recognition testing was also completed to examine neurophysiological correlates. Results indicate significant brain-behavior correlations between MMN responses to the across versus within category deviants and behavioral discrimination sensitivity. Moreover, better performance on a speech in noise task was also correlated with greater MMN amplitude to across versus within category deviants. These findings suggest the MMN elicited using a double oddball paradigm could serve as a neural marker of phonetic categorization skill and may be a good predictor of behavioral performance in individual adult CI listeners.

Podium Paper I.B.

Maintaining a Stable Voice with a Cochlear Implant

Justin Aronoff, PhD; *Abbigail Buente; Melanie Samuels; Elizabeth Abbs; Torrey Loucks, PhD,* University Of Illinois At Urbana-Champaign, Champaign, IL

Although cochlear implants provide degraded vocal pitch information, the information they deliver can potentially still improve the stability and quality of a patients' vocal production. The goal of this study was to determine 1) How the improvements in vocal stability differ with one versus two cochlear implants and 2) How improvements in vocal stability relate to the perception of pitch. Nine bilateral cochlear implant users vocalized the vowel /a/ while wearing no cochlear implants, one cochlear implant, or two cochlear implants. Participants were also tested on a task where they matched the pitch of stimulation across ears. As expected, the results indicated that cochlear implants improved vocal stability. Additionally, there was a significant improvement in vocal stability with two ears compared to the worse ear alone. However, there was no additional benefit to using two ears compared to the better ear alone. This suggests that there is a better ear affect but not a binaural benefit in terms of vocal stability, at least when using clinical programs.

Additionally, across participants, improvements in vocal stability corresponded with more reliable pitch matches, suggesting that improved vocal stability may require good pitch perception.

Podium Paper I.C.

Cochlear Implantation in Cases of Unilateral Hearing Loss: Quality of Life

Margaret Dillon, AuD; Emily Buss, PhD; Meredith Anderson, AuD; English King, AuD; Kevin Brown, MD; Harold Pillsbury, MD, University Of North Carolina At Chapel Hill, Chapel Hill, NC

Ellen Deres, AuD, UNC HealthCare

Patients with unilateral hearing loss experience reduced localization abilities, speech perception in noise, and quality of life as compared to normal hearers. The ability to use binaural cues for improved spatial hearing is limited by current treatment options as they route the signal from the affected side to the normal hearing ear. It is of interest whether cochlear implantation of the affected ear would improve performance on localization and speech perception tasks due to binaural input. Patients may report an improvement in quality of life resulting from restored spatial hearing. The objective of this study was to assess the subjective benefit of cochlear implant recipients with unilateral hearing loss, and the relationship with localization and speech perception measures. Twenty subjects with unilateral moderate-to-profound sensorineural hearing loss underwent cochlear implantation of the affected ear. Speech perception, localization, and quality of life measures were assessed preoperatively, and one, three, six, nine and twelve months postoperatively. Subjects reported an improvement in quality of life with the cochlear implant. Subjective benefit reflected performance on localization and speech perception measures. Patients with substantial unilateral hearing loss may experience an improved quality of life with a cochlear implant as compared to currently approved treatment options.

Podium Paper I.D.

Psychophysical Tuning Curves in Pediatric Cochlear Implant Listeners

Julie Arenberg Bierer, PhD; Kelly Jahn, AuD; Mishaela Dinino, MS, University Of Washington, Seattle, WA

Heather Kreft, MS, University of Washington, Minneapolis, MN

Andrew Oxenham, PhD, University of Minnesota, MN

Tremendous variability exists in outcomes with cochlear implants for both adults and children. Many of the developments in cochlear implant processing and programming have been developed based on data from post-lingually deafened adults. However, children who are born deaf and implanted early may have different needs for programming than adults. In this study, psychophysical detection thresholds were obtained across the electrode array for both broad and focused electrode configurations. In addition, psychophysical tuning curves, using a forward masking paradigm, were measured for one channel in the middle of the array for each ear. Nine ears were tested in 6 pediatric cochlear implant listeners who wear the Advanced Bionics device. A fast, Bekesy-like tracking procedure was used to measure detection thresholds and forward masked levels at threshold. Standard two-interval, two-alternative forced choice tuning curves were also obtained for comparison. Thresholds in quiet for broad and focused stimulation were, on average, 3 dB lower for children than adults. The degree of channel interaction assessed with psychophysical

tuning curves will be quantified and compared with existing data from post-lingually deafened adults. The results of this study could inform future developments in cochlear implants specifically for pediatric listeners.

Podium Paper I.E.

Have Technological Advancements in Hearing Aids Improved Subjective Outcomes?

Jingjing Xu, PhD; Jason Galster, PhD; Elizabeth Galster, AuD; Alyson Gruhlke, AuD; Amanda Wolfe, AuD, Starkey Hearing Technologies, Eden Prairie, MN

Hearing aid technology has experienced an explosion of advancement in the past decade. Innovations, such as receiver-in-the-canal devices, feedback suppression, and wireless connectivity, have evolved and substantially shaped hearing aid provision and use. The purpose of this study was to measure changes in subjective reports of hearing aid performance due to technological advancements over time using Device Oriented Subjective Outcome (DOSO) scale data. The DOSO is a device-oriented questionnaire, that produces scores for six outcome subscales: speech cues, listening effort, pleasantness, quietness, convenience, and use. Between 2014 and 2015, 132 bilateral hearing aid wearers who participated in clinical trials at Starkey completed the DOSO for their own devices. These data were compared to the interim normative data that were collected from 189 hearing aid wearers between 2004 and 2005 (Cox et al., 2014, JAAA). The results showed that hearing aids with 2015-era technology performed significantly better than their counterparts with 2005-era technology in all DOSO subscale domains, except listening effort. These data contribute to a better estimate of DOSO norms for devices with more recent technology. Additional DOSO data collected with newer experimental technology were contrasted to the 2015-era data, which revealed additional subjective benefits of technological advancements.

Podium Paper I.F.

Replacing Word-Recognition with Speech in Noise in Standard Audiometric Assessment

Matthew Fitzgerald, PhD; Amanda Burke, AuD; Daniel Krass, AuD; Honey Gholami, AuD; Jannine Larky, MS; Sarah Levy, AuD; Austin Swanson, AuD; *Goutham Telukuntla, AuD*, Stanford University
Grace Nance, BS, University of Louisville
Devon Palumbo, BS, University of Texas Dallas

Word-recognition in quiet has been a staple of the audiologic test battery for over 50 years. However, there is increasing awareness that word-recognition in quiet has little relationship with the real-world communication abilities of the patient, and is insensitive for detecting other disorders such as 'hidden hearing loss'. To address these issues, we are devising a new clinical protocol in which speech-in-noise testing, rather than word-recognition in quiet, is the default speech test in the audiologic test battery. In addition to our basic audiometric testing, we have added two additional features: a) monaural and binaural speech-in-noise testing via the QuickSIN, and b) the SSQ12 (Speech Spatial Questionnaire 12). We have data on over 1300 adults, which suggest that most instances in which word-recognition in quiet is excellent can be predicted with a combination of audiometric thresholds and QuickSIN values. These data have been used to create clinical recommendations in which speech in noise testing becomes the default clinical test of speech perception, with guidelines for when word-recognition in quiet is likely to have

diagnostic significance and should be conducted. Making this subtle, but fundamental shift in the audiologic test battery is likely to have significant research and clinical implications.

PODIUM SESSION II: ELECTROPHYSIOLOGY (AEPS)

Podium Paper II.A.

Investigation into Auditory Processing During Sleep in Children

Adrienne Roman, PhD; Carlos Benitez-Barrera, MA; Alexandra Key, PhD; Anne Marie Tharpe, PhD, Vanderbilt University Medical Center, Nashville, TN

The auditory system in humans is the only sensory system that remains active for the continuous scanning and processing of information during sleep; however, little research has investigated this phenomenon. This study examined whether a brief exposure to auditory stimuli during sleep could result in memory traces on event-related potentials in children. Ten preschool children with normal hearing (3-5 years) were presented with three randomly selected nonwords (250 trials; 45-50 dB SPL) for 10 minutes during a regular nap (sleep state verified by EEG). After the nap, children's memory for the stimuli was evaluated using a passive listening version of the 'old/new' event-related potential paradigm that included three nonwords from the nap exposure (repeated condition, 45 trials), 3 new nonwords (sham repeated condition, 45 trials), and 45 other distinct nonwords (novel condition). Memory for the 'nap exposure' set was reflected by the increased positive amplitudes at midline parietal locations between 350-600ms compared to the sham and novel conditions. This evidence of the memory trace for the auditory stimuli experienced during sleep may have implications for children with hearing loss who routinely remove their assistive devices during sleep. Preliminary results from children with cochlear implants will be discussed.

Podium Paper II.B.

Current Applications of ECochG Beyond the Diagnosis of Meniere's Disease

John Ferraro, PhD, University Of Kansas Medical Center, Kansas City, KS
Paul Kileny, PhD, University Of Michigan Medical School
John Durrant, PhD, University of Pittsburgh Medical Center

For over two decades, the primary use of Electrocochleography (ECochG) has been in the diagnosis/assessment/monitoring of Meniere's disease (MD)/endolymphatic hydrops. However, several recent studies have shown the benefits of applying this under-utilized clinical tool in the diagnosis/study of other disorders of hearing and balance such as Auditory Neuropathy Spectrum Disorder (ANSD), superior semicircular canal dehiscence (SCCD) and noise-induced hearing loss (NIHL). This presentation will provide an update by Drs. Durrant and Kileny on the use of ECochG in the diagnosis of ANSD and SCCD, respectively, and Dr. Ferraro on how ECochG may be useful in assessing supra-threshold hearing function in noise-exposed populations.

Podium Paper II.C.

Feasibility of Acupuncture to Induce Sleep for BAER Testing

Nicole Holmer, MS; Elizabeth Artola, Seattle Children's Hospital, Seattle, WA
Anne Lynn, MD; Susan Norton, PhD, Seattle Children's Hospital & University of Washington School of Medicine

Purpose: Main aims of this study were 1) evaluate feasibility and effectiveness of acupuncture to achieve a sleep state to perform diagnostic brainstem auditory evoked response (BAER) and evoked otoacoustic emissions (EOAE) testing in medically complex children, and 2) assess acceptability of acupuncture as an alternative to anesthesia for BAER testing. Method: Patients received acupuncture treatment with press needles to induce sleep. Next, a diagnostic BAER/EOAE was performed. Collected data included the number of BAER thresholds, sleep indicators, and acceptability of this procedure. Results: A total of 15 patients were tested (mean age= 2.5 years) and 87% fell asleep with treatment. On average, 7 of 10 desired BAER thresholds were obtained per patient. Mean delay to sleep was 31 minutes. Two patients failed to sleep with acupuncture. There were no adverse safety events. In FY2016 the mean cost of BAER testing requiring anesthesia was $9418 ($8070 - $10731). Estimated total cost of an acupuncture-BAER combination is $1227 per patient. Audiologists and parents reported high satisfaction (>85%) on post-testing surveys. Conclusion: This study showed that acupuncture is effective, safe, and cost-efficient to induce sleep in medically complex pediatric patients. It was an acceptable alternative to anesthesia for parents and providers.

Podium Paper II.D.

Auditory Brainstem Response of the Bottlenose Dolphin Across Click Rate

Robert Burkard, PhD, University At Buffalo, Buffalo, NY
James Finneran, PhD, Space And Naval Warfare Systems Center Pacific, US Navy, San Diego, CA
Jason Mulsow, PhD; Dorian Houser, PhD, National Marine Mammal Foundation, San Diego, CA

Auditory brainstem response (ABR) rate effects have been investigated in many mammalian species, including humans. Rate can be used as a probe into adaptation processes in the auditory nerve and brainstem. Click-evoked ABRs were obtained in bottlenose dolphins using both conventional averaging and maximum length sequences (MLSs); the latter disentangles ABRs that overlap in time, and thus allows the study of adaptation at very high rates. Bottlenose dolphins varied in age and in their upper-cutoff frequency of hearing. Conventional rates included 25, 50 and 100 Hz. Average MLS rates were approximately 50, 100, 250, 500, 1000, 2500 and 5000 Hz. Click level was 135 dB peSPL. We assessed the latency and amplitude of several ABR peaks across rate. ABRs were observed in all animals, for all rates. With increasing rate, peak latencies increased and peak amplitudes decreased. There was a trend for an increase in the interwave intervals with increasing rate, which appeared more robust for the normal-hearing group. For those rates where ABRs were obtained for both conventional and MLS approaches (50 Hz, 100 Hz), mean latencies and amplitudes for the ABR peaks (averaged across subjects within the 'normal-hearing' and 'hearing-impaired' groups), were in reasonably good agreement.

Podium Paper II.E.

Jet Fuel and Noise Exposure Results in Central Auditory Dysfunctions

O'neil Guthrie, PhD, Northern Arizona University, Flagstaff, AZ

Exposure to jet fuel is the single most frequent chemical exposure among military personnel and almost every soldier will be exposed to military noise during their career. Combined fuel and noise exposures represent a significant health risk for military personnel. Yet, the neurotoxic profile of this combined exposure has not been

characterized. The current series of experiments were designed to determine whether or not subtoxic exposures to fuel would interact with non-damaging noise exposures to induce a central auditory dysfunction (CAD). 160 rats were randomized into 4 groups: control, noise-exposed, fuel-exposed and fuel+noise exposed. Structural and functional assays were used to assess the auditory system from end-organ to the cerebral cortex. The combined results revealed that there was a significant synergistic effect between fuel and noise exposures. This effect could be characterized as significantly slow responses from cortical neurons. The data also suggested that the observed cortical effect may be driven by sub-cortical abnormalities. These CADs occurred in the absence of structural and function alterations to the end-organ and the cochlear nerve. Therefore, it appears that combined fuel+noise exposure may exert consequences on auditory function that may be more insidious than what was previously known.

Podium Paper II.F.

Jackson Heart Study: Central Auditory Processing Deficits and Normal Hearing

Christopher Spankovich, PhD; Lauren Mcnichol, AuD; Mary Frances Johnson, AuD; John Schweinfurth, MD; Charles Bishop, AuD, University Of Mississippi Medical Center, Jackson, MS

Normal pure tone threshold sensitivity does not necessarily indicated normal hearing. The auditory processing of a sample of 1322 participants of the Jackson Heart Study, a prospective epidemiological study of cardiovascular disease and health disparities in African Americans, was assessed between 2008 and 2013. Here we present cross-sectional data on participants with normal pure tone thresholds with and without perceived hearing loss and relationship to central auditory processing outcomes, Quick Speech-in-Noise (SIN) and Dichotic Digits. The results suggest that perceived hearing problems, despite normal threshold sensitivity are associated with central auditory deficits.

PODIUM SESSION III: SPEECH PROCESSING

Podium Paper III.A.

Measuring Listening Effort in Children with Hearing Loss: Single- Versus Dual-Task?

Ronan McGarrigle, PhD; Samantha Gustafson, AuD; Benjamin Hornsby, PhD; Fred Bess, PhD, Vanderbilt University Medical Center, Nashville, TN

Dysfunctional levels of stress and energy found in children with hearing loss (CHL) are likely related to the mental demands of sustained effortful listening (Bess, Dodd-Murphy, & Parker, 1998; Bess & Hornsby, 2014). This study investigated the sensitivity of two commonly-used behavioral measures of listening effort. Thirty-seven children with normal-hearing (CNH) and 48 CHL completed both a dual-task and a single-task paradigm. CHL performed each task aided (n = 43) and unaided (n = 30). A subset of CHL (n = 25) were tested in both conditions. The dual-task paradigm involved word recognition and response to a visual probe. For the single-task paradigm, verbal response times were recorded during word recognition. Each task was completed in three listening conditions modulated by signal-to-noise ratio (SNR). The single-task paradigm revealed: (1) group differences in verbal response times between CNH and CHL across listening conditions, and (2) changes in verbal response times as a function of SNR. The dual-task paradigm revealed no significant main effects of hearing status (CNH versus CHL) or SNR. Although neither

task showed differences due to hearing aid use, the single-task paradigm was more sensitive than the dual-task paradigm in detecting changes in listening effort associated with HL.

Podium Paper III.B.

Code-Switching in Bilingual Adults: Impact on Masked Speech Recognition

Paula Garcia, PhD, Human Auditory Development Laboratory, Boys Town National Research Hospital, Omaha, NE
Lori Leibold, PhD, Human Auditory Development Laboratory. Center For Hearing Research. Boys Town National Research Hospital
Emily Buss, PhD, University of North Carolina School of Medicine, Chapel Hill, North Carolina
Lauren Calandruccio, PhD, University of North Carolina School of Medicine, Cleveland, Ohio
Barbara Rodriguez, PhD, Department of Speech and Hearing Sciences, University of New Mexico, Albuquerque, New Mexico

Bilingual speakers often alternate between their first (L1) and second languages (L2), within and between sentences during conversations; this is referred to as code-switching. Previous research investigating the impact of code-switching on communication has relied on reaction time measures, showing that unexpected code-switching influences comprehension [1]. Understanding speech in noise is challenging for non-native listeners even when code-switching is not required and they learned their L2 early in life [2]. This study evaluated the effect of code-switching on adult Spanish/English bilingual listeners' (N = 20) speech recognition of English and Spanish words at a fixed SNR in speech-shaped noise. There were four target conditions: (1) English-only, (2) Spanish-only, (3) Unexpected-English, and (4) Unexpected-Spanish. In the Unexpected -English condition, the probability of a Spanish word was 75% on a given trial and the probability of an English word was 25%. The probabilities were reversed in the Unexpected-Spanish condition. Performance was better in the English-only (L2) compared to Spanish-only (L1) condition. Accuracy was poorer in both Unexpected conditions compared to the corresponding single-language conditions, and accuracy was poorer when switching to Spanish (L1) than to English (L2). Results suggest a cost of code-switching when bilingual listeners alternate between languages in noisy environments.

Podium Paper III.C.

Speech-in-Speech Recognition in School-Age Children and Adults

Emily Buss, PhD, University Of North Carolina At Chapel Hill, Chapel Hill, NC
Lori Leibold, PhD, Boys Town National Research Hospital, Omaha, NE
Heather Porter, PhD; John Grose, PhD, Children's Hospital, Los Angelese, CA

Children perform more poorly than adults on a wide range of masked speech perception paradigms, but this effect is particularly pronounced when the masker itself is also composed of speech. The present study evaluated two factors that might contribute to this effect: the ability to segregate target from masker speech, and the ability to recognize target speech based on sparse cues (glimpsing). Speech reception thresholds (SRTs) were estimated for closed-set, disyllabic word recognition in children (5-16 yrs) and adults in a one- or two-talker masker. Speech maskers were 60 dB SPL, and they were either presented alone or in combination with a 50-dB-SPL speech-shaped noise masker. There was an age effect overall, but performance was adult-like at a younger age for the one-

talker than the two-talker masker. Noise tended to elevate SRTs, particularly for older listeners and when summed with the one-talker masker. Removing time/frequency epochs associated with a poor target-to-masker ratio markedly improved SRTs, with larger effects for younger listeners; the age effect was not eliminated, however. Results were interpreted as indicating that development of speech-in-speech recognition is likely impacted by development of both segregation and the ability to recognize speech based on sparse cues.

Podium Paper III.D.

Realistic Evaluation of Speech Understanding

Elon Ullman, BA, Advanced Hearing Concepts/Smith-Kettlewell Institute, Bodega Bay, CA
Helen Simon, PhD; Albert Lotze, BA; Harry Levitt, PhD, Smith-Kettlewell Eye Research Institue, San Francisco, CA

Most methods of evaluating speech understanding use standardized test materials that are not representative of everyday speech communication. The method being evaluated focuses on everyday communication by having the subject signal (e.g., by pressing a button) whenever speech is not understood in an actual conversation or passive listening. Watching television allows for convenient implementation of the method. The experiment compared button pressing (BP) during continuous viewing of a news broadcast to that of the subject repeating back (RB) what was said. The RB method provides an objective measure of how well the speech is understood. The RB method, however, diverges from a realistic communication situation in that the speech needs to be presented in short segments to allow sufficient time for the speech to be repeated back. The RB method can serve as a reference for calibrating the subjective BP method. The difference between the BP and RB methods is a useful indicator of the subjects' self-assessment of how well they understand speech. It is hypothesized this method could be used to predict the degree of satisfaction with a hearing aid in a noisy environment.

Podium Paper III.E.

Rapid Evaluation of Hearing using Modified Versions of the Triple Digit Test

Douglas Brungart, PhD; Van Summers, PhD; Leilani Ramos; Hector Galloza, Walter Reed National Military Medical Center, Bethesda, MD

Pure tone audiometry is the gold standard for identifying hearing impairment, but there are many cases where environmental noise, a lack of calibrated equipment, or time constraints make traditional audiometric threshold measurement impossible. In these situations, speech-in-noise tests can help detect individuals who have a high probability of hearing impairment because they can be conducted with a high-level target speech signal that is a) loud enough to be audible to hearing impaired listeners and b) presented in broadband noise that is loud enough to mask out any environmental sounds. One example of such a test is the Triple Digit Test, which has been shown to be effective for identifying hearing impaired listeners even when delivered over a relatively uncontrolled commercial phone line (Watson et al., 2012). Here we present the results of six modified versions of the Triple Digit Test that used a fixed rather than adaptive SNR with five different maskers (positive or negative Schroeder phase harmonic complexes, male or female speech, and noise). Results from more than 800 listeners demonstrate that these modified tests (in particular the positive phase masker) can reliably distinguish between listeners with different levels of hearing impairment in as few as ten trials.

Podium Paper III.F.

Influences on Band Independence in Speech Recognition

Nathaniel Whitmal, PhD, University Of Massachusetts, Amherst, MA

The popular Speech Intelligibility Index algorithm assumes that individual frequency bands provide independent contributions to speech intelligibility. This assumption implies that intelligibility in adverse conditions may be improved by enhancing selected bands containing important speech cues. However, this assumption - which has received limited scrutiny -- conflicts with contemporary results showing synergetic interaction between frequency bands when single-vowel stimuli are used and/or pitch cues are altered. The goal of the present study was to determine how band independence and consonant primary cues depend upon pitch cues and vowel context. Thirty subjects performed a speech recognition task with adaptively-filtered nonsense syllables, presented either as recorded or after channel vocoding that removed pitch information. Band independence metrics were computed from recognition error statistics and analyzed inferentially, using a novel ad hoc data transformation. Results indicate that band independence relies heavily on detection of voicing cues in individual bands; when these cues are modified, vowel-specific synergetic interactions appear. Implications for band independence and improving the intelligibility of processed speech will be discussed.

PODIUM PRESENTATIONS: Saturday, March 4, 2017

PODIUM SESSION IV: AMPLIFICATION / HEARING AIDS

Podium Paper IV.A.

Domain-Specific Locus of Control and Hearing Aid Uptake

Rebecca Kelly-Campbell, PhD, University Of Canterbury, Christchurch, NA
Peggy Nelson, PhD, University Of Minnesota, Minneapolis, MN

Locus of control (LoC) has been linked with hearing aid (HA) uptake. However, previous research has relied on LoC questionnaires that are not domain-specific. Kelly-Campbell and Allan (2016) applied a method of content analysis to assess the relationship between LoC (Origin and Pawn scales) and continued HA use. In this procedure, participants were interviewed about their experiences relating to HAs. Interview transcripts were coded for evidence of origins and pawns. The results indicated that LoC was related to continued HA use. The purpose of this study is to use the same method to assess the relationship between LoC and HA uptake. Participants were divided into a HA uptake group and a non-uptake group, based on their purchase decision at their initial HA consultation at several private practice clinics. Data collection continued until 35 participants were in each group, based on an a priori sample size analysis. In addition to interview data, demographic, audiometric, hearing handicap, and age data were collected for each participant. There were significant differences between the groups, based on LoC, even after controlling for the other variables. These results highlight the relationship between LoC and HA uptake, suggesting that LoC may be a target for intervention.

Podium Paper IV.B.

Hearing Aid RCT Comparing Best-Practices and OTC Service Delivery

Larry Humes, PhD; *Dana Kinney, MA; Tera Quigley, AuD; Christine Herring; Sara Rogers, AuD; Anna Main, AuD,* Indiana University, Bloomington, IN
A single-site, prospective, double-blind placebo-controlled randomized trial was conducted to determine the efficacy of hearing aids in older adults delivered using audiology best practices (AB). The efficacy of an alternative over-the-counter consumer-decides (CD) approach was also evaluated. Of 188 eligible adults, aged 55-79 years with mild-to-moderate hearing loss, 163 enrolled as a volunteer sample. The same high-end digital mini-behind-the-ear hearing aids were fitted bilaterally to all participants. The primary outcome measure was the Profile of Hearing Aid Benefit (PHAB) and the secondary outcome measure was the Connected Speech Test (CST) presented at 65 dB SPL (+3 dB signal-to-babble ratio). Additional measures of hearing-aid benefit, satisfaction and usage were also obtained. Intention-to-treat analyses were performed. The AB service-delivery model was found to be efficacious for most of the outcome measures with moderate or large effect sizes (Cohen's d) observed. The CD service-delivery model was also efficacious with similar effect sizes. However, the CD group had a significantly lower percentage of participants who were likely to purchase hearing aids after the trial. Efficacious over-the-counter service-delivery models may increase accessibility and affordability of hearing aids for millions of older adults. (Work supported by NIDCD R01 DC011771.)

Podium Paper IV.C.

Towards Individualization of Hearing Aid Microphone Technologies in Adults

Todd Ricketts, PhD; Erin Picou, PhD, Vanderbilt University Medical Center, Nashville, TN
For hearing aid users, microphone technologies have the potential to significantly improve speech recognition in noisy situations. However, optimal performance is greatly affected by the interaction between source location (on- versus off-axis) and microphone processing. For example, directional processing can optimize the signal-to-noise ratio for one listening environment (talker front), while providing a detriment for another (talker behind). Rather than assuming that automatic switching algorithms provide the preferred microphone setting in complex noisy environments, we hypothesized that, for an individual listener, preference may be affected by a number of factors including differences in individual listening needs and abilities. The purpose of this study was to examine the potential relationships between performance, benefit, listening needs and microphone preference in complex listening environments. Results suggest that adult listeners differ in their preferences for microphone settings and that these preferences are relatively stable across a range of complex, noisy listening situations. Further, individual preference does not appear to be related to the magnitude of directional benefit. The long term goals of this work is to develop a clinically viable test battery which better predict preferred microphone settings in individual listeners. Scientific and clinical implications of the findings will be discussed.

Podium Paper IV.D.

Can Sound Beams Improve TV Listening with Asymmetric Hearing?

Vishakha Rawool, PhD, West Virginia University, Morgantown, WV
Individuals with asymmetric hearing often report lack of balance while listening to the TV and a need to turn up the volume even in the presence of one normal ear. A new sound beaming technology relies on ultra-frequency sounds to transmit desired sounds to the listener. Ultra-frequency sounds have wavelengths that are only a few millimeters long and

thus naturally travel in extremely narrow beams, which allows the beaming of desired sounds to the listener. This study was designed to compare TV listening experience with regular TV speakers and a speaker with sound beaming technology. Ten adults with asymmetric auditory sensitivity participated in the study. They were familiarized with a visual analogue scale (VAS) (0 to 100) designed to document listening ability. They were allowed to adjust the level of the TV and ceiling speakers to most comfortable listening levels. Then they practiced listening to 2-minute segments of a DVD with the TV and with sound beaming speakers. Then they watched the DVD again while completing the VAS in the two listening conditions. Seven out of the 10 participants preferred the sound beam speaker while the paired t-test performed on the average VAS scores missed significance ($p = 0.06$).

Podium Paper IV.E.

Evaluation of the 1:1 Communication Mode and of the Self-Fitting

Caslav (Chas) Pavlovic, PhD; Meena Ramani, PhD; Nick Michael, MS, Batandcat Corporation, Palo Alto, CA

With the HELP from NIDCD (NIH Award Number R44DC014030) we have developed an experimental device broadly falling into the category of modern PSAPs which are characterized by both hearing aid functionality as well as by a consumer entertainment functionality (such as in this case a high end headset). In this study, we investigate the performance of the device with respect to self fitting (characteristic of most of the PSAPs) and of the novel device-to-device direct communication capability (1:1) Thirty subjects have been tested in various listening conditions using categorical estimation procedure of Pavlovic et al. (J.Acoust.Soc.Am: 373-382,1990), as well as a questionnaire. Preliminary results indicate the while in quiet conditions the 1.1 modality provides no advantage, with the increase in noise level the 1:1 mode provides a substantial improvement. With respect to self-fitting the results are at par with those achieved by prescriptive formulae prior to an audiological adjustment. The results also indicate that the self-fitting procedure can be dramatically simplified: it will be possible to adjust the device using just one parameter controlled by the user.

Podium Paper IV.F.

Effects of Compression on Sound Localization Cues

Anna Diedesch, PhD, Oregon Health & Science University, Portland, OR
G. Christopher Stecker, PhD, Vanderbilt University, Nashville, TN

Wide-dynamic range compression has been shown to alter interaural level difference cues (ILD) in hearing aids. Previous studies have reported reduced lateralization consistent with the attenuation of ILD by fast-acting compression, particularly for high-pass filtered noise (Wiggins and Seeber 2011 JASA 130(6): 3939-3953). Here, we measured binaural acoustic recordings to estimate frequency-specific ILD and interaural time differences (ITD) in anechoic and simulated reverberant rooms. Siemens Motion 700 behind-the-ear hearing aids were coupled to comply tips with 0-3 vents, or to open domes. Binaural cross-correlation and intensity-difference calculations were used to estimate interaural cues. Previous findings for linear hearing aids, using the same methodology, showed reduced ILD and erratic ITD in simulated reverberation and minimal effect of hearing aid venting (Diedesch and Stecker, AAS poster 2016). Results showed measured interaural cues for a slow-compression rate were similar to linear hearing aid fitting. Consistent with current

literature, ILD was reduced by a fast-compression rate. ITD did not appear to be effected by compression. [Supported by NIH R01-DC011548]

Podium Paper IV.G.

RESTART Theory: How Envelope Processing Constrains Spatial Hearing

G. Christopher Stecker, PhD; Anna Diedesch, PhD, Vanderbilt University School Of Medicine, Nashville, TN

An emerging theory of human spatial hearing posits that binaural features are sampled only at moments of positive envelope fluctuations such as sound onsets and infrequent modulation events. Labeled 'RESTART theory,' this view helps to explain the robustness of spatial hearing in complex environments by young unimpaired listeners, the relationship between sound localization and temporal regularity, and potential links between envelope-processing measures (gap detection) and binaural sensitivity. In this presentation, we briefly review 30+ years of evidence that led to RESTART theory before examining its implications for spatial perception and attention in normal and impaired listeners, for spatial analysis and synthesis in applications of machine listening and virtual reality, and for spatially robust signal processing in hearing aids and cochlear implants. [Supported by NIH R01-DC011548]

Podium Paper IV.H.

Extended High Frequency Amplification through 10 kHz Improves Speech Understanding

Laura Street, AuD; Suzanne Levy, PhD; Tim Streeter, MS; Drew Dundas, PhD; Judy Brimacombe, MA; Brent Edwards, PhD, Earlens Corporation, Menlo Park, CA

Previous studies demonstrated that hearing-impaired individuals benefit on speech-on-speech tasks when the simulated bandwidth of amplification was increased from 5 to 10 kHz (Levy et al 2015; Moore et al, 2010). In this study, participants with mild to severe sensorineural hearing loss were fit with contact hearing devices providing usable gain of up to 70 dB out through 10 kHz (Fay et al 2013, Gantz et al 2017), and their performance on the Hearing in Speech Test (HIST) was assessed. The reception thresholds for sentences (RTS) were measured in an asymmetric spatial configuration with the target on one side and two masking talkers on the opposite side.Two amplification conditions were tested: full bandwidth delivered by the contact hearing device and limited bandwidth where participants received 0 dB of gain at 6 kHz and above in order to account for the effective bandwidth limitations of conventional acoustic hearing aids (Struck and Prusick 2017). Preliminary data suggest that participants fit with the contact hearing device perform better on the HIST when the bandwidth of amplification is extended to 10 kHz, similar to the degree of benefit previously obtained under simulation. Correlations between audiometric configuration and degree of RTS improvement will be discussed.

PODIUM SESSION V: HEARING LOSS AND DIAGNOSTIC AUDIOLOGY

Podium Paper V.A.

Lowest Acceptable Performance Level and Noise Tolerance Profile

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The goal was to find an appropriate performance criterion for the evaluation or comparison of sensory or behavioral intervention strategies with the hearing-impaired. Twenty eight young listeners with normal hearing were asked to repeat meaningful sentences (CUNY) presented in multi-talker babble. Twelve sentences were presented at each of six signal-to-noise ratios. After listening at each signal-to-noise ratio, listeners were asked to estimate the length of time for which they would be able and (separately) willing to sustain participation in a group conversation under the conditions just experienced. On average, listeners estimated they would be able and willing to sustain participation for 10 minutes when word recognition was 72% and 86%, respectively. These performance levels were obtained at signal-to-noise ratios of -0.7 and +0.5 dB, respectively. In a separate assessment of noise-tolerance profiles, the listeners fell into two groups. One group (n=29) was most concerned with the noise's speech-interference. The other (n=9) was most concerned with the annoying properties of the noise itself. Subsequent analyses revealed little difference in terms of performance. For the 'annoyance' group, however, ability and willingness to sustain participation for 10 minutes required 80% and 91% word recognition, respectively. It is concluded that the lowest acceptable performance level depends on at least three factors: the duration of listening, ability versus willingness, and the listener's noise tolerance profile. Other factors such as the complexity of the language, the effect of hearing loss, the motivation of the listener, and the interactive style of the listener were not studied here. These findings, however, support the use of a performance criterion well above 50% for the evaluation or comparison of sensory or behavioral intervention strategies with the hearing-impaired.

Podium Paper V.B.

Menopause and Postmenopausal Hormone Therapy and Risk of Hearing Loss

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Background: Menopause may be a risk factor for hearing loss and postmenopausal hormone therapy (HT) may slow hearing decline; however, there are no large prospective studies. Methods: We prospectively examined independent associations between menopause, HT and self-reported hearing loss in 80,972 women in the Nurses' Health Study II (1991-2013). Baseline and updated information was obtained from validated biennial questionnaires. Cox proportional hazards regression models were used to estimate multivariable-adjusted relative risks (MVRRs). Results: After 1,410,928 person-years of follow-up, 18,558 cases of hearing loss were reported. There was no association between menopausal status and risk of hearing loss but older age at menopause was associated with higher risk. The MVRR for natural menopause for age 50+ compared with <50 was 1.10 (95% CI 1.03, 1.17). Among postmenopausal women, longer duration of HT (estrogen or estrogen plus progestogen) use was associated with higher risk (p-trend <0.001). Compared with women who never used HT, the MVRR of hearing loss among women who used oral HT for 5-9.9 years was 1.15 (95% CI 1.06, 1.24) and for 10+ years was 1.21 (95% CI 1.07, 1.37). Conclusion: Older age at menopause and longer duration of postmenopausal HT are associated with higher risk of hearing loss.

Podium Paper V.C.

Hearing Loss and Incident Injuries Requiring Health Care

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Kathy Pichora-fuller, PhD, University Of Toronto
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Background and Objectives: Injuries are responsible for 11% of global disability adjusted life years. The objective was to determine if hearing loss is associated with increased incidence of workplace and non-workplace injuries and associated health care among American adults. Methods: We performed a prospective cohort study of adults 18 years and older participating in Panels 9-16 (2004-2012) the Medical Expenditure Panel Survey who were representative of the U.S. general population. Participants underwent five rounds of interviews over two years. Self-reported hearing loss was determined in round 2, and injury occurrence and associated health care use was ascertained in rounds 3-5. Poisson regression was used to estimate the adjusted relative incidence of injuries and associated health care use among participants with hearing loss relative to participants with normal hearing. Survey weights were used to account for the complex survey design. Results: Individuals with hearing loss had significantly higher rates of workplace and non-workplace injuries and associated emergency department visits, hospital admissions and outpatient appointments over an average 1.3-year follow up. The associations were larger in younger adults, women, and low-income individuals. Conclusions: Hearing loss is independently associated with higher rates of workplace and non-workplace injuries requiring health care among U.S. adults.

Podium Paper V.D.

A New Outcome Measure to Assess Social Participation in Adults

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Methods: Study 1 generated content for the measure through interviews with 25 adults with hearing loss and nine clinicians and researchers. Study 2 evaluated the relevance and clarity of the measure through cognitive interviews with 14 adults with hearing loss and an expert panel with 20 clinicians and researchers. Study 3 refined the measure and assessed its psychometric properties by applying modern psychometric analysis, namely Rasch analysis, and traditional psychometric analysis to data collected from 381 adults with hearing loss. Results: Study 1 generated a pool of 53 items that measured three domains: behaviour, emotion and identity. Study 2 confirmed that the items were relevant and clear. However, the response scale required adjustment for clarity. Study 3 led to the removal of items with unfavourable psychometric properties, such as poor fit or redundancy. The finalised 19-item measure consisted of two subscales: (1) behaviour and (2) perception. Each subscale had good reliability and validity. Conclusion: This research demonstrates the value of engaging key stakeholders and utilising modern psychometric approaches to develop outcome measures for use in research and clinical practice.

Podium Paper V.E.

Measuring Auditory Thresholds with Frequency-Limited Environmental Sounds and Spondee Words

Sarah Poissant, PhD; Richard Freyman, PhD; Kimberly Adamson-Bashaw, BA; Marissa Levy, University Of Massachusetts Amherst, Amherst, MA

Young children or other difficult-to-test patients often habituate to warble tones or tire of testing prior to full audiogram measurement, leading too often to referral for sedated electrophysiological testing. Here we share the results of two experiments designed to assess the validity and reliability of sound-field thresholds obtained with potentially more engaging stimuli. Subjects were young adults with normal hearing whose warble tone thresholds were compared to detection thresholds for half-octave-wide environmental sounds and identification thresholds for octave-wide spondee words. A subset of conditions employed hearing loss simulation with both rising and falling slopes. The threshold tester was blinded to the audiometric configuration. Results revealed highly stable environmental sound thresholds which, on average, were within 5 dB of those obtained with warble tones for flat configurations, but slightly underestimated thresholds for steeply sloping configurations. Filtered spondee thresholds were marginally more variable and usually between 5 and 10 dB poorer than warble tone thresholds, likely due to the increased demands of the identification task. Results also suggest refinements that could lead to even tighter matches to warble thresholds and the strong promise of these novel stimuli and methods as an adjunct to traditional audiometric procedures for difficult-to-test patients.

Podium Paper V.F.

Wideband Acoustic Immittance: Effects of Measurement Equipment, Age, Gender, and Ear-Canal Area

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Kathryn Giradrin, AuD, Holyoke Medical Center
Nicholas Horton, PhD, Amherst College, Amherst, MA

Wideband acoustic immittance measures (WAI) are an active area of research aimed at the development of an objective and noninvasive measurement that can identify a range of middle-ear disorders. This work collected systematic measurements of WAI quantities on adult subjects with normal middle ears, with approximately ten female and ten male subjects in each decade of life from 20 to 80 years old. Results are reported from subjects with air-bone gaps of less than or equal to 10 dB at audiometric frequencies. WAI was measured using two distinct FDA-approved devices: HearID from Mimosa Acoustics and Titan from Interacoustics. Silicone molds were made of each ear canal in order to measure the ear canal's cross sectional area at the measurement location. This presentation will compare the WAI measurements across the six decades of life, the two distinct instruments, and the effects of the assumed versus measured cross sectional ear-canal area.

Podium Paper V.G.

Using AudGenDB to Describe Middle-Ear Function in Normal and Down Syndrome Pediatric Patients

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The Audiological and Genetic Database (AudGenDB) is a biomedical-computing infrastructure that collects information from multiple centers and integrates them into a

large relational database that allows users to build complex queries of data across datasets from several clinical disciplines. AudGenDB currently contains anonymized data from over 105,000 patients, including 4.4 million diagnoses, ~203,000 audiograms, ~123,000 tympanograms, speech audiometry, and other physiologic data. Large databases provide the ability to evaluate normative values with high statistical significance, and to compare these to rare populations of patients. To demonstrate the power of AudGenDB, we have evaluated middle-ear tympanometric values of normative population aged, <1-18 years and compared them to those values in patients with Down Syndrome (DS). A detailed description of the temporal changes in middle-ear normative data will be described and compared to test results in DS patients. Results indicate reduced external canal volumes, lower median static admittance values, and a broader peak pressure distribution. These data demonstrate the power of using a large biomedical database to characterize the hearing health of both normal patients and those with conditions that occur with low incidence in the population. [Supported by NIH-NIDCD R24DC012207]

Podium Paper V.H.

Effects of Middle Ear Pressure Compensation on Wideband Acoustic Immittance (WAI) and Evoked Otoacoustic Emissions in a Normal-Hearing Adult Population

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This study investigated the effect of positive and negative middle ear pressure (MEP) on distortion-product (1.5 to 8 kHz) and transient evoked (1 to 5 kHz) otoacoustic emissions (OAEs), and power absorbance (PA) in a normal-hearing young adult population (18 -34). This project evaluated the effectiveness of testing at ambient compared to a compensated pressure corresponding to participants' tympanic peak pressure. Outcome measures were analyzed considering factors of gender, ethnicity, frequency, and MEP magnitude. Testing was done at elevated MEP and natural state MEP for each participant. A single system, Titan by Interacoustics, was used to collect all measures and is the only commercially available system for assessing OAEs at peak pressure. One-hundred and four participants (67 females, 37 male) were recruited for testing. Mean absolute amplitude and noise level for OAE measures and mean PA varied across frequencies and differed between genders, ethnic groups, and test conditions (ambient versus peak). Equivalent ear canal volume, participants' ability to sustain abnormal MEP, and Titan's ability to reach target peak pressure were investigated as sources of these differences. Results of this study suggest clinical benefit for a more accurate assessment of middle ear status and cochlear integrity for patients with elevated MEP.

PODIUM SESSION VI: AUDITORY PROCESSING AND TINNITUS

Podium Paper VI.A.

High Frequency Hearing Loss in Children with Learning Disorders

David Moore, PhD; Allison Bradley, PhD; Chelsea Blankenship, AuD; Nicholette Sloat, MS; Audrey Perdew; Morgan Bamberger; Lisa Hunter, PhD, Cincinnati Children's Hospital, Cincinnati, OH

Children with listening difficulties (LiDs), but normal audiograms, are often assessed for 'auditory processing disorder'. Most of these children have at least two other learning disorders, most commonly academic, language and attention impairments. Here, we

compared ear, brainstem and psychoacoustic function between children with LiDs and matched typically developing (TD) children 6-12y.o. All children had normal audiograms (0.25-8kHz -20dBHL), but 15/45 (33%) children with LiD (3/22, 14% TD, $p<0.01$) had -1 threshold -25dBHL at 10,12.5,14 or 16kHz. Children with LiD also had higher threshold otoacoustic emissions. Of the children with LiD and high frequency hearing loss, 7/15 (47%) had ventilation tubes earlier in life. Compared with TD children, those with LiD had reduced amplitude, high frequency otoacoustic emissions. No differences were found between the groups when tested for cochlear synaptopathy using wave I auditory brainstem response amplitude, and brainstem frequency following response amplitude and phase locking as metrics. Of children who had a primary diagnosis of LiD, 34/49 (69%) also had a diagnosis of language impairment (5/58, 9% TD). Additional children who received a primary diagnosis of language impairments are currently being assessed. We conclude that extended high frequency hearing loss may play a role in childhood learning difficulties.

Podium Paper VI.B.

Testing Visual Attention Capabilities in Children with Suspected Auditory Processing Disorder

Nicholas Altieri, PhD; Gabriel Bargen, PhD; Ronald Schow, PhD, Idaho State University, Pocatello, ID

Auditory Processing Disorder (APD) is an impairment of auditory cognitive capabilities affecting school aged children and adults. Unfortunately, common screening measures for APD, such as the Multiple Auditory Processing Assessment (MAPA), only test auditory skills. Although we have normative data on MAPA auditory tasks, we do not know whether they are predictive of deficits that children may have in the visual modality, or with integrating auditory and visual information. Importantly all three skills: auditory, visual, and auditory-visual attention contribute to success in ecological settings. We developed visual tests analogous to the auditory tests used in the MAPA. This allowed us to begin determining the extent to which auditory and visual capabilities predict one another, and which auditory, visual, or auditory-visual tests best predict a childs attentional abilities. We obtained data in a group of school-aged children (ages 8-11). Participants completed the MAPA temporal domain tasks (Tap, Pitch Pattern, and Duration), then completed visual tasks designed to be similar to these MAPA subtests. They also completed a new audiovisual matching test. Moderate correlations were observed across auditory and visual tests. Finally, factor analysis results showed that Tap and Frequency tests from the MAPA load most strongly on one temporal factor.

Podium Paper VI.C.

The Listen-Say Test in Children: Phonetic Discrimination and Reproduction

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David R. Moore, PhD, Communication Sciences Research Center, Cincinnati, OH

The human ability to hear and reproduce phonetic information is important in all spoken communication. No reliable, validated and standardized tests are available to assess both these skills in children who struggle with language and learning. We report here development of an American 'Listen-Say'-test that uses monosyllabic minimal word pairs in a 3-interval, 2-alternative (XAB) adaptive level method to obtain discrimination thresholds

within ten phonetic categories in noise. The speech stimuli consists of 36 unique high frequency words familiar to children at 30 months of age balanced for vowel placement. Phonetic contrasts are chosen with respect to perceptual confusion and typical consonant production development. Speech production scores, accuracy and reaction times are obtained in a separate module by oral response and tester evaluation. Collapsed data from a longer and shorter version of the 'Listen-Say'-test in older, Swedish school children (mean age=8.6 y, SD=7.9; typically developing, TD, N=59 and with language impairment, LI, N=14) showed an overall significantly lower discriminative performance in children with LI in noise (fixed signal to noise ratio, + 5dB (Mdn=82.2%, range=54%-93%) compared to TD (Mdn=91.4%, range=56%-100%). Production scores (percent whole words correct) showed even larger differences (TD, N=26, M=91.4%, range=69%-100%; LI, N=10, M=74.8%, range=49%-93%).

Podium Paper VI.D.

Speech Recognition and Comprehension in Children with Unilateral Hearing Loss

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This study investigated the speech recognition and comprehension abilities of school-aged children with unilateral sensorineural hearing loss (UHL) under classroom-like conditions designed to assess spatial release from masking. In Experiment 1, subjects' recognition abilities were measured using HINT-C sentences in the presence of speech spectrum noise (SSN) and two-talker child babble (TTB) in co-located and spatially-separated target and masker configurations, including symmetric and asymmetric masker placement at 60 degrees left and/or right. Reception thresholds for sentences (RTS) in subjects with UHL showed considerable variability, with many thresholds being more than one standard deviation poorer than the mean of normal-hearing age-matched control subjects. As expected, RTS were poorest relative to controls when either the SSN or TTB masker was asymmetrically placed on the side of the normal-hearing ear. In Experiment 2, auditory comprehension abilities were measured using passages from the Test of Narrative Language in the symmetric masking condition at three different signal-to-noise ratio conditions, including one at each subject's individual RTS. Analyses to date suggest that children with UHL were able to exploit story context to support comprehension as long as signal-to-noise ratios were sufficient. The implications of the results of both experiments for potential intervention approaches will be discussed.

Podium Paper VI.E.

Assessment of Functional-Hearing Deficits in Active-Duty Service Members

Ken Grant, PhD; Douglas Brungart, PhD; Sandeep Phatak, PhD; Melissa Kokx-Ryan, AuD; Olga Stakhovskaya, PhD, Walter Reed National Military Medical Center, Bethesda, MD

Exposure to sub-concussive explosive blasts can give rise to hearing difficulties without causing any significant increase in audiometric thresholds. Here, we provide an update to a prevalence study of such hearing deficits in roughly 3600 active-duty Service Members with and without a history of blast exposure. Also reported are results of a follow-up study deigned to reveal potential causes of this functional-hearing deficit in two smaller groups of subjects: 1) normal-hearing thresholds - 20 dB HL from 250-8000 Hz), no blast exposure, normal performance on an abbreviated version of the speech, spatial, and qualities of hearing questionnaire (SSQ), and normal scores on prevalence screening measures; 2)

history of blast exposure, normal to near-normal hearing thresholds, and poor performance on either SSQ or prevalence screening measures. Roughly 20 auditory and visual tests of peripheral, central and cognitive processing were used to determine whether the effects of blast exposure were limited to auditory processing deficits or more generally attributed to cognitive processing deficits. Electrophysiological tests were also used to determine the integrity of neural signals propagating to higher brain centers. The long-term aim is to develop a strategy to separate hidden hearing loss from other processing deficits caused by blast exposure.

Podium Paper VI.F.

Tinnitus Management: Recommendations Based on Results of Four Controlled Studies

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Tinnitus is experienced by 10-15% of the adult population. Tinnitus services at clinics and hospitals are inconsistent and these services should be based on research evidence. At the National Center for Rehabilitative Auditory Research (NCRAR), efforts have been ongoing to develop and test various methods of tinnitus management. Four randomized controlled trials have been completed at the NCRAR since 2013, and results of these trials can help to inform tinnitus management services. Two of these trials compared the efficacy of using hearing aids versus combination instruments (hearing aid and sound generator combined) for tinnitus management. A third trial evaluated the clinical effectiveness of Progressive Tinnitus Management (PTM) when implemented at two Veterans Affairs medical centers (Memphis and West Haven). The fourth trial evaluated the adaptation of PTM as a telephone-based method to teach self-help skills remotely. Each of these trials and their findings will be discussed in brief. Principles of tinnitus management that have been derived from these trials will be described along with specific recommendations for providing clinical tinnitus services.

Podium Paper VI.G.

Is the Pitch Rating Method Used to Characterize Tinnitus Valid?

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We aimed to validate the pitch-rating method - a method commonly used to estimate the frequencies present in tinnitus (the 'tinnitus spectrum') - and its ability to provide an accurate estimate of the spectral composition of objective stimuli. We attempted to validate this method for a variety of tinnitus-like reference stimuli: pure tones, multi-component tones, and noisy stimuli. In separate conditions, 10-15 subjects listened to each reference stimulus and rated the similarity of the pitches of 11 different comparison stimuli with frequencies ranging from 500-12000 Hz, yielding a 'perceptual spectrum.' When reference stimuli were pure tones, the perceptual spectrum measurements led to accurate estimates of the frequencies present in the test stimuli at the group level but not at the individual level. For reference pure tones at 5 kHz and above, only 50-65% of the individual perceptual spectra matched the acoustic stimuli. For the complex tones and noises with multiple frequency bands, perceptual spectra did not identify the presence of multiple frequencies in reference stimuli. Consequently, we suggest that caution be used when estimating the spectral characteristics of tinnitus using this method, particularly for tinnitus resulting in spectral measurements in the regions above 5 kHz.

Podium Paper VI.H.

Measuring the Effect of Tinnitus on Attention and Memory

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Bothersome tinnitus may cause problems with sleep, concentration and/or mood, which may explain why those with bothersome tinnitus often perform more poorly on tests that require concentration and memory than those without tinnitus. One aspect of this problem that has not been evaluated is the impact that task-irrelevant background noise might have on performance in tests of attention and memory for those with bothersome tinnitus. Low-level noise-like maskers appear to provide some relief for individuals with tinnitus, and irrelevant speech-like sounds are known to interfere with memory tasks for listeners without tinnitus. However, little is known about the impact of background sounds on concentration and memory. In this study, individuals with bothersome tinnitus and age- and hearing-matched controls performed a selective attention task, where they identified the direction of an arrow while ignoring the direction of the flanking arrows, and a spatial location task where they recalled the location of letters in a 4x4 grid. These tasks were completed in three auditory conditions: 1) quiet, 2) low-level white noise, and 3) irrelevant speech signal. Preliminary results suggest those with tinnitus have longer reaction times and reduced memory span, but may be less impaired by the presence of irrelevant speech.