American Auditory Society Scientific and Technology Meeting
March 2-4, 2023

POSTER ABSTRACTS

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ANATOMY and PHYSIOLOGY

Category: Anatomy and Physiology

Poster #: 001

Mapping the Connectivity of Auditory Cortex with Diffusion MRI Tractography

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Objectives: Auditory cortex receives feedforward input from the medial geniculate nucleus of the thalamus. While it has traditionally been assumed that auditory signals from medial geniculate reach the primary auditory cortex first before being serially transmitted to secondary and associative auditory cortex, recent human electrophysiological evidence suggests a parallel pathway from auditory thalamus to posterior superior temporal gyrus. This pathway is hypothesized to quickly transmit incoming speech signals to speech-sensitive superior temporal gyrus for rapid phonetic encoding. However, to our knowledge, human studies have not verified the existence of these direct pathways to non-primary auditory cortex. In the present work, we use state-of-the-art diffusion MRI tractography approaches to investigate the connections between medial geniculate and auditory cortical subdivisions.

Design: Using high quality, high resolution publicly available diffusion MRI datasets, we ran probabilistic tractography between medial geniculate nucleus and auditory cortex. The first dataset was collected on a 3 Tesla Connectom diffusion-optimized scanner in a single participant over nine sessions at a spatial resolution of 0.76 mm isotropic with over 1200 diffusion directions. The second dataset is the 7 Tesla Human Connectome Project, collected in 184 individuals at 1.05 mm isotropic spatial resolution in 64 diffusion directions. Data were analyzed with Mrtrix3, using multi-shell, multi-tissue constrained spherical deconvolution in order to estimate voxel-wise fiber orientation distribution functions. We then conducted probabilistic tractography between medial geniculate nucleus, defined from our previous work mapping human subcortical auditory anatomy, and auditory cortex subdivisions, defined from the Human Connectome Project Multi-Modal Parcellation atlas.

Results: We find tractography evidence for distinct pathways from medial geniculate nucleus in the thalamus to primary auditory cortex and posterior superior temporal gyrus in humans.

Conclusions: Using diffusion MRI tractography, we quantified connectivity between human auditory thalamus and distinct subdivisions of auditory cortex that could potentially contribute differentially to audition and speech communication. As this analysis was conducted in state-of-the-art diffusion MRI datasets, future work will explore these connections in disorders with speech processing consequences as well as how these connections vary among individuals with diverse language and auditory experiences.

Category: Anatomy and Physiology

Poster #: 002

Systematic Changes in Ear-Canal Geometry from Infancy to Old Age

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Objectives: Ear-canal geometry influences a wide range of audiological recommendations and measurements, from how often to update the earmolds of young hearing aid users to assumptions underlying wideband acoustic immittance measurements (WAI). Despite its importance, a comprehensive description of canal geometry and its maturation does not exist. Thus, ear-canal dimensions, parameterized by age, were measured from infancy through old age from computed tomography (CT) scans.

Design: Utilizing the medical imaging software OsiriX MD V.12.01, measurements were made on 136 de-identified, high-resolution temporal bone CT scans (ages 0-90 years) using a multiplanar reconstruction methodology. The canal's termination, central axis, entrance, and first bend were identified based on objective definitions, and the canal's cross-sectional area was measured along its central axis in 1-2 mm increments. Measurements also included the area within the tympanic annulus, the area at canal's first bend, and the area at the entrance as well as the length of the canal and the location of the first bend. These areas and lengths were analyzed systematically across age cohorts. The CT scans were obtained retrospectively through UMass Chan Medical School, and both Smith College and UMass were exempted from IRB oversight.

Results: Measurements from 136 subjects were analyzed in age cohorts of 0-1, 1-2, 2-3, 4-6, 7-9, 10-13, 14-17, 18-30, 31-60, and over 61 years. In general, left and right ears from a given subject were far more similar than measurements across subjects. Both median canal length and median distance from the tympanic annulus to the first bend increased with age cohort through the 14-17 years cohort, with nominal differences in these medians between age cohorts 14-17 years and older cohorts. The tympanic annulus area appears to increase with age cohort up to the 4-6 cohort, suggesting this bony ring may grow early in life. In contrast, areas along the ear canal at most locations generally increase systematically across all age cohorts. For example, the median first-bend area changed from infancy through the oldest age cohort from 15 mm2 (0-1 years) to 17 mm2 (1-2 years) to 19 mm2 (2-3 years) to 24 mm2 (4-6 years) to 28 mm2 (7-9 years) to 35 mm2 (10-13 years) to 41 mm2 (14-17 years) to 44 mm2 (18-30 years) to 65 mm2 (31-60 years) to 63 mm2 (61 plus years). Median areas at most other canal locations, including the area at the canal entrance, tended to increase with age cohort.

Conclusions: The median ear canal generally increased in cross-sectional area and length with increasing age cohort, indicating strong correlation between age and canal geometry development. Notably, while length and area growth were most dramatic between the youngest age cohorts, increases in area did not stop at the beginning of adulthood but appear to continue into at least middle age. The novel CT multiplanar reconstruction measurements provide insight into the ear canal's geometry and its variation with age. The comprehensive analysis of the canal's dimensions can help improve future audiologic protocols and measurements.

Category: Anatomy and Physiology

Poster #: 003

Hazardous Noise Effects on Cortex Genomic and Mitochondrial DNA Integrity 30 Days Post-Exposure in the Rats

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Objectives: Noise exposure triggers many psychological brain disorders such as depression, anxiety, and emotional stress. Furthermore, noise exposure also is a risk factor for pathological brain disorders such as cognitive decline, dementia, and Alzheimer's disease. Noise-induced sensorineural damage contributes to these disorders and may be the result of noise-triggered DNA damage accumulation. Indeed, previous studies have observed DNA damage accumulated in the brain even days after acute noise exposure and were repaired after a month. However, this study has only investigated one specific type of DNA nucleotide modification. Many studies have shown that noise exposure could potentially induce other DNA damage types such as double-strand breaks. Likewise, mitochondrial DNA also shows a high susceptibility to noise exposure. Whether or not those DNA damages could be fully repaired long after noise exposure is unknown. This is highly relevant

because the level of DNA damage can be an indicator of overall brain health and any remaining DNA damage could be a threat to the brain and its normal function. Therefore, this study was designed to investigate the DNA integrity in the brain at 30-days after acute noise exposure compared to a control

Design: Long Evans Rats have been randomly grouped into the noise (N=6) or control (N=6) group. The noise group rats were exposed to a 3-hour, 105dB SPLpeak, broadband white noise (12.5 Hz - 20 kHz) while the control group rats were sham-exposed. This noise regiment was hazardous to the auditory pathway proven by both DPOAE and ABR tests. 30 days after noise or sham exposure, the cortex was collected. Cortex DNAs were extracted and used as templates for Long-PCR-based DNA damage analysis. This PCR-based assay is based on the principle that DNA templates with DNA damage stall polymerase and generate fewer amplicons when compared to the amplicons from DNA templates without DNA damage.

Results: We have found that genomic DNA extracted from noise-exposed cortex generated a smaller amount of long-DNA amplicons relative to that from the control cortex, while the short-DNA amplicons (internal control) were relatively similar between the two treatment groups. Meanwhile, the differences were also observed for the mitochondrial DNA.

Conclusions: These results indicate that noise exposure triggers both genomic and mitochondrial DNA damage in the brain and that DNA damage persists even 30 days after noise exposure. This information suggests that the remaining DNA damage could be a potential contributor to noise-induced brain disorders. To improve brain health in noisy environments, future studies on treatments should focus on both preventing DNA damage accumulation and improving DNA damage repair. DNA integrity could be a useful biomarker for evaluating pharmacological treatments.

COCHLEAR IMPLANTS

Category: Cochlear Implants

Poster #: 004

Utility of Pitch Ranking in Cochlear Implant Mapping

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Objectives: Cochlear implant (CI) recipients vary widely in speech recognition outcomes. One source of this variability could be poor spectral resolution due to an inability to discriminate pitch differences between stimulation from adjacent electrode contacts. Inclusion of a pitch ranking procedure when mapping CI users may identify pitch confusions or non-discriminations between electrode contacts. The present report evaluated the incidence of pitch confusions and non-discrimination in CI users, and whether modifying the mapping of the CI to eliminate pitch confusions resulted in improved sound quality and/or speech recognition with the CI.

Design: Adult CI users completed a pitch ranking procedure at either 3- or 6-months post-activation. The pitch ranking procedure was a two-alternative forced-choice task. Participants were randomly presented with stimulation from two electrode contacts sequentially and asked to indicate which one was higher in pitch. A minimum of 7 trials were completed for each contact pair comparison to determine whether stimulation from

the electrode contacts followed cochlear tonotopicity, were reversed, or were non-discriminable. For cases of pitch reversals or non-discrimination, the filter frequencies were adjusted or electrode contacts were deactivated in attempt to improve the sound quality. Speech recognition was evaluated with CNC words in quiet. The contralateral ear was masked, when warranted.

Results: Of the 51 participants at the time of data review, 12 demonstrated pitch reversals or non-discrimination between adjacent electrode contacts. The location of the specific electrode contacts was not consistent across participants, with 7 demonstrating pitch reversals or non-discrimination for contacts in the mid-frequency region and 5 for contacts in the high-frequency region. Better sound quality was reported and demonstrated for some cases after mapping adjustments were made to improve the spectral resolution.

Conclusions: Pitch reversals or non-discrimination between adjacent electrode contacts was observed in approximately 25% of CI users. Including the pitch ranking procedure in the mapping of CI devices can identify pitch reversals or non-discrimination between adjacent electrode contacts that may negatively influence outcomes with the device.

Category: Cochlear Implants

Poster #: 005

Influence of Frequency-to-Place Mismatches on Binaural Hearing

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Objectives: Binaural hearing abilities of cochlear implant (CI) and electric-acoustic stimulation (EAS) users with unilateral hearing loss (UHL) may be influenced by electric frequency-to-place mismatches. Electric mismatches are the discrepancies between the filter frequencies and the cochlear place frequencies for individual electrode contacts. Electric mismatches can create discrepancies in the auditory cues presented in combination with the contralateral ear, known as interaural mismatches, which can negatively influence binaural hearing abilities. This preliminary review assessed the binaural hearing abilities of CI and EAS users with UHL during the first year of device use.

Design: Masked speech recognition was reviewed for 29 adult CI and EAS users with normal to near-normal hearing (NH) in the contralateral ear. Performance was assessed with AzBio sentences in a 10-talker masker presented at 0 dB SNR in two target-to-masker configurations: 1) target and masker co-located from the front (0¬∫ azimuth) and 2) target from the front and masker presented 90¬∫ towards the NH-ear.

Results: The influence of electric mismatch was more pronounced at the later intervals, with a distinct benefit of target/masker separation for participants with less electric mismatch at the 12-month interval.

Conclusions: Preliminary data suggest that electric frequency-to-place mismatches may significantly influence the binaural hearing abilities for CI and EAS users with UHL. CI and EAS users may experience a greater spatial release from masking when electric mismatches are minimal. These data suggest the utility of methods to minimize or eliminate electric mismatches, including implantation of a long electrode array and/or use of a place-based mapping procedure in the assignment of the filter frequencies, to support long-term binaural hearing abilities.

Category: Cochlear Implants

Poster #: 006

Sequential Learning in Children with CIs and Typically Hearing Peers

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Objectives: Sequential learning is a statistical learning mechanism that supports rule-based learning (e.g., grammatical development). Children with cochlear implants (CIs) have demonstrated sequential learning deficits in experimental tasks; however, findings have been mixed due to the heterogeneity of task demands across sequential learning paradigms. The serial reaction time (SRT) task is a paradigm used to study implicit sequential learning in visual, nonverbal contexts. Past work has demonstrated that children with CIs show learning through a reduction in reaction time to implicit, repeated sequences relative to random sequences; however, these children also show longer reaction times to all stimuli relative to typically hearing peers. Performance by children with typical hearing suggests that SRT stimuli can be labelled (i.e., verbally mediated), and that degree of verbal mediation moderates learning of implicitly presented sequences. Furthermore, children with larger vocabularies showed weaker implicit learning for visual stimuli that could be easily labelled, suggesting that use of higher-level, language-dependent strategies hinders implicit learning. The current investigation utilizes SRT sequences with high and low degrees of verbal mediation to 1) compare implicit sequence learning by children with cochlear implants and typically hearing peers, 2) determine if language skills (i.e., vocabulary size, rapid automatic naming skills) affect underlying implicit sequential mechanisms across groups, and 3) to evaluate explicit recall of implicitly learned verbally and nonverbally mediated sequences. We hypothesize that, relative to typically hearing peers, children with cochlear implants will show 1) overall longer reaction times but comparable implicit learning on a traditional nonverbal SRT, 2) poorer vocabulary skills, therefore better implicit learning on a verbally mediated SRT, and 3) no differences in explicit recall of implicit SRT sequences.

Design: Seven- to fifteen-year-old children with cochlear implants and aged-matched typically hearing peers will be recruited; currently, nineteen children with CIs and nineteen typically hearing children have completed testing. Participants complete a baseline motor task using the SRT button apparatus, visual nonverbal and verbally mediated SRT tasks, visuospatial memory span tasks using sequences of stimuli from both SRT tasks, and a questionnaire addressing verbal strategy use during sequential learning tasks. Participants complete each memory span task immediately following each SRT task; presentation order of SRT tasks is counterbalanced across participants. Participants additionally complete standardized measures of nonverbal intelligence (WASI-II Matrix Reasoning), expressive vocabulary (EVT-2), visuospatial short-term memory (CABC Location Span), and rapid automatic naming (CTOPP-2 rapid naming tasks); general executive function is assessed via parent report (BRIEF).

Results: Data collection and analyses are in progress and will be completed by January 2023. Preliminary analyses indicate that children with CIs and typically hearing peers demonstrate comparable reaction time on verbal and nonverbal SRT tasks. Both groups demonstrate implicit learning of nonverbal but not verbal sequences.

Conclusions: If language skills robustly moderate performance on a verbally mediated SRT task, findings suggest that general statistical learning mechanisms and higher-order, language-dependent mechanisms operate in competition. Such findings support normalizing task demands within learning paradigms to account for language-dependent confounds (e.g., verbal mediation), especially as language-dependent learning mechanisms may be underdeveloped in children with hearing loss.

Category: Cochlear Implants

Poster #: 007 **Mentored Student Research Poster Award**

Music Re-Engineering Impacts Music Enjoyment Among Single-Sided Deafness Cochlear Implantees

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Objectives: Previous work has demonstrated potential benefits of music re-engineering for improving music appreciation in cochlear implant (CI) users, which is known to be diminished compared to normal-hearing (NH) users. However, music appreciation in the single-sided deafness (SSD) population is not well-studied. Our objective was to investigate music appreciation in SSD cochlear implantees using music re-engineering software. We hypothesized that patient-directed music re-engineering may enhance music enjoyment in SSD CI users.

Design: A multidisciplinary team of neurotologists, audiologists, sound engineers, and web designers collaborated to create a novel music-re-engineering application. Adult SSD CI listeners were recruited from community and tertiary medical center settings. Participants rated excerpts from 5 major genres of music (country, pop, rock, rap, classical) on music enjoyment measures (pleasantness, musicality, naturalness) using a visual analog scale (scale of 1-10; 10=maximal enjoyment, 1=no enjoyment). Participants were asked to re-

engineer excerpts by adjusting treble, bass, percussion, and reverberation, and again rated their enjoyment. Each participant completed the study under the following audio input conditions: 1) direct streaming into the CI, 2) external speaker with CI on (i.e., hearing through the CI and contralateral NH ear), 3) external speaker with CI off (i.e., hearing only through the NH ear). Hearing and demographic data were collected. Descriptive statistics were calculated and paired t-tests were performed to compare outcomes in all three conditions.

Results: Fourteen SSD CI users completed the study. Mean (SD) age was 42.07 (11.25) years. Average (SD) CI usage was 1.50 (1.03) years. Mean (SD) post-surgical CI pure tone average (PTA) was 35.56 (5.90) dB (with the CI on) and NH ear PTA was 10.42 (5.93) dB. Four individuals had residual hearing (mean PTA [SD] 68.3 [13.09] dB). 85% reported an interest in mixing music of their choosing. Mean (SD) music enjoyment rating (averaged across pleasantness, musicality, naturalness) in the 3 listening conditions were as follows: direct CI input pre-mixed 4.04 (1.75), post-mixed 5.66 (2.10); external speaker/CI pre-mixed 9.32 (0.97), post-mixed 9.46 (0.66); external speaker/CI off pre-mixed 9.64 (0.69), post-mixed 9.8 (0.40). The direct CI input condition demonstrated significantly lower pre- and post-mixed music enjoyment ratings compared to the other 2 conditions. Post-mixed excerpts were rated significantly higher than original pre-mixed excerpts across all measures of enjoyment in the direct-CI input condition, and higher in the ratings of pleasantness and naturalness in the external speaker/CI-on condition.In a subgroup analysis comparing individuals with and without post-implant residual hearing, there was no significant difference in pre-mixed music enjoyment in the external speaker/CI-on condition. Individuals with residual hearing showed a greater increase in post-mixed ratings of musicality compared to the non-residual hearing individuals (10 vs. 9.8, $p<0.01$); however, there was no significant difference in post-mixed music enjoyment ratings of pleasantness and naturalness.

Conclusions: User-directed music re-engineering enhances music enjoyment for SSD CI listeners when the audio is streamed directly into the device and when played through external speakers. CI users with residual hearing in their implanted ear may show some benefit in music enjoyment compared to CI users without residual hearing.

Category: Cochlear Implants

Poster #: 008

Singing to Understand Pitch Representation Through a Cochlear Implant

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Objectives: Music is poorly delivered through a cochlear implant. Although much is known about the distortion of an auditory signal through a cochlear implant, it is unclear exactly which attributes of signal distortion are most relevant to perceived pitch. Numerous reports describe pitch representation and sound quality as being poor. Distortions to temporal coding, poor spectral representation, distortions to tonotopic representation, neural degeneration, auditory plasticity, and memory of how a note and instrument sounded with a normal hearing ear make it extremely difficult to determine how notes are perceived through an implant. Musicians with a cochlear implant and a contralateral normal-hearing ear (single-sided deafened musicians) provide a unique opportunity to study the representation of notes through an implant.

Design: Single notes from a synthesized instrument are played directly into a cochlear implant processor of single-sided deafened musicians. The musician is tasked with singing or vocally imitating the note heard. In this design, the stimulus note is only heard by the implanted ear, but auditory feedback from vocalizations is only heard through the normal-hearing ear. All stimuli and auditory responses are recorded, and fundamental frequencies are extracted.Many variables are manipulated. These include note played, instrument played, number of notes played at a given time (e.g., single notes or chords), and frequency allocation of the cochlear implant. The task is repeated when the subject plays the notes themselves (i.e., with a piano keyboard) providing visual and muscle memory cues to the sound and when the listener is blinded to the note presented. Additional data will be collected in response to single electrode stimulation at varying electrodes and stimulation rates. Control data is collected using stimulus presentation to only the normal-hearing ear.

Results: Preliminary analysis of the extensive data collected with our first subject provide many interesting insights. Singing what she hears was very difficult as the sounds did not have easily matched pitches. However, imitating the sounds was considered an easier task. The subject self-reports that their imitations are fairly accurate and describes her own vocalized imitations as a "Yoko Ono concert". The fundamental frequency of these vocalizations strongly correlates with the fundamental frequency of the stimuli for notes up to approximately E4 (330 Hz). Notes above E4 are imitated with fundamental frequencies at approximately 330 Hz. Changes in frequency allocation have had minimal effects of vocal imitations. These results are consistent with pitch being delivered through temporal modulations in the signal. The effect of spectral shape of the signal seems to have relatively little impact on perceived pitch through the implant. An additional observation is that the perceived fundamental frequency of a chord is significantly lower than the perceived fundamental frequency for any of the component notes in the chord. It is predicted that this is caused by temporal beating within channels caused by the multiple notes.

Conclusions: Preliminary data suggest that sound quality through an implant is poor, and pitch is primarily encoded by temporal modulations. Spectral shape appears to have limited effect. Temporal beating of multiple notes may be highly problematic with current signal processing techniques. These results are important for understanding how to redesign cochlear implant signal processing strategies for music and pitch representation.

Category: Cochlear Implants

Poster #: 009

The Impact of Prior Noise Exposure on Cochlear Implantation: A Double-Insult Preclinical Model

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Objectives: Surgical trauma in cochlear implant (CI) patients leads to residual hearing loss and this can in turn result in poor CI outcomes. The damage to the neurosensory structures and potentially the outcomes can be further negatively impacted from accumulated hazardous noise exposure over time. Chronic, hazardous acoustic overexposure causes irreversible mechanical and structural damage to the inner ear and is associated with severe-to-profound sensorineural hearing loss (SNHL). Veterans and protective services members, such as firefighters, are at an increased risk of SNHL due to occupational noise exposure. Our goal was to establish a novel preclinical model to characterize the effects of prior hazardous noise exposure combined with a subsequent CI mechanical and surgical trauma. We further aim to characterize the mechanisms and patterns of residual hearing loss post-CI in this double-insult model.

Design: The University of Miami Institutional Animal Care and Use Committee approved all procedures. Brown Norway rats were exposed to broadband (4-16 kHz) noise at 110 dB for 1 hour to induce SNHL. The noise was characterized from our prior study aimed to determining the appropriate dose to product measurable SNHL. CI was performed 1 or 3-months post-noise exposure with auditory brain stem responses (ABR) pre and post-noise exposure and subsequent to CI trauma at different time points (up to 84 days post CI) were compared. We characterized the changes in residual hearing and compared it with CI only controls (n = 5 each). The contralateral non implanted ears provided controls for a paired comparison. At 84 days post-CI, cochleae were harvested for histological studies.

Results: Functional measurements showed a permanent threshold shift (PTS) post-noise trauma in both noise groups mimicking SNHL in patients. Additionally, significant shifts in ABR threshold were observed in both low and high noise damage groups with CI compared to the CI only group. As expected, immunohistology revealed significant damage in the basal to middle sections of the cochleae in all the groups receiving CI. Additional outer hair cell (OHC) loss was observed at apical regions for both noise-exposed groups.

Conclusions: Our results highlight patterns of sensorineural damage with prior noise exposures that could explain poor CI outcomes in patient populations with extensive noise history. With this double-insult model, we were able to localize the permanent damage within specific cochlear regions, and characterize patterns of hearing loss post-implantation. The model further enables considerations for neurotherapeutic techniques, including mild therapeutic hypothermia post-CI which broadly counteracts inflammation, apoptosis and cell death mechanisms within the inner ear. Supported by NIH R01DC01379801A1 and 1I01RX003532-01A2.

Category: Cochlear Implants

Poster #: 010 **T35 Research Trainee Poster**

Investigating Reliable Objective Measures of Bimodal Benefit

Sarah Dale Medina, BA; René Gifford, PhD, Vanderbilt University, Nashville, TN

Objectives: The benefits of bimodal hearing compared to unilateral CI-alone performance are well documented for speech perception in quiet and in noise; however, bimodal benefit is highly variable and not reliably related to audiometric thresholds in the non-implanted ear. Our primary aim was to replicate past studies of behavioral bimodal bandwidth effects in an ecologically valid paradigm. That is, we aimed to define the degree of bimodal benefit provided by a commercial hearing aid (HA) equipped with a bimodal fitting approach for frequency limiting in various low-pass filtered conditions. Our hypotheses were that adult bimodal listeners would 1) demonstrate significant bimodal benefit for low-pass filtered speech with a cut-off frequency of 250 Hz, and 2) exhibit additional benefit with increasing acoustic bandwidth up to 1000Hz. Our secondary, exploratory aim was to evaluate the effects of low-pass filtered speech at the varying low-frequency cutoffs on cortical activity via functional near infrared spectroscopy (fNIRS),ÄØin auditory and auditory association areas.

Design: A prospective study was completed with 5 adult cochlear implant users (planned N=15) with aidable thresholds in the non-implanted ear. Unaided pure-tone audiometry for the non-implanted ear and the threshold equalizing noise (TEN) test for cochlear dead regions were completed. Speech perception was assessed in the CI-alone and bimodal conditions for CNC monosyllabic word recognition in quiet and in multitalker babble at +10 dB signal-to-noise ratio (SNR). Four bimodal conditions were created using the participants' CI processors

with either an Oticon MORE 1 miniRITE or Xceed BTE in the non-implanted ear. HAs were fit using the bimodal,ÄØprogramming option in the software to achieve low-pass cutoffs at 250, 500, 750, and 1000Hz. For all conditions, HA settings were verified to match NAL-NL2 targets. Unprocessed speech stimuli were presented in sound field at 65 dB SPL for quiet and 70 dB SPL for noise. fNIRS cortical activation data were obtained in response to AzBio sentences presented in the sound field at 65 dB SPL and listeners completed an active closed-set word identification task via numerical keypad.

Results: Behavioral preliminary analyses revealed no effect of HA low-pass cutoff. However, the data are consistent with bimodal benefit compared to CI-alone scores for both quiet and noise and increasing bimodal benefit with HA low-frequency cutoff for speech perception in quiet. Participants with confirmed cochlear dead regions showed no further bimodal benefit with HA low-frequency cutoffs exceeding the dead region frequency. Aided speech intelligibility index (SII) data revealed a statistically significant effect of HA low-pass cutoff frequency confirming HA audibility did increase with cutoff frequency. fNIRS analysis is forthcoming and will be presented for our preliminary dataset.

Conclusions: Despite well-known benefits associated with bimodal hearing, bimodal benefit may not consistently increase with HA acoustic bandwidth compared to conditions with steeply sloping low-frequency filters used in laboratory-based experiments. Rather, additional individual factors likely impacting the naturalistic bimodal experience include hearing loss severity and configuration in the non-implanted ear, the presence of cochlear dead regions, and the resultant aided SII will limit our ability to quantify a frequency-specific HA bandwidth effect.

Category: Cochlear Implants

Poster #: 011 **Mentored Student Research Poster Award**

Concurrent Recording of eCAP and eABR in Cochlear Implant Users

Jenna Van Bosch, BS; Stacey Kane, AuD; Margaret Dillon, AuD, PhD; Matthew Dedmon, MD, PhD; John Grose, PhD, University of North Carolina at Chapel Hill, Chapel Hill, NC

Objectives: The acoustically evoked auditory brainstem response (ABR) is a commonly used diagnostic measure for objectively evaluating the status of the auditory pathway. The ABR consists of five distinct peaks, waves I through V (WI-WV), which reflect synchronous neural activity from the 8th cranial nerve through the upper brainstem. WI also corresponds to the compound action potential (CAP) in electrocochleography. In acoustic hearing, a metric of interest is the amplitude ratio between WI and WV. This ratio cannot be extracted from the electrically-evoked ABR (eABR) in cochlear implant (CI) users because stimulus artifact obscures eWI. However, the electrically-evoked CAP (eCAP), corresponding to eWI, can be measured as a separate test. The purpose of this feasibility project is to determine if the eCAP and eABR can be measured in a single test, allowing for an efficient extraction of the eWI - eWV amplitude ratio.

Design: Participants were seven MED-EL CI users ranging in age from 25 to 71 years. All completed loudness scaling on three electrode pairs (basal, mid, apical) using stimuli from the proprietary MAESTRO Auditory Nerve Response Telemetry (ART) test. The ART test uses a paired-pulse stimulation sequence to generate an artifact-free eCAP, and also features a logic trigger pulse coincident with each pulse sequence. This trigger was used to synchronize an Intelligent Hearing Systems ABR unit. In this configuration, the ART test was used to measure the eCAP and, simultaneously, the eABR evoked by a single fixed-polarity pulse within the paired-

pulse sequence. For comparison, the eABR was also collected at the same fixed loudness and a comparable stimulation rate using the proprietary eABR test within the MAESTRO software.

Results: Robust eABRs were elicited using a single fixed-polarity pulse within the ART paired-pulse sequence. The morphology of this eABR compared favorably to the eABR elicited using the dedicated MAESTRO eABR test. The eCAP amplitude measured with ART varied markedly across participants and showed some association with the stimulation current level. The eWV amplitude varied less markedly across individuals. The large across-subject variability in eCAP amplitude relative to eWV amplitude undermines the reliability of this ratio.

Conclusions: It is feasible to concurrently measure the eCAP and eABR in adult, MED-EL cochlear implant users using a single test procedure. The eABR measured in this concurrent test compared well with the eABR measured in the dedicated MAESTRO test. This is note-worthy because the eABR elicited in the combined test was constrained to fixed-polarity stimulation pulses whereas the MAESTRO eABR test uses alternating polarity. Challenges remain in deriving a simple metric analogous to the WI /WV in acoustic ABRs due to the variability in eCAP amplitude across participants.

Category: Cochlear Implants

Poster #: 012

Novel Musical Consonance-Dissonance Task in Normal Hearing and CI Users

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Objectives: Musical consonance and dissonance, are aspects that contribute to overall sound quality and pleasantness. Music-based listening tasks can be a useful metric to assess the impact of programming parameter changes for hearing aids and cochlear implants (CI). We created a novel music test that assesses harmonic consonance-dissonance and overall music sound quality perception, and we administered the task to normal hearing (NH) listeners and CI recipients. We hypothesized that there would be a monotonic relationship between harmonic consonance and pleasantness ratings within the NH cohort, and that performance of CI users would show a similar pattern at the group level, but there would be significant interpersonal variability. Secondarily, we hypothesized that listeners with more music training would perform better at this task by showing more contrastive ratings across the for tiers of consonance-dissonance.

Design: NH subjects (n=20) and CI recipients (n=12, study recruitment still open), with a wide range of musical training backgrounds, were asked to complete a music listening task lasting about 30 minutes. The task consisted of listening to 40 synthetic piano music samples and rating the "pleasantness" of each music sample on a 5-point unipolar Likert scale. Ten distinct melodies were generated and each melody was paired with 4 possible versions of accompanying chord structure, creating increasing levels of harmonic dissonance, and resulting in a corpus of 40 music samples.

Results: Within the NH cohort, listeners rated the most consonant clips as most pleasant and the most dissonant clips as least pleasant, as expected, with significant differences between each tier of harmonic consonance-dissonance. Preliminary results from the CI recipients show that at the group level the subjects perceive a

difference between the most consonant and the most dissonant tiers, but that the intermediary tiers are not remarkably different. There is a trend in the NH cohort that subjects with more musical training are more sensitive to any element of dissonance (shown by steeper slopes of the psychometric functions), as compared to those with less musical training.

Conclusions: Normal hearing and cochlear implant users' responses were collected on a novel music listening task assessing harmonic consonance-dissonance. This task evaluates two aspects of music perception: 1) overall pleasantness of piano music samples, and 2) the sensitivity of a listener to harmonic dissonance within music samples. The NH cohort responded, as anticipated, with a monotonic relationship between reported pleasantness and the tier of consonance-dissonance contained in the music samples. The CI cohort showed more variability in responses, both in overall pleasantness ratings and in sensitivity to dissonance. This task may be useful for studying fitting parameters of hearing devices that may impact music perception.

Category: Cochlear Implants

Poster #: 013

Understanding the Aided Soundfield Audiogram in Cochlear Implant Patients

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Objectives: In hearing aid users, aided soundfield audiograms may differ from one patient to the next depending on their unaided thresholds and the amplification formula that is used. In contrast, all cochlear implant users who use a given device with a given sensitivity setting are expected to have the same aided soundfield audiogram- as long as the electrical thresholds programmed in their speech processor have been measured correctly and have not changed since programming. Furthermore, speech perception measures are not expected to relate to aided audiometric thresholds.

Design: We collected and tabulated aided audiograms from the adult cochlear implant patient population at the NYU Cochlear Implant Center. Those with device failures were excluded from our data set. As of this writing, we have processed over 120 audiograms from 36 patients, and we intend to include data from over 100 patients when presenting this research. Individual aided thresholds were considered, as well as the average aided thresholds across all frequencies.

Results: With the exception of a small number of clear outliers, average aided audiometric thresholds were between 20 and 35 dB HL for all cochlear implant users. Notably, for "outlier" patients who returned for a follow-up programming appointment, cochlear implant aided thresholds returned to the 20-35 dB range. Additionally, exploratory analyses showed that any correlation between speech perception scores and cochlear implant aided thresholds were driven by the outliers.

Conclusions: When electrical thresholds are accurately measured, the cochlear implant fitting software invariably results in a flat aided audiogram in the normal to mild hearing range. Exact values of these aided thresholds depend on the T-SPL and sensitivity settings of the speech processor. Aside from cases of device failure, acoustic aided thresholds higher than 35 dB indicate that the electrical thresholds have changed over time or were incorrect to begin with. Elevated frequency-specific aided thresholds should be addressed with electric threshold programming adjustments targeted at the electrode(s) in question.

DIAGNOSTIC AUDIOLOGY / OTOLOGY

Category: Diagnostic Audiology / Otology

Poster #: 014

A Diagnostic Battery for Unexplained Self-Reported Hearing Loss

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Objectives: Despite a diagnosis of normal hearing, many people experience hearing disability in their everyday lives. This study compared the standard diagnostic battery and an experimental supplemental battery in their ability to explain variance in self-reported hearing disability and handicap and predict whether a person will report a significant disability.

Design: Adults with clinically normal or mild hearing loss thresholds were asked to complete the 12-item version of the Speech, Spatial, and Qualities of Hearing Scale and the Hearing Handicap Inventory for Adults as measures of self-reported hearing disability and handicap, respectively. Participants completed the standard diagnostic battery, including audiometric thresholds, a word recognition task, and sentences-in-noise task; and an experimental supplemental diagnostic battery including extended high frequency thresholds, a survey of listening effort that accompanied the sentence-in-noise task, auditory and non-auditory tests of working memory and attention, and the Meaning of Life survey (quantifies overall satisfaction with life). The variance explained by the standard and experimental battery were compared, and a model was built to predict the hearing disability and handicap reported by individual participants. Furthermore, the benefit of adding the experimental supplemental battery to the standard battery was compared to the cost of the added time it takes to complete the experimental supplemental battery.

Results: The model of the standard battery, that included pure-tone average, word recognition score, and sentence-in-noise score, did not explain any variance in self-reported hearing disability, hearing handicap, or specific speech-in-noise disability. The model of experimental battery included more covariates than the standard battery model; therefore, the initial experimental model underwent backward elimination to remove insignificant predictors. The final model included history of noise exposure, presence of tinnitus, the Meaning of Life Questionnaire score, and effort required to perform the sentence-in-noise task, and explained 35% of the variance in hearing disability and 20% of the variance in hearing handicap. Tests of working memory and extended high frequency thresholds were removed from the final model. Added to the standard diagnostic assessment, the time required to implement the significant predictors of hearing disability and handicap was a total of 5 minutes plus 5 minutes to administer the Speech, Spatial, and Qualities of Hearing Scale and the Hearing Handicap Inventory for Adults.

Conclusions: The standard diagnostic battery cannot explain self-reported hearing difficulty in people with normal-mild audiometric thresholds. A 10-minute addition to the standard diagnostic battery might help audiologists understand some of the deficits underlying complaints of hearing loss in people with a diagnosis of normal hearing and guide appropriate treatment and referral plans.

Category: Diagnostic Audiology / Otology

Poster #: 015

Accuracy of Audiometric Indicators of Hearing Trouble in Young Adults

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Objectives: There is a long history of using audiometric criteria to identify people likely to experience hearing trouble in daily life. Audiometric criteria have different probabilities of positive results indicating hearing trouble (positive predictive value, PPV) and negative results indicating no hearing trouble (negative predictive value, NPV). The current study characterizes various audiometric criteria in predicting self-reported hearing trouble in young adults.

Design: Cross-sectional, nationally representative data from the National Health and Nutrition Examination Survey (NHANES 1999-2006, 2011-2012, and 2015-2016 cycles) for adults aged 20-39 years (n=5694) were used in the current study. Audiometric thresholds were used to calculate various audiometric indicators, including any threshold greater than 15 or 25, bilateral pure tone average (.5, 1, 2, 4 kHz) greater than 25 or 40, and those previously or currently used or recommended for use by the World Health Organization, American Medical Association, United States Veterans Administration, United States Army, and the National Institute for Occupational Safety and Health. We report sensitivity, specificity, PPV and NPV for each audiometric indicator in predicting self-reported hearing trouble.

Results: Population prevalence of self-reported hearing trouble for 20-39-year-olds was 13%. Indicators range from highly sensitive (e.g., any audiometric threshold worse than 15 dB HL) to highly specific (e.g., bilateral pure tone average thresholds worse than 40 dB). The audiometric indicators examined in this study varied in their ability to predict self-reported hearing trouble. A criterion of any threshold greater than 15 dB HL yielded positive predictive values close to naïve declaration that everyone has excess hearing trouble (15% vs 13%, respectively). Audiometric criteria used or recommended for use by the World Health Organization, American Medical Association, and National Institute for Occupational Safety and Health resulted in positive predictive values greater than 50% (i.e., leading to an outcome that is more likely than not correct). Audiometric criteria accounting for both ears (e.g., bilateral pure tone average (.5, 1, 2, 4) resulted in the most accurate prediction of hearing trouble (63 to 68% positive predictive value).

Conclusions: Some audiometric indicators of hearing trouble (e.g., any threshold poorer than 15 dB) are inaccurate to the point of providing little or no justification for testing. The preponderance of people identified using these criteria do not report hearing trouble, so these criteria do not provide a reasonable basis for decision-making. Audiometric indicators relying on averages have greater predictive ability and may be suitable for use in many applications, including occupational settings.

Category: Diagnostic Audiology / Otology

Poster #: 016 **Mentored Student Research Poster Award**

Auditory Implications of Sound Exposure in Musicians

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Objectives: Musicians are exposed to greater than typical sound levels for longer than typical durations. Unsurprisingly, there is a larger incidence of hearing loss and tinnitus among musicians relative to the general population. Musician auditory system may thus serve to investigate potential early damage to the auditory system related to sound exposure, despite normal audiograms. Conventional tests aimed at detecting such hidden hearing loss (HHL), based on investigating the afferent neural pathway, have so far produced inconclusive results. This is in part because (1) subtle peripheral loss at the periphery is likely compensated by mechanisms that control central gain, producing normal/near-normal estimates of auditory function, and (2) sound exposure is typically estimated only through questionnaires, which can be limited by individual recall ability. When damage in the system reveals itself as tinnitus (increased central gain), the middle ear muscle reflex (MEMR) has emerged as a reliable marker in humans and animals. Conversely, the medial olivocochlear reflex (MOCR) has been shown to be hyperactive following peripheral loss in animals. We used an innovative click-based test of efferents to examine the effects of noise exposure on the MEMR and the MOCR. We hypothesized that elevated MEMR thresholds and a hyperactive MOCR will indicate a history of extensive noise exposure. The goal of this study is to develop a composite metric indicative of early damage despite clinically normal hearing.

Design: We evaluated cochlear, MOCR, and MEMR functioning in 40 musicians and 45 non-musicians (18-35 yrs) with clinically normal hearing. Questionnaires of noise exposure history and noise dosimetry were used to determine lifetime noise exposure and daily noise dose, respectively. Click-evoked otoacoustic emissions (CEOAEs) and the MOCR were concurrently measured with the MEMR activation being monitored using clicks (rate=62.5 Hz; 80-95 dB peak-to-peak SPL in 5 dB steps). We also evaluated stimulus-frequency OAEs and hearing thresholds at audiometric and extended-high frequencies (0.5-20 kHz). Additionally, we measured broad bandwidth auditory brainstem response (ABR) with clicks (bandwidth=0.8-16 kHz; rate=11.1 Hz) and speech intelligibility using the coordinate response measure sentences in speech-shaped noise (-16 to 0 dB SNR).

Results: Preliminary results demonstrate group separation in three metrics: the MOCR, the MEMR, and dosimetry. No other conventional tests show any group separation in general consensus with the literature and consistent with our prediction. Musicians demonstrated significantly larger daily noise dose relative to non-musicians. Although no group differences in CEOAE level were observed, only about half of the musicians show measurable MOCR while >80% of non-musicians demonstrated MOCR activation. Finally, the MEMR, as measured using ear canal click reflectance show considerable group separation albeit in the direction opposite to that expected. Further analysis is ongoing, and we plan to apply machine learning approaches to reduce data dimension and obtain a composite measure of hearing function using the tests that optimally separate the two groups based on sound exposure.

Conclusions: Our data indicate musicians are at risk of noise-induced damage and contrary to conventional afferent measures, tests of the efferent pathway appear to perform better in separating noise-exposed vs. non-noise-exposed individuals.

Category: Diagnostic Audiology / Otology

Poster #: 017

Withdrawn

Category: Diagnostic Audiology / Otology

Poster #: 018

Uncovering Hidden Noise Induced Cochlear Neuropathy

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Objectives: Noise exposure may yield cochlear neuropathy in the absence of hearing loss. Therefore, current electrophysiologic approaches to uncover such deficits have deployed amplitude-intensity functions, latency-intensity functions, and summating potential-action potential ratios. However, these approaches have not demonstrated enough consistency to be reliable. In the current experiment we created a normal hearing threshold noise induced neuropathy model. We hypothesize that the morphology of wave-I from auditory brainstem recordings would be a sensitive measure of noise induced neuropathy.

Design: The peripheral auditory nervous system of Long-Evans rats was used as a model system. The animals were randomized into two groups (N = 5 per group); noise, and control. To quantify waveform morphology a bi-partition slope vector approach was employed at equal stimulus sensation and equal stimulus intensity.

Results: The results revealed that unlike absolute amplitude and latency measures, the quantification of waveform morphology effectively and consistently differentiated normal from noise induced neuropathy.

Conclusions: The combined results suggest that waveform morphology may be used to uncover hidden noise induced cochlear neuropathies.

Category: Diagnostic Audiology / Otology

Poster #: 019

Stimulus Presentation Rate Uncovers a Hidden Ototoxic Effect of Jet Fuel and Noise

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Objectives: To test the hypothesis that change in auditory stimulus presentation rate will uncover hidden ototoxic effects of combined exposure to legally safe jet fuel and non-damaging background noise.

Design: The auditory brainstem of young adult rats was used as a model system. The animals were randomized into the following experimental groups (N = 5 per group): Fuel+Noise, fuel-only, noise-only and control. Auditory brainstem responses were evaluated at click rates that ranged from 10 to 100/sec.

Results: The results revealed that neither low nor high click rates (presented in isolation) could identify statistically significant differences between the experimental exposures. However, a change in click rate from 10 to 100 within the same recordings uncovered ($p < 0.05$) the presence of a hidden ototoxic effect among the Fuel+Noise exposed group. This effect manifested as a failure of wave-I amplitude to change as the stimulus rate changed. Interestingly, the effect was not detected by wave-I amplitude-intensity or latency-intensity functions.

Conclusions: Click rate assays (change in rate within the same recording) may be a sensitive approach for detecting and/or monitoring subclinical/hidden ototoxic effects of the auditory nerve.

Category: Diagnostic Audiology / Otology

Poster #: 020

Tobramycin Pharmacokinetics Predict Hearing Loss in Patients with Cystic Fibrosis

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Objectives: Patients with cystic fibrosis (CF) experience frequent lung infections that necessitate the use of antibiotic therapy that may be ototoxic. Drug and dosage monitoring of aminoglycosides (AG) for patients with CF is critical as previous data suggest that over half of these patients develop AG-induced hearing loss. This prospective, longitudinal study of patients with CF aimed to examine changes in pure-tone hearing thresholds as they relate to IV tobramycin treatments. We employed pharmacokinetic (PK) modeling of peaks, troughs, and cumulative drug exposures that model slower clearance from body tissues including the inner ear.

Design: IV tobramycin dosing and plasma levels from 29 CF patients (aged 7-22 years, 66% female) receiving inpatient treatment at Cincinnati Children's Hospital were used to construct pharmacokinetic (PK) models. Plasma concentrations were obtained at 3 and 10 h after IV infusion. These levels were fit using Bayesian estimations to predict drug exposure in the body's deeper tissues. Measures included the central compartment (C1) and second compartment (C2) trough concentrations, area under curve (AUC), trough maximum concentrations, and cumulative area under the curve (AUCC). All patients had serial pure-tone threshold audiometry testing in both the standard (0.25-8.0 kHz) and extended high frequency (EHF) range (10-16 kHz). Hearing loss was defined as threshold greater than 15 dB at any frequency. A change in hearing was defined by ASHA-shift criteria (≥10 dB at two adjacent frequencies or ≥20 dB change at one frequency). The PK variables were compared to the first and last audiogram to predict changes in hearing with repeated IV treatments.

Results: Significant hearing shifts were observed between baseline and last treatments in about 30% of patients, and these changes appeared to progress from unilateral to bilateral hearing loss. A significant correlation was observed between the EHF average and the sum of final C2 concentrations ($p=0.019$). Total drug exposure (sum of total AUCCs) was also correlated with poorer EHF hearing $p=0.042$). Comparisons in PK variables between the first and last treatment showed significant changes in all variables. There was a non-significant trend ($p =$

0.075) toward higher total drug doses and higher AUCCs (p = 0.088) between the group with a significant hearing change and the group with no change.

Conclusions: Approximately 30% of patients had worsening of audiograms over the study, and standardized AUCCs were predictive of poorer hearing at the last treatment. To explore the trends seen in serial monitoring, a larger multisite study is currently underway to enroll more participants in a larger sample with longer follow-up durations. Continuous monitoring of hearing tests along with drug concentrations in CF patients with IV-AG treatments is important to detect early changes in hearing due to ototoxicity.

Category: Diagnostic Audiology / Otology

Poster #: 021

Developing a Risk Assessment Tool for Age-Related Hearing Loss

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Objectives: Age-related hearing loss (ARHL) is a consequence of the aging process, in combination with genetic predisposition and environmental insults endured by the ear. ARHL typically begins in the third and fourth decade of life as evidenced by worsening of high frequency thresholds and a decline in otoacoustic emissions as a function of age. However, due to the multifaceted pathophysiology of ARHL, it is largely unknown what individual, environmental and lifestyle factors interact to predict one's susceptibility to develop ARHL during midlife. Therefore, the objective of this study is to develop and validate a self-administered risk assessment tool for predicting early-onset ARHL in a diverse sample.

Design: 100 adults between the ages of 30 and 50 years will be recruited from the greater Chicago metropolitan area using stratified simple random sampling approach to ensure a diverse sample. Participants will complete an electronic RedCap-based 26-item questionnaire, which was developed to identify the risk factors associated with early-onset ARHL. The main outcome measure is the Revised Hearing Handicap Inventory (RHHI). Risk score will be calculated as the sum of scores on items related to self-reported exposure to toxic chemicals, ototoxic drugs, occupational noise, recreational noise, impulse noise as well as self-reported symptoms of temporary threshold shift, cigarette smoking, and presence of other health conditions such as diabetes and hypertension.In addition to quantifying risk based on positive risk factors, risk scores will be corrected for anti-aging behaviors such as consumption of a healthy diet and regular exercise. A secondary outcome measure is the Tinnitus Handicap Inventory, which will be administered if participants indicate yes to a general tinnitus question. Initial construct validity will be assessed by examining the correlation coefficients between each construct and self-reported hearing difficulty as estimated using the RHHI. ROC curves with different cut-off points will also be examined to determine the tool's ability to classify low-risk and high-risk participants. Data collection is expected to be completed in January 2023.

Results: Our hypothesis is that the aging process is exacerbated by one's exposure to environmental toxins as well as lifestyle factors such as poor diet, cigarette smoking, and poor health. Therefore, we predict that individuals who report greater number of risk factors for early-onset ARHL will have poorer scores on the RHHI compared to those who report few risk factors. Because this study will incorporate a stratified simple random sampling approach, the study will report on risk factors across a diverse sample of young and middle-aged adults.

Conclusions: The findings from this study will be used in future studies examining physiological measures of peripheral auditory function in the presence of various environmental, lifestyle and individual risk factors. Together, the risk assessment tool and physiological measures will aid in the systematic examination of individual susceptibility for developing age-related hearing loss during midlife.

Category: Diagnostic Audiology / Otology

Poster #: 022 **Mentored Student Research Poster Award**

Do Eardrum Electrodes Affect Sound Transmission in the Ear?

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Objectives: In this study, we investigated how sound transmission in the ear is affected by placing an electrode on the eardrum. We hypothesized that the electrode increases the eardrum's mass, thereby reducing sound transmission at high frequencies. We also investigated two different methods of electrode placement. A common method for placing an eardrum electrode involves placing it in the canal and securing it with a foam tip. This method is hypothesized to result in a slit leak, allowing low-frequency sound to leak out. An alternative approach would be to create a bore in the wall of the foam tip that the electrode can be threaded through. We hypothesize that this method of placement will eliminate the slit leak and preserve the low frequencies.

Design: We measured wideband absorbance in 11 artificial ears (10 with high acoustic admittance, 1 with low admittance), and 6 human ears (5 with a type A tympanogram, 1 with a type B tympanogram). Distortion product otoacoustic emissions (DPOAEs) were also measured in the human ears. Measurements were completed for 5 different conditions: (1) baseline with no electrode in the canal, (2) dry electrode in the canal but not touching the eardrum, secured underneath a foam eartip, (3) dry electrode in the canal not touching the eardrum, secured through a bore in the foam eartip (subsequent conditions were completed using this method), (4) hydrated electrode in the canal but not touching the eardrum, and (5) hydrated electrode touching the eardrum. In contrast to the typical approach of drilling through the foam to create a bore, we developed a method in which a needle is heated and pushed through the foam to create the bore. The electrode is then threaded through the bore and advanced slowly by hand until contacting the eardrum. Confirmation of electrode placement on the eardrum relies on subject report and reddening of the eardrum (otoscopy). Our analysis includes comparing absorbance and OAEs between the conditions.

Results: Data demonstrates that absorbance slightly increases near the resonant frequencies of the artificial and human ears when the electrode contacts the eardrum. There was no change seen in DPOAEs in the human ears when the electrode contacts the eardrum. A comparison of the absorbance measurements between the electrode placement methods revealed significantly higher absorbance from 125 Hz-1000Hz for the condition where the electrode was secured under the foam. Absorbance was minimally affected when the electrode was placed using our bore method.

Conclusions: The changes in absorbance when the tympanic membrane electrode is placed on the eardrum are not consistent with an increase in the mass of the eardrum, as originally hypothesized. An alternative explanation is that the wick of the electrode absorbs some of the sound. However, the changes do not appear

substantial enough to affect sound transmission as DPOAEs were minimally affected by electrode placement. Results also demonstrate that our bore method significantly reduces the likelihood of causing a slit leak and low-frequency sound leaking out of the ear canal during measurements.

Category: Diagnostic Audiology / Otology

Poster #: 023 **Mentored Student Research Poster Award**

Effects of Acoustic Leaks on TEOAE Measurements in Adults and Newborns

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Objectives: Transient-evoked otoacoustic emissions (TEOAE) probe cochlear function and are used routinely in audiological assessment and for hearing-screening purposes. Acoustic stimulation and recording are conducted using a probe that is inserted into the ear canal. Previous work has demonstrated loose probe fits introduce artificial changes in wideband absorbance due to acoustic leaks, but this effect has not been investigated for TEOAEs. This work investigates the effect of acoustic leaks on TEOAE level, noise, and signal-to-noise ratio (SNR). Objectives were to (1) assess the effect of microscopic holes in ear tips on adult measurements conducted in the sound booth, and (2) assess changes in TEOAEs (ΔTE) associated with loose probe fits in newborn hearing-screening settings.

Design: Twenty-two young, normal-hearing adults (22 ears) underwent repeated TEOAE measurements. Testing was conducted using modified rubber ear tips with microscopic holes (diameters= 0.5, 0.8, 1.0, 1.2, and 1.5 mm), and an unmodified (no-leak) condition. Also, TEOAE measurements were obtained in twenty-one normal-hearing newborns, in whom 28 measurements were identified as having loose probe fits using criteria based on low-frequency absorbance and impedance phase. In adults, ΔTE values were computed as the differences between the no-leak condition and each leak size. In newborns, ΔTE values were computed between each of 28 measurements with loose fits, and a no-leak measurement within the same ears. In both groups, ΔTE was computed for TEOAE level, noise, and SNR at three half-octave bands with center frequencies 2000, 3000, and 4000 Hz. Separate repeated-measure ANOVA analyses evaluated the effect of acoustic leaks (6 leak sizes at 3 frequencies) on TEOAE level, noise, and SNR. In addition, multiple one-sample t-test evaluated the significance of ΔTE compared to 0 dB. The magnitude of ΔTE level was compared to test-retest differences to determine their clinical importance.

Results: In adults, ANOVA analysis showed no significant effect of leaks for any TEOAE measure. Likewise, ΔTE values were not significantly different from 0 dB with few exceptions: significant increases in TEOAE level and noise for the 1.5-mm leak at 2000 Hz, a decrease in SNR for the 0.5-mm leak at 3000 Hz, and an increase in level for the 1.0-mm leak at 4000 Hz. Median ΔTE level exceeded published upper limits of TEOAE test-retest at 2000 Hz for the 1.5 mm size. In newborns, loose probe fitting resulted in a significant increase in noise and a decrease in SNR at 2000 Hz, and no significant change in TEOAE level.

Conclusions: Acoustic leaks did not result in changes in TEOAE values except for a significant increase in TEOAE level and noise at 2000 Hz for the largest tested leak size. Therefore, mid-frequency TEOAEs are not prone to significant changes when leaks are smaller than 1.5 mm. In newborns, there was a significant increase

in noise but no change in TEOAE level. The noise increase in association with loose probe fits was markedly greater in screening settings compared to adults. This suggests that improper probe fits in newborns may result in increased noise that can cause a failure on SNR screening criteria.

Category: Diagnostic Audiology / Otology

Poster #: 024

Does Hearing Loss Configuration Impact the Association with Falls?

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Objectives: Falls pose a significant morbidity and mortality risk in patients; therefore, identifying potential falls risks and providing counseling is critical to ensure patient safety and longevity. There has been recent evidence of an independent association between hearing loss and falls that appears dose-dependent (that is, increasing levels of hearing loss is associated with increased odds of falling). To date, mechanisms that explain the association have not been fully evaluated. The current objective was to determine if the configuration of hearing loss impacted the odds of falling. By examining hearing loss configurations, we may be able to: 1) better understand if certain audiogram configurations may confer greater risk, which would be useful for clinicians counseling patients and 2) gain indirect insight into potential factors that help to explain the association.

Design: A cross-sectional study of 19,365 adult patients seen in our institution's audiology clinic between June 1, 2013 and June 1, 2021 was conducted. Audiometric data were retrieved from our institution's audiology database. All raw pure-tone threshold data was processed using the Audiogram Classification System (AMCLASS). The AMCLASS program allows for processing of audiograms and provides severity, type, and configuration of the hearing loss using validated and previously published methods. For this study, we included patients who were classified as either normal or symmetric sensorineural hearing loss by AMCLASS and excluded patients if they had asymmetric, conductive, or mixed hearing loss. Self-reported falls status, demographics, health-related comorbidities, and number of falls-related medications were extracted from the electronic medical record for those included in the analysis. Logistic regression will be used in the analysis with falls status (faller vs non-faller) being the outcome of interest.

Results: Of patients seen between 2013-2021, 9,895 met the inclusion criteria. The audiometric configuration for each ear was analyzed. For the right ear, 22.7 % (2249/9895) had normal hearing, 49.8% (4932/9895) had a sloping configuration, 21.5% (2129/9895) had a flat configuration, 1.52% (150/9895) were peaked hearing loss, 1.44% (142/9895) were troughed-shaped hearing configuration, 2.24% (222/9895) were 'other' configuration, and 0.72% (71/9895) were rising configuration. For the left ear, 22.7 % (2248/9895) had normal hearing, 50.8% (5025/9895) had a sloping configuration, 20.6% (2034/9895) had a flat configuration, 1.61% (159/9895) were peaked hearing loss, 1.57% (155/9895) were troughed-shaped hearing configuration, 2.15% (213/9895) were 'other' configuration, and 0.61% (61/9895) were rising configuration. The pure-tone average was calculated for each ear. Data analyses are actively underway. The planned analysis is logistic regression with falls as the outcome of interest. For the unadjusted model, only hearing loss configuration (with normal as the reference category) will be included. The adjusted model will include hearing loss configuration (reference category is normal), age, sex (reference category is male), race (reference category is White), the number of comorbidities, and the number of falls-related medications.

Conclusions: Conclusions will be drawn following data analysis.

ELECTROPHYSIOLOGIC RESPONSES

Category: Electrophysiologic Responses

Poster #: 025

Neural Measures of Individual Noise Tolerance and Noise-Reduction Outcomes

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Objectives: Many people with sensorineural hearing loss have difficulty understanding speech in daily life. Despite improving speech perception in quiet conditions, prescriptive amplification provides limited benefits under noisy listening environments. Thus, current digital hearing aids commonly implement noise-reduction (NR) algorithms; however, NR processing inevitably distorts some speech cues while attenuating noise. Although emerging evidence suggests that hearing-aid users with similar audiograms react very differently to these conflicting effects, the neural bases of the individual variability in perceptual outcomes with NR processing are understudied. Our core hypothesis is that variability in NR outcomes among adult listeners with similar hearing sensitivity may come from individual differences in noise tolerance that can be quantified through electroencephalography (EEG) measures of cortical and subcortical responses.

Design: Thirty-six native speakers of American English between 18 and 34 years of age participated in the first experiment. They had pure-tone thresholds no worse than 25 dB HL at any of the test frequencies up to 8 kHz. We simultaneously measured behavioral and cortical evoked responses during a speech-in-noise task in which natural monosyllabic words were presented with NR off and on at individualized signal-to-noise ratios targeting 70% speech intelligibility. The Ephraim-Malah NR algorithm was used in the NR condition. The amplitude ratio of auditory-cortical responses to target words and noise at the auditory cortex during speech-in-noise tasks was computed to index individual noise tolerance. For the second experiment, another cohort of twenty-six native speakers of American English was recruited. They also had pure-tone thresholds lower than 25 dB HL at any of the test frequencies up to 8 kHz, and their ages ranged from 19 to 41. We developed subcortical measures of individual noise tolerance that are less affected by cognitive efficacy using speech-evoked auditory brainstem responses with a synthesized speech syllable /da/. The speech syllable /da/ was presented at a +3 dB signal-to-noise ratio over speech-shaped noise in the noise and the NR conditions.

Results: The findings from the first experiment showed that the cortical index of individual noise tolerance, estimated from cortical evoked responses during speech-in-noise tasks, can predict individual speech-in-noise perception benefits (or lack thereof) from NR processing. Our data revealed that individual variability in this cortical index of noise tolerance was mainly driven by their selective attention efficacy. Further, using objective subcortical measures of noise tolerance that are relatively unaffected by cognitive efficacy, the findings from the second experiment indicated that adding noise and introducing NR processing had considerably varying effects on brainstem responses across individuals.

Conclusions: Large individual differences in noise tolerance were revealed in both cortical and subcortical measures. The present study indicates that listeners with lower noise tolerance, captured by our novel EEG measures, are likely to get more perceptual benefits from NR processing. Our approach may help develop objective measures for characterizing individual noise tolerance and provide more tailored hearing intervention strategies.

Category: Electrophysiologic Responses

Poster #: 026 **Mentored Student Research Poster Award**

Cochlear Filter Width Influence on Envelope Following Responses

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Objectives: Envelope following responses (EFRs) are auditory evoked potentials that provide a non-invasive window into the encoding of envelope periodicity of sounds. EFRs have been used in a variety of settings ranging from determining hearing thresholds to verifying hearing aid benefit. However, EFRs are highly variable among listeners affecting its clinical translation. We recently reported that while the middle ear influences EFR amplitude at the low and extended high frequencies, it does not seem to explain the between-listener EFR variability. The objective of this study is to investigate the relationship between cochlear processing and EFR amplitude since the interaction of harmonics within a cochlear filter is essential for EFR generation. We hypothesize that cochlear filtering, specifically, individual differences in harmonics resolving ability, determines EFR amplitude and thus its variance. We predict that progressively increasing envelope modulation for any given carrier will reduce EFR amplitude but the roll-off will occur at an earlier envelope frequency for lower frequency carrier frequencies due to narrow cochlear filter widths resolving the modulation sidebands, i.e., falling outside the filter.

Design: A total of 21 young normal-hearing adults participated in the study. EFRs were elicited by 1 and 4 kHz tones amplitude modulated at 80, 120, 160, 240, 320, and 400 Hz and presented monoaurally at 60 dB SPL. EFRs were recorded between the vertex (non-inverting) and the nape (inverting) while the participants watched a closed-caption movie. Stimulus frequency otoacoustic emission (SFOAE) two-tone suppression (2TS) was employed to estimate cochlear filter bandwidth at 1 and 4 kHz. The probe was set at 40 dB SPL close to 1 or 4 kHz (fp) and discrete frequency suppressors (fs; 60 dB SPL) ranging from 0.4 to 2.1 times the fp were used to extract SFOAE. In total, 23 2TS points per fp were obtained with a greater density close to the fp. For both EFRs and SFOAEs, forward pressure level calibration was used to minimize across-subject variability due to external and middle ear differences.

Results: Preliminary analysis shows the expected bandwidth difference between 1 and 4 kHz as measured using SFOAE-2TS - larger bandwidth for 4 kHz probe in absolute scale and narrower, sharper, on the ratio/logarithmic scale. EFR data also shows an expected pattern of reduction in amplitude with increasing modulation frequency. The reduction in amplitude is influenced by previously reported fine structure in the EFR-based temporal modulation transfer function (TMTF) in a frequency-specific manner. The frequency effect is novel because previous studies used broadband stimuli. This new finding suggests a likely cochlear filter bandwidth role in EFR generation. Further direct relationships are being investigated.

Conclusions: Although theoretically well-known, we report the first evidence for the role of the cochlear filter bandwidth on EFR generation. Our results provide important insights into a previously unknown cochlear role in EFR-based TMTF.

Category: Electrophysiologic Responses

Poster #: 027 **T35 Research Trainee Poster**

Comparing the Frequency Following Response in Earphones Versus Sound Field

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Objectives: The frequency following response (FFR) is an auditory evoked potential that originates in both subcortical and cortical regions of the auditory system. It is reflective of the fidelity of the auditory system in processing spectral and temporal information. The overall goal of this study is to increase the range of applications of the FFR in the clinic, such as the verification of assistive devices in children and infants, which requires sound field testing. The specific aims of our study include comparing the FFRs elicited via insert earphones versus sound field with multiple consonant-vowel (CV) syllables and utilizing synthetic and naturally spoken CV stimuli to further investigate their ecological value. We hypothesize that FFR amplitude will be similar for sound field versus insert earphones and across syllables, but will differ for synthetic versus naturally spoken stimuli.

Design: A total of 20 individuals with normal hearing participated in the study (15 female, and 5 male). The mean age for participants was 28 years old with a range of 17-50 years. Normal hearing was confirmed through baseline testing for all participants. A two-channel acquisition montage was used to collect the FFR binaurally for a total of 8 conditions with 4096 sweeps averaged per condition. Two different consonant-vowel (CV) stimuli were used. The synthesized /ba/ and /da/ stimuli had a fundamental frequency (F0) at 100 Hz representing a male speaker and the naturally spoken stimuli were recorded from a female speaker with a F0 at approximately 200 Hz. All stimuli had a duration of 170 ms. The Intelligent Hearing Systems Smart EP system was used with stimuli presented through: (1) shielded ER3 insert earphones and (2) a JBL speaker placed one meter in front of the participants' ears.

Results: Descriptive analysis was conducted using SPSS software. The F0 magnitudes were log-transformed to satisfy statistical requirements for normality and analyzed using a three-way Analysis of Variance (ANOVA) with transducer, syllable, and stimulus type as factors. The collected data support no significant difference between the FFR insert earphones and sound field measurements. No significant differences in F0 amplitude were noted between the two CV syllables, /ba/ versus /da/. As hypothesized, there was a significant difference observed between F0 magnitude for synthetic and natural stimuli, with the synthetic stimuli yielding a larger magnitude.

Conclusions: The study findings demonstrate that the FFR can successfully be measured in the sound field, which serves as a step forward for FFR clinical applications. Both CV stimuli elicit comparable F0 magnitudes. Further analysis of the characteristics of the FFR and research in this area of electrophysiology are needed to

understand the differences between naturally spoken and synthesized stimuli and the influence of F0 differences. The Frequency Following Response has the potential to be implemented in the clinic for verification of devices when evaluating hearing aid and cochlear implant users, and as an outcome measure for auditory rehabilitation and retraining therapy. [Funded by NIH-NIDCD T35 DC008763 (PI: L.Hood)].

Category: Electrophysiologic Responses

Poster #: 028 **T35 Research Trainee Poster**

Cortical Auditory Evoked Potentials - Determining the Optimal Number of Sweeps

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Objectives: Cortical auditory evoked potentials (CAEPs) are a late latency response reflecting cortical activity associated with stimulus onset detection, sensory processing, attention, and memory. Currently, CAEPs are primarily used in audiology clinics for hearing threshold estimation and as a crosscheck tool to determine the functionality of hearing aids and cochlear implants. Limited clinical use of CAEPs is due to additional equipment cost and procedure duration constraints. To increase clinical feasibility, this study investigated the effect of the number of sweeps on the ability to elicit a repeatable CAEP waveform to speech stimuli in two paradigms targeting sensory and memory processes.

Design: The study involved 20 normal-hearing adults (19 female, 1 male) with a mean age of 25 years. A prototype clinical system (Intelligent Hearing System) with a standard two-channel acquisition montage was utilized with the ground electrode at Fpz, non-inverting electrodes at Cz and Pz, and inverting electrodes joined with a jumper cable and placed at A1 and A2. Electrode impedances were at or below 5 kOhms. The syllable differentiation task presented four different consonant-vowel syllables with equal probability and 0.5/sec presentation rate. This task included six 3-minute blocks, with each presenting each syllable 10 times, to allow averaging across the increasing number of sweeps (from 10 sweeps in one block to 60 sweeps across all six blocks). The auditory incidental memory task utilized 51 single-syllable pseudowords, one of which was selected at random to be repeated 50 times and the rest were presented once with all stimuli being presented at 0.9/sec rate (a total of 100 sweeps). The memory task was presented as two 7-minute blocks, each with 25 sweeps for the repeated and presented once conditions. The order of the tasks was counterbalanced across participants. Stimuli were delivered at 75 dB SPL via a wireless speaker positioned at 0 degrees azimuth, 1 meter away from the participant at ear level. Participants were instructed to watch a silent video with no subtitles for the duration of the session.

Results: The expected sensory CAEP responses (P1-N1-P2) were observed at Cz in each of the six 10-sweep averages for the syllable differentiation task. Statistically significant syllable differentiation was observed in the P1-N1-P2 amplitude and latency (P1: 50-80 ms, N1: 90-120 ms, P2: 180-220 ms) starting with the CAEP averages based on 40 sweeps, with N1 and P2 being most sensitive to speech sound differences. In the auditory incidental memory task, the expected higher amplitudes in response to the repeated than non-repeated stimuli (P300: 300-500ms, P600: 500-800ms) were observed starting with the averaged based on 25 sweeps.

Conclusions: As few as 10 artifact-free sweeps may be sufficient to observe a P1-N1-P2 complex, while 25-40 sweeps per average are needed to detect stimulus-related amplitude differences. While further work is needed with a larger sample of more diverse participants, these results indicate that CAEPs can be acquired using

relatively brief procedures to provide objective measurement of sound detection and higher auditory processing, especially in nonverbal or medically complex patient populations. [Supported by NIH-NIDCD T35-DC008763]

Category: Electrophysiologic Responses

Poster #: 029 **T35 Research Trainee Poster**

Auditory Gating in Children with Mild-to-Severe Hearing Loss

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Objectives: Auditory sensory gating refers to the phenomenon in which neural responses are attenuated to irrelevant or redundant stimuli that are presented in close succession. This neurophysiological process prevents excess auditory stimuli from inundating upper cortical centers, which aids in preventing the unnecessary expenditure of limited cognitive resources. Research has established that elevated auditory thresholds correlate with adult amplitude gating indices, and that gating in the somatosensory domain correlates with verbal and performance in children with mild-to-severe hearing loss. Despite these associations, the unique effects of hearing loss on auditory gating have yet to be established in children. To this end, the current study sought to identify the relationships between auditory experience on auditory gating in children with mild-to-severe hearing loss.

Design: The study comprised 37 children aged 7-15 years, including 24 children with normal hearing and 13 children who were hard of hearing (i.e., bilateral mild-to-severe hearing loss and fit with hearing aids). Participants were passively presented with a paired-pulse 1 kHz auditory stimulation with an inter-stimulus interval of 0.5 s during magnetoencephalography (MEG). Participants also completed a variety of questionnaires, neurobehavioral assessments outside the scanner. Auditory evoked and oscillatory responses to each stimulus were identified for each stimulation using sLORETA and beamforming source reconstruction, respectively, and the effect of group (i.e., normal hearing, hard-of-hearing) and stimulus (stimulus 1, stimulus 2) were evaluated. Connectivity measures between the left and right auditory cortices were also computed and statistically evaluated.

Results: As expected, each auditory stimulus induced an evoked and gamma oscillatory response that peaked in the primary auditory cortices bilaterally. There was a significant main effect of stimulus, such that the response to the second stimulus was attenuated relative to the first stimulus ($p = .033$), indicative of significant auditory gating across groups. However, there were no main effects of group or hemisphere, nor were there any interactions. With regards to connectivity, there was a significant stimulus-by-group interaction ($p = .045$), such that connectivity between the left and right auditory cortices increased from stimulus 1 to stimulus 2 in the children who are hard-of-hearing, while there was a slight decrease in connectivity between stimulus 1 and

stimulus 2 in children with normal hearing. Moreover, stimulus-related increases in connectivity were related to higher verbal ability in the children who are hard-of-hearing, controlling for degree of hearing loss ($p = .007$).

Conclusions: While preliminary, these results suggest that children who are hard-of-hearing show altered auditory connectivity profiles during auditory gating relative to normal-hearing peers, and that this altered connectivity is related to verbal ability. These data may provide an insight into the relationship between basic sensory processing and higher-order cognitive and language outcomes in this population.

Category: Electrophysiologic Responses

Poster #: 030 **Mentored Student Research Poster Award**

Envelope Following Response Partly Explains Individual Differences in Cocktail-party Effect

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Objectives: Young listeners with clinically normal hearing show large variability in their ability to segregate the speech of multiple talkers speaking simultaneously, the so-called cocktail-party effect (CPE, Cherry, 1952). Lutfi et al. (2020) used perturbation analysis (Berg, 1990) to evaluate two general factors thought to be responsible for the individual differences: decision weights - the relative reliance listeners place on individual segregation cues, and internal noise - degradations in the internal representation of segregation cues resulting from stochastic neural processes. The authors concluded that individual differences in performance in their experiments were mainly due to internal noise, but they did not consider the internal noise source. The present study evaluated Envelope Following Responses (EFR) using rectangular wave, amplitude-modulated (RAM) at 40 and 120 Hz to measure possible contributions of the cortex and midbrain to internal noise in a CPE task similar to that of Lutfi et al. (2020).

Design: Twenty-six participants, aged 19-26 years (15 females), were recruited for the study. All listeners had normal tympanometry and pure-tone thresholds (< 25 dB HL) between 0.25-8 kHz, except for one participant with a mild, 30 dB HL threshold at 4-kHz in the right ear. EFRs were measured using a rectangular wave amplitude-modulated stimulus with a carrier frequency of 4-kHz, modulation frequency (MF) of 40 and 120-Hz, and modulation depth of 100% presented at 70 dB SPL. The EFR set up used a four-electrode montage, bandpass filter setting of 10-1000 Hz, 60-Hz line filter, sampling rate of 4-kHz, stimulus rate of 2/sec, sampling period of 1-ms, and a minimum of 1000 sweeps. The signal-to-noise ratio was calculated from a Fast Fourier Transform to obtain signal magnitude at the MF and noise floor within 10-Hz of the modulation frequency. The CPE task was a two-talker speech segregation task using synthesized vowels spoken by one or two talkers distinguished by fundamental frequency (F0= 120 vs 150) and azimuth location (θ= 0 vs 30°). Random perturbations were independently added to each talker on each trial (σ= 10 Hz and 10°). Decision weights on the values of F0 and θ for each listener were estimated from regression coefficients in a general additive model where the perturbations were predictor variables for the listener's trial-by-trial response (1 or 2 talkers). The decision weights were used to estimate for each listener a weighting efficiency (representing the impact of the decision weights on performance) and a noise efficiency (representing the influence of internal noise).

Results: The SNR of the EFR at 120 Hz MF, but not 40 Hz, was significantly correlated with the noise efficiency (r=0.25, p=0.048), contributing to a significant correlation to overall performance (r=0.31, p=0.027) on the CPE task. As SNR increased, performance on the CPE task improved. Further analysis showed that noise floor level was a significant contributor to noise efficiency (r=-0.42, p=0.0002) and overall efficiency (r=-0.37, p=0.0074).

Conclusions: The results suggest that the noise level measured in EFRs from the midbrain might be a contributor to individual differences in performance on a CPE task among young, normal-hearing individuals.

Category: Electrophysiologic Responses

Poster #: 031

Sustained Attention increases Auditory Cortical Decoding of Syllables

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Objectives: Speech perception requires sustained attention and constant updating and manipulation of information stored which is also referred to as working memory. Working memory plays a critical role in speech comprehension and in complex cognitive tasks such as learning and reasoning. Effective speech perception relies on the interplay of utilization of working memory and attention control. Event related potentials (ERP) can be used to assess differential processing of speech sounds in the brain. However, little is known about how the brain process different speech information, specifically phonological features in active attentional tasks with working memory demands. In the present study, we recorded ERPs to syllables presented in an n-back task, which engages sustained attention and working memory. We leveraged recent machine learning approaches to study how and at what timescale the brain decodes phonological information under high and low attention and working memory demands. We predict that the syllable decoding for the 2-back condition would be stronger than the no-back condition.

Design: Electroencephalography (EEG) from 64 channels was recorded while participants performed no-back and 2-back tasks. Twenty-two participants in the age range of 18-26 years listened to an auditory stream of six different CV syllables presented randomly in no-back condition. They were asked to press a button when they heard the same syllable as 2 prior in 2-back condition. So, 2-back condition requires sustained attention while memorizing and retrieving the speech sound constantly and comparing it with what they heard recent. The continuous EEG was further analyzed offline, down sampling and filtering. Independent component analysis (ICA) was performed to identify and remove the components associated with ocular movement and other artifacts and were epoched separately for different syllables. Linear support vector machine classifier was used to decode the syllables from the clean ERPs. The features used for the classification were the scalp-topographies of ERPs. Classification was performed for each time point in the ERP, to obtain a temporal waveform of classification across time. This enabled us to assess the timescale of classification of the syllables in two conditions.

Results: The decoding accuracies were compared between 2-back (excluding the trials with responses) and no-back condition for each syllable across the time window of -100 to 1000 ms with reference to the onset of the syllable. Decoding accuracies were significantly greater in 250-350 ms time window for 2-back condition than 1-back condition.

Conclusions: The results suggest increased decoding of syllables or phonological information during highly demanding cognitive load conditions such as increased working memory load and sustained attention. The effect of sustained attention on decoding and classification of different syllables by the neural systems would have implications in terms of selective listening and speech perception in noise. The objectivity of the test to predict these effects used in the present study would be helpful in assessing the efficacies of rehabilitation in difficult-to-test populations.

Category: Electrophysiologic Responses

Poster #: 032 **Mentored Student Research Poster Award**

Predicting Audibility with Cortical and Sub-Cortical Envelope Following Responses

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Objectives: Previous efforts have used sub-cortical envelope following responses (EFRs) elicited by the first and second formants of vowels, and fricatives to predict frequency-specific audibility. In this work, a machine learning technique is developed to use the simultaneously elicited cortical EFRs to speech and examine the benefit of using both cortical and sub-cortical responses to predict frequency-specific audibility.

Design: The speech token "sashi" is used as the stimulus. To elicit frequency-specific subcortical EFRs, the fundamental frequency (f0) in the first formants of vowels, and second and higher formants of vowels were modified to differ by 8 Hz. Fricatives were amplitude modulated at 93.75 Hz. Cortical EFRs follow the slow (<15 Hz) amplitude envelope of the stimulus. For proof of concept, audibility in normal-hearing individuals is varied in a frequency-specific manner. "sashi" is filtered in six ways to remove at least one of low (<1.1 kHz), mid (1.1-3.5 kHz), and high (>3.5 kHz) frequencies. Subcortical and cortical EFRs are recorded over 400-trials from 25 adults (18- 30 years) and 25 children (5-17 years) under those six stimulus conditions. A multi-class classification task was designed to identify the audibility of low, mid, and high frequencies resulting in a six-class classification problem. Logistic regression (LR) is used to perform this classification. Cortical and sub-cortical features for LR are extracted from the frequency domain representation of coherent average EEG waveforms. Cortical features included the real and imaginary parts of all the Fourier coefficients below 15 Hz. Sub-cortical features include spectral amplitudes at the response frequencies of the 6 stimuli and the average amplitude at noise frequencies surrounding the response frequencies. The improvement in classification accuracy after including cortical features is calculated as a function of the number of EEG trials used for the feature extraction.

Results: For the number of trials ranging from 60 to 300, the accuracy of the classifier using both cortical and sub-cortical features ranged from 77% to 92% in adults and 70% to 83% in children. This is significantly higher than the 64% to 88% accuracy in adults and 54% to 74% accuracy in children, achieved when using only sub-cortical features. It can also be noticed that the improvement in accuracy after including cortical features is higher in children.

Conclusions: In adults and children, the accuracy of predicting frequency-specific audibility improves with the simultaneous use of cortical and sub-cortical EFRs. Including cortical features helps improve accuracy at a

fixed number of trials or reduces the number of trials needed for a fixed level of accuracy. Although EEG-based frequency-specific audibility assessment is challenging in children, including cortical activity in the analysis can improve the accuracy significantly.

Category: Electrophysiologic Responses

Poster #: 033

Spontaneous EEG Oscillations and Auditory Function in Preterm Infants

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Objectives: Very preterm (<32 wks gestational age [GA]) and extremely preterm infants (<28 wks) are at high risk for speech language impairments and permanent hearing loss. Continuous EEG can be used to measure spontaneous neural activity and functional connectivity between brain regions known to support speech and language development. In preterm infants, the normal development of oscillatory activity is altered. Specifically, preterm infants show increases in low-frequency activity (delta, theta) and reduced higher-frequency activity (alpha, beta) compared to term infants. However, differences in spontaneous neural activity across brain regions and relationships with sub-cortical auditory function in preterm infants have yet to be explored.

Design: This longitudinal study aims to improve early prediction of speech, language and pre-literacy deficits in preterm infants. It includes 150 infants who will be assessed from birth to 3 years with resting-state functional MRI, resting and speech-evoked EEG, hearing and speech-language measures. In this analysis, 46 preterm infants (24-32 weeks GA) were tested at 3 months corrected age (range = 1-5 mos; male = 57%). Auditory Brainstem Responses (ABR) were measured using broadband (70 dB nHL) and level-specific CE-Chirp stimuli (1 and 8 kHz; Eclipse, Interacoustics). Spontaneous EEG was recorded while the infants were sleeping using a high-density net (124 channels; EGI, Inc). Relative power (delta, theta, alpha, beta, and gamma bands), phase coupling, and cross-frequency amplitude-amplitude coupling (CFC) between low-frequency (theta, alpha) and high-frequency (gamma) oscillations was calculated. Separate repeated measures ANOVAs examined differences in spontaneous EEG across brain region topography, hemisphere, and hearing status.

Results: Lateralization of maximal relative power varied by oscillatory band. Delta power had a right hemisphere preference, while gamma power demonstrated a left hemisphere preference. Relative power varied by region with maximal delta power within the occipital/temporal areas and maximal alpha-gamma power within the central/frontal areas. CFC showed stronger coupling in the central/parietal regions and weaker coupling within the frontal/temporal/occipital regions. Phase coupling was reduced in the alpha band. Significant relationships were found between global relative power (delta, theta, alpha, beta) and MRI brain abnormality scores (beta) and physiological hearing thresholds which ranged from normal to moderate loss.

Conclusions: Sensory deprivation involved in hearing loss, leads to changes in synaptic and membrane properties throughout the central nervous system. Our preliminary analysis showed that by 3 months of age, preterm infants with slight to moderate hearing loss had changes in relative power and phase coupling compared to preterm infants with normal hearing. Additionally, hearing thresholds were significantly correlated with

relative power (delta-beta). These results are the first to characterize spontaneous EEG activity in preterm infants as a function of hemisphere and region and to explore relationships with sub-cortical auditory function.

Category: Electrophysiologic Responses

Poster #: 034 **Mentored Student Research Poster Award**

Cortical Encoding of Acoustic Changes in Different Noise Types

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Objectives: Understanding speech in background noise is challenging for many individuals, including those who are older and those who have hearing loss. A measure of neural coding may help us to understand more about the underlying causes of performance variability present in these populations. The purposes of this study were (1) to better understand the effect of noise type on cortical auditory evoked potentials (CAEPs) that were evoked to acoustic changes within a stimulus, (2) to explore how the variables of age and hearing loss modify these effects, and (3) identify which noise type conditions correlated best with behavioral speech-in-noise test results. It was predicted that evoked potentials would be most affected when the signal and noise type were most similar to each other, that age and hearing loss would result in weaker evoked potentials, and that understanding words presented in background babble would correlate best with brain measures recorded in babble.

Design: Cortical auditory evoked potential and speech-in-noise testing were completed in 35 adult participants varying in age from 20 years old to 76 years old and hearing status with pure-tone averages (500, 1000, 2000, and 4000 Hz) ranging from 4 dB HL to 42 dB HL. Cortical auditory evoked potentials were elicited using an /uiu/ synthesized vowel signal. Multiple P1-N1-P2 responses resulted (onset and acoustic change complexes): N1-P2 responses were recorded to the signal onset, the change from /u/ to /i/, and the change from /i/ back to /u/. The signal was presented in four different noise conditions: no noise, continuous speech spectrum noise, two-talker modulated noise, and two-talker babble. These noise types allowed for rough estimates of energetic and informational masking. The Words in Noise (WIN) test was used to assess speech-in-noise understanding.

Results: Preliminary analyses demonstrated (1) an effect of noise type on cortical auditory evoked potentials amplitude and latency. Amplitudes of all peaks for the babble noise condition were notably reduced compared to the other noise types, and the quiet noise condition had the earliest latencies and largest amplitudes across peaks. The continuous condition was most similar in morphology to the quiet condition. (2) Evoked potentials were weaker and speech-in-noise scores were worse for the older hearing-impaired individuals compared to the younger individuals. (3) Correlational results between electrophysiology and behavior across noise types generally reveal that weaker responses (smaller amplitude and longer latency) are found for those with poorer understanding in noise.

Conclusions: The data confirm that weaker cortical auditory evoked potentials generally coincide with poorer speech-in-noise understanding. It may be that auditory evoked potentials in background noise can help explain the variability in speech-in-noise understanding that is seen clinically or predict behavioral outcomes in difficult-to-test individuals. Further research is needed to clarify the possible causal relationship between brain measures and the speech understanding in noise. [Funded by the NIH/NIDCD R01DC015240]

HEARING LOSS / REHABILITATION

Category: Hearing Loss / Rehabilitation

Poster #: 035

Normative Data for Subjective Hearing Difficutlies in US Service Members

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Objectives: In 2015, Henry et al. developed the Tinnitus and Hearing Survey (THS) as a tool to aid clinicians in choosing whether to address a patient's tinnitus or hearing-related complaints first. This is accomplished by comparing the listener's self-reported handicap on the hearing difficulty portion of the test (THS-H subscale) to the listener's self-reported level of bothersomeness on the tinnitus portion of the test (THS-T subscale). Conceivably, the THS could also be used to compare absolute levels of hearing-handicap and tinnitus-bothersomeness across patients. However, no clinical norms for making these kinds of comparisons were provided in the original version of the test. Aim: To develop normative data for the THS on a large cadre of US service members (SMs), with the ultimate goal of making the THS a useful tool for assessing the severity of a patient's complaints about hearing and tinnitus relative to other individuals with varying levels of hearing loss and tinnitus.

Design: A total of 20,267 SMs completed the THS-H and 4,952 SMs completed the THS-T. The subscales were analyzed separately by gender, age, and hearing. The tinnitus subscale was further analyzed by frequency of tinnitus occurrence (never to daily) and, for those experiencing tinnitus more than once per year, by level of tinnitus severity based on the three-level question asked of all us SMs as part of their annual hearing test (bothered a little, a lot, not bothered at all). Both the THS-H and THS-T were collected primarily on an 11-point scale, rather than the 5-point scale used in the original. However, 134 individuals provided data on both the 5-point and 11-point versions of the test, making it possible to convert between the two.

Results: The large dataset makes it possible to plot percentile curves for the full range of scores on the THS-H and THS-T. Roughly 5% of normal hearing listeners had composite scores on the 11-point THS-H higher than 26/40, which therefore could be considered a cutoff for an "abnormally poor" score. Those who reported that they frequently experienced tinnitus but were not bothered by it scored similarly on the THS-T to those that reported that they rarely experienced tinnitus at all, with 95% of this group scoring less than a 9/40 on the 11-point THS-T. The comparability of the 5-point and 11-point versions of the tests was assessed by fitting a linear curve between the percentile scores. These curves were highly correlated ($r=0.99$ and $r=0.097$), suggesting a simple linear equation can be used to convert scores between the two test versions.

Conclusions: The THS is a valuable tool for comparing the relative severity of hearing and tinnitus problems and, with the new normative data provided here, it can now also be used to quantify the absolute severity of complaints. We believe that the ability to rapidly assess and document the severity of hearing complaints will have great benefits both for making immediate judgments about how to treat clinical patients and for tracking long-term changes in the hearing and tinnitus complaints of noise-exposed populations. The views expressed in this abstract are those of the author(s) and do not necessarily reflect the official policy of the Department of Defense or the U.S. Government.

Category: Hearing Loss / Rehabilitation

Poster #: 036

Training and Methodology of Hearing Screening among Community Health Workers

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Objectives: Community Health Workers (CHWs) have played a critical role in health care systems, particularly in low-resource settings. While evidence has shown CHWs to screen for hearing loss accurately when compared to a hearing healthcare specialist, a systematic understanding of hearing screenings conducted by CHWs is lacking, especially in regard to the training involved, evaluation process, and type of hearing screening equipment involved. The aim of this systematic review is to shed light on the training, evaluation processes, and technology are employed by CHWs to provide hearing screenings in the adult population and to compare the accuracy of hearing screening by CHWs to ear and hearing care professionals.

Design: All titles and abstracts were screened independently by two reviewers and each study was included or excluded based on criteria defined prior to the screening process. Criteria for exclusion of studies included: (1) study does not evaluate hearing screenings, (2) study does not involve CHWs conducting some aspect of hearing screenings, (3) study does not include adult participants (> 18 years), (4) study is from before September 12, 1978, (5) the study was not primary research (systematic/literature reviews), (6) study was a non-English publication. Other titles and abstracts were excluded if they were for abstract submissions, conference meetings, or graduate theses. The 31 studies included in the title and abstract screening phase then underwent a full-text screening by two reviewers using a hierarchical method of exclusion with disagreements again resolved by a third independent reviewer. References from included articles and systematic/literature reviews were examined to identify other articles that could be included.

Results: The initial search returned 222 studies, and after 130 duplicates were removed, there were 92 studies included in the next phase of title and abstract screening. After applying exclusion criteria, 31 full-text articles were reviewed yielding a final total of 14 studies for the final qualitative synthesis. All included articles were from low- and middle-income countries and training of CHWs was heterogeneous in duration, curriculum, screening procedure, and equipment used. The role of CHWs in hearing care extended beyond hearing screenings 7 studies, while the remaining 7 studies were training CHWs to deliver various hearing care services including ear wash out and dry mopping, diagnosis of ear disease, hearing aid fittings, and counseling. Evaluation of knowledge of CHWs following training was completed mostly by pre- and post-questionnaires with one article completing an Objective Structured Clinical Examination (OSCE). However, 8 articles did not report evaluating CHWs at all. Equipment varied from smart-phone and tablet-based audiometers to self-report and whisper test. Comparing accuracy of CHWs to other hearing care professionals was evaluated in 5 studies and showed comparable agreement and diagnosis.

Conclusions: While CHWs have been shown to be effective in providing hearing screenings to older adults, guidelines for training and evaluating CHWs to complete hearing screenings is still lacking. As the goals and services needed will differ based on location and needs of the community they are serving, standards should be set to ensure the highest quality hearing care is being provided.

Category: Hearing Loss / Rehabilitation

Poster #: 037

Community Health Advisor Training for Improving Access to Hearing Healthcare

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Objectives: Community Health Advisors have the potential to increase access to services and address inequalities in healthcare provided to those living in remote areas or for those who have been historically marginalized. The purpose of this study was to report on the effectiveness of a training program for Community Health Advisors who will be providing aural rehabilitation to those with hearing loss in their communities as part of an NIH-sponsored clinical trial with over-the-counter hearing aids. We predicted that the training would provide Community Health Advisors with the essential information to conduct the aural rehabilitation sessions.

Design: Sixteen adults living in West Central or South Alabama completed the training sessions for Community Health Advisors. These adults were selected because they had some community involvement experience. Three training sessions were held during the Fall of 2022, each lasting approximately three to four hours. In total, eight modules were presented, and generally, they focused on hearing loss, amplification options, and communication issues. Community Health Advisors completed a pre- and post-training assessment survey, a pre- and post-training content quiz, and a post-training feedback form. The seven-item assessment survey asked respondents to rate their confidence in discussing aspects of hearing and hearing loss including parts of the ear, the audiogram, and the degrees of hearing loss to name a few. The pre- and post-training quiz asked five multiple choice questions related to audiogram symbols, communication strategies, and hearing aid features. Finally, the feedback survey asked Community Health Advisors to rate, for example, how clear the presentations were, how engaging the presenters were, and if they felt comfortable conducting the aural rehabilitation sessions based on the information provided. Statistical analyses were conducted to determine changes in their confidence levels presenting material associated with the aural rehabilitation program, and in their understanding of content.

Results: Community Health Advisors demonstrated they understood the content presented during the training sessions and they felt confident presenting material to adults with hearing loss during the aural rehabilitation sessions. The feedback survey also suggested Community Health Advisors believed the training provided them with essential information for conducting aural rehabilitation.

Conclusions: The results from this study suggest that Community Health Advisors can be recruited to conduct aural rehabilitation programming to adults with hearing loss living in rural or underserved communities. The findings indicate that audiologists can train and collaborate with Community Health Advisors to help fill gaps in hearing healthcare services in these regions. Potentially, therefore, improvements in hearing healthcare across the county can be realized through this initiative.

Category: Hearing Loss / Rehabilitation

Poster #: 038

Identification of 'Red Flag' Conditions by Patients, Audiologists, and Otolaryngologists

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Objectives: The objectives of this study were to assess the accuracy of assessment of red flag medical conditions that require evaluation and management by a physician prior to hearing rehabilitation by comparing assessments from patients, audiologists, and otolaryngology providers who served as the gold standard. Red flag conditions included conditions such as excessive cerumen, unilateral or sudden loss, dizziness, among others.

Design: Two study cohorts were used in this prospective study: (1) patients without hearing complaints presenting for a routine primary care visit and subsequently failed a hearing screening (n = 104), and (2) patients presenting for the first time to an otolaryngologist (n = 186) with hearing complaints. No participant in either cohort had prior diagnosis of hearing loss or hearing aid use, and all participants were between 65-75 years old. Participants in both cohorts completed a checklist that contained red flag conditions prior to seeing a provider. For the primary care cohort, patients presented to the primary care provider, completed a hearing screening and failed, and underwent subsequent visits for a comprehensive audiologic evaluation with an audiologist followed by an exam by an otolaryngologist. For the otolaryngology cohort, patients presented for an audiologic evaluation with an audiologist followed by an exam by an otolaryngologist. Both hearing health care providers also completed a red flag checklist, along with their assessment of hearing aid recommendations and medical clearance for hearing aid use.

Results: The majority of the patients reported no red flag conditions, 71% and 59% for the primary care and otolaryngology cohorts, respectively. These rates were 88% and 80% for the audiologists and 86% and 80% for the otolaryngologists for each respective cohort. If a red flag condition was reported by any rater, the majority reported only one condition. The two most common red flag conditions identified by patients in the primary care cohort were dizziness and excess cerumen or otalgia, with hearing loss in one ear or sudden hearing loss the most commonly reported in the otolaryngology cohort. The absolute agreement between the patient and audiologist was 67% and 68% for the primary care and otolaryngology cohort respectively, with the agreements between the patient and otolaryngologist of 67% and 71%, and audiologist and otolaryngologist 86% and 78% respectively. Additional agreement metrics (McNemar's Test, Kappa Coefficient) will be presented, along with the audiologic assessments of hearing aid recommendations, medical clearance for hearing aid use, and otolaryngology exam results.

Conclusions: Overall, the majority of our participants in both cohorts denied having a red flag condition, which was also true based on the red flag checklists completed by both audiologists and otolaryngologists. Not surprisingly, more red flags were identified for those patients presenting with hearing complaints in the otolaryngology cohort compared to the primary care cohort where participants did not present for the purposes of hearing complaints. The absolute agreement among the raters was good. Accurate identification of red flag conditions by patients may have important implications for consumer-driven hearing rehabilitation options, especially now that over-the-counter hearing aids are on the market.

Category: Hearing Loss / Rehabilitation

Poster #: 039

Prevalence of Diabetes in a Low-Income Community Hearing Aid Bank

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Objectives: Thirty-seven million people in the United States have diabetes that may result in vascular macro- (brain, heart, and extremities) and microvascular (ear, eye, kidney, and neuropathy) complications. Minorities, those of lower socioeconomic status, and lower levels of education have a higher prevalence of hearing loss due to diabetes. The purposes of this study were to determine if: (1) social vulnerability predicts diabetes prevalence rates in the state of Oklahoma, and (2) prevalence of this chronic condition in a low-income community hearing aid bank exceeds that for the general population.

Design: An ecological study design was used to determine if social vulnerability, as an explanatory variable, predicts diabetes prevalence in Oklahoma. Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health. Data for this ecological study included social vulnerability and diabetes prevalence rates aggregated by county in Oklahoma from the US Centers for Disease Control and Prevention. ,ÄØData for this ecological study included social vulnerability and diabetes prevalence rates aggregated by county in Oklahoma. Descriptive statistics for social vulnerability and diabetes prevalence were computed across all 77 Oklahoma counties. ArcGIS was used to illustrate the social vulnerability and diabetes prevalence per county in Oklahoma. U.S. Census TIGER shapefiles were used and linked to the social vulnerability and diabetes data. Linear regression was used to demonstrate the association between diabetes prevalence (dependent variable) and social vulnerability (independent variable). Studentized residuals were examined for deviations from linear model assumptions. All statistical tests were performed assuming a 5% chance of type one error, using SAS 9.4. A cross-sectional survey and retrospective chart review of 300+ LIHHS determined the prevalence of diabetes in a community hearing aid bank. Prevalence odd ratios for diabetes were calculated for patients in the low-income community hearing aid bank compared to the general population of the state of Oklahoma.

Results: Descriptive statistics for both social vulnerability and percent county population with diabetes were used in the linear regression. The mean diabetes prevalence rate in the state of Oklahoma was 9.2%. ArcGIS maps were included as separate files. Oklahoma County social vulnerability score was associated with percent county population with diabetes (p=0.0049). For each on 1% increase in county population with diabetes, social vulnerability score increases 0.05 points (95%CI: 0.02, 0.09). The cross-sectional survey and retrospective chart review yielded a 37% prevalence rate for diabetes in our community hearing aid bank (Prevalence odds ratio = 5.94; 95%CI 2.68, 13.16; Z=4.38; p=0.000006).

Conclusions: Social vulnerability predicted diabetes prevalence rates in the state of Oklahoma. In our low-income community hearing aid bank, our patients are nearly six times more likely to have diabetes than the general population. It is important to counsel these patients about the importance of keeping control of their diabetes and monitoring their hearing sensitivity. Informational counseling materials developed for these purposes will be shared.

Category: Hearing Loss / Rehabilitation

Poster #: 040

Dementia and Hearing Aid Use and Cessation: A National Study

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Objectives: The current standard for management of hearing loss in the United States is use of a hearing aid. Anecdotal evidence suggests that use of a hearing aid use may be less effective in the context of cognitive impairment, though national data on use and cessation does not exist. We sought to examine factors associated with cessation of hearing aid use and if this was differential by dementia status. We hypothesize those with dementia are more likely to cease use of a hearing aid over time, yet factors of the care environment may facilitate continued hearing aid use.

Design: This longitudinal analysis of the National Health and Aging Trends Study (NHATS) followed participants who self-reported hearing aid use in 2011 to estimate risk of hearing aid cessation by 2020. We specifically examined whether cessation of use differed by dementia status using generalized estimating equations and logistic regression with NHATS survey weights and accounting for loss to follow-up. Supplemental analyses were undertaken to examine the contribution of caregiving and environmental factors on hearing aid cessation.

Results: Of 1,619 older adults who reported hearing loss (24% 80-84 years, 47% female, 78% White), 33% reported dementia and 53.5% reported using a hearing aid at baseline. Dementia was not associated with hearing aid use at baseline. However, older adults who had or developed dementia during follow-up were about 50% more likely (OR: 0.48; 95% CI: 0.32, 0.71) to cease use a hearing aid after adjusting for demographic, health, and economic factors. Health and environment factors were not associated with cessation of use.

Conclusions: Older adults with dementia are more likely to cease hearing aid use compared to those without, even among those who previously were users. Innovative strategies to support hearing ability in those with dementia which present self-management strategies or alternative support for communication besides a hearing aid may better meet the needs of this vulnerable population.

Category: Hearing Loss / Rehabilitation

Poster #: 041

Rural-Urban/Regional Differences in Dual Sensory Loss and Depression in India

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Objectives: Prior work suggests sensory loss may be a risk factor for depression in older adults. However, most research is focused on high income countries, and research on disparities by rural-urban status and geographic location is lacking. Within India, where 71% of adults 60 years old or older live in rural areas, there is a stark rural-urban divide in many health outcomes and socioeconomic characteristics. There is also variation in healthcare access among the states. We investigated rural-urban and regional differences in the prevalence of dual sensory loss and its association with depression in a population-based study of adults living in India.

Design: We used data from the first wave of the Longitudinal Aging Study in India (LASI), the first nationally representative survey of adults 45+ years with their spouses in 35 states and union territories. LASI obtains information about the health, economic, and social factors of aging in India. Our study sample consists of 30,555 respondents aged 60+ years with complete exposure, outcome, and covariate data.Depression was assessed with the Short Form Composite International Diagnostic Interview (score ≥3 points). Dual sensory loss was determined by respondents' self-reported or perceived difficulty regarding hearing (hearing aid use, prior diagnosis of hearing/ear-related problems) and vision (poor/very poor report of distance/near vision) function. Sensory loss was modeled as no loss, vision loss only, hearing loss only, and dual sensory loss.Multivariable-adjusted logistic regression was used to estimate the odds ratios (OR) and 95% confidence intervals (CI) between sensory loss and depression. We examined rural-urban and regional differences by inclusion of an interaction term between urbanicity and sensory loss and between sensory loss and region.

Results: Overall, 24.1% had vision impairment, 5.8% had hearing impairment, and 3.5% had both. The prevalence of depression was 9.2%. After adjusting for demographics (age, sex, education, marital status, economic status, urbanicity, and region) and health characteristics (diabetes, heart disease, hypertension, stroke, and smoking history), urban residents, compared to their rural counterparts, had higher odds of depression associated with vision loss (vs. no loss) (OR, 2.18; 95%CI, 1.73-2.76 and OR, 1.74; 95%CI, 1.53-1.97, respectively). Similarly, for urban dwellers, dual sensory loss was associated with higher odds (OR, 3.11; 95%CI, 2.02-4.79) of depression, compared to their rural counterparts (OR, 1.98; 95%CI, 1.53-2.56). After adjusting for the same covariates, the West region, containing Gujarat, Daman & Diu, Dadra & Nagar Haveli, Maharashtra, and Goa, (vs. the North region, containing Jammu & Kashmir, Himachal Pradesh, Punjab, Chandigarh, Uttarakhand, Haryana, Delhi, and Rajasthan) had a higher association between vision and dual loss and depression (OR, 2.74; 95%CI, 1.99-3.76 and OR, 9.62; 95%CI, 4.09-22.65, respectively).

Conclusions: Poor vision and/or hearing loss may be a risk factor for depression in adults in India aged ≥60 years. The association was strongest for those with dual sensory loss in urban areas or in the West region, suggesting that adults with sensory loss across multiple systems may be an important group to target for intervention, and that disparities may exist by urbanicity and geographic region in India.

Category: Hearing Loss / Rehabilitation

Poster #: 042

Hearing Loss and Fear of Falling in NHATS

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Objectives: Falls are the leading cause of injury in older adults. Recent literature suggests that hearing loss (HL) is associated with increased risk of falling. However, whether HL is associated with fear of falling (FoF) and how this fear may affect one's behavior remains understudied. We investigated this association in the National Health and Aging Trends Study (NHATS). We hypothesize that participants with HL have greater odds of reporting FoF and having limited their activity in response to that fear. Furthermore, we hypothesize that hearing aid users, compared to non-users, are less likely to have FoF and limit their activities.

Design: The NHATS is a cohort study of a nationally representative sample of Medicare beneficiaries ages 65 and older in the US. We included 2,577 participants with data on hearing and falls from Round 11 (2021). The outcomes of interest were FoF and limited activity due to FoF. Participants were asked whether they worried about falling in the last month (i.e., FoF), and those who responded yes were asked whether this worry limited their activity. Hearing status was assessed using pure-tone audiometry and categorized based on 4-frequency pure-tone average (0.5, 1, 2, and 4 kHz) as: normal hearing (<25 decibels hearing level [dB HL]), mild (≥25 to<40 dB HL), moderate (≥ 40 to<60 dB HL), and severe+ (≥ 60 dB HL) HL. Covariates included demographics (age, sex, race, education) and comorbidities (hypertension, diabetes, stroke). Participants also reported hearing aid use.

Results: A total of 646 (25%) participants had normal hearing and 958 (37%), 804 (31%), and 169 (7%) had mild, moderate, and severe+ HL, respectively. Of those with any degree of HL, 576 (30%) reported using hearing aids. Participants with severe+ HL had greater odds of reporting FoF (OR = 1.87, 95% CI 1.07, 3.27), but this association was attenuated after adjusting for demographics and health conditions (OR = 1.48, 95% CI 0.77, 2.82). However, among those who reported FoF (n=913), we found a graded association between worse hearing and odds of reporting limiting activity due to FoF in adjusted models (OR = 1.33, 95% CI 0.82, 2.15; 1.50, 95% CI 0.87, 2.58; 2.43, 95% CI 1.13, 5.21 for mild, moderate, and severe+ HL respectively [p-value for trend = 0.04]). Yet, this association was only statistically significant for those with severe+ HL. In secondary analyses including only participants with HL, we compared hearing aid users and non-users. While hearing aid users had lower odds of reporting FoF or limiting their activities than non-users, these findings were not statistically significant (OR for FoF = 0.82; 95% CI 0.62, 1.08 and OR for limiting activity due to FoF = 0.70; 95% CI 0.40, 1.24).

Conclusions: Our results suggest that worse hearing may be associated with limitation in activity secondary to fear of falling. Being able to perform daily activities is an essential component of healthy aging; thus, any limitation in activities can have a tremendous deleterious effect and quality of life. Further studies investigating the potential preventative role of hearing aids are warranted.

Category: Hearing Loss / Rehabilitation

Poster #: 043

Association Between Hearing Difficulty and Dementia on Healthcare Utilization Patterns

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Objectives: Hearing difficulty (HD) and Alzheimer's Disease and Related Dementias (ADRD) are prevalent among older adults and may each affect healthcare utilization via changes in communication and help-seeking behaviors. Yet, few have examined the combined effect of the two conditions on healthcare utilization. The

objective of this research is to characterize the effect of HD and ADRD on healthcare utilization among Medicare beneficiaries. A priori, we hypothesize that those with concurrent HD and ADRD will experience greater healthcare utilization compared to those without either condition.

Design: We pooled 2016-2019 data from the Medicare Current Beneficiary Survey, an annual nationally representative healthcare survey of Medicare beneficiaries. Proxy respondents and assistants were used for those who had trouble during the survey interview. The analytic sample included 23,546 Medicare beneficiaries 65+ years (representing a weighted population of 27.3 million). The three primary outcomes of interest were: (1) hospitalizations, (2) 30-day readmissions among those hospitalized (n = 2,325), and (3) total Medicare spending over a one- and two-year period. The primary exposure was self-reported hearing difficulty (HD) and/or self-reported physician diagnosis of Alzheimer's Disease and Related Dementias (ADRD). From this, a four-level group variable was created: no HD or ADRD, HD only, ADRD only, and concurrent HD and ADRD. Negative binomial (number of hospitalizations) and robust Poisson (30-day readmissions) regressions were used to model the association of healthcare utilization by HD/ADRD status. Medicare spending and HD/ADRD status was characterized using log-linear regression. Models were adjusted for sociodemographic and clinical covariates.

Results: In the weighted sample, 53.8% reported no hearing difficulty (HD) or Alzheimer's Disease and Related Dementias (ADRD), 43.0% HD only, 1.3% ADRD only, and 1.9% concurrent HD and ADRD. Compared to participants with neither condition, those with concurrent HD and ADRD had higher incidence of total hospitalizations over one-year (Incidence Rate Ratio [IRR]=1.31; 95% Confidence Interval [CI]=1.03-1.67) and two-year (IRR = 1.53; 95% CI = 1.15-2.02) periods. No association between HD/ADRD status and readmissions was found in the one-year (IRR=1.43;95%CI=0.94-2.17) or two-year period (IRR=1.11; 95%CI=0.72-1.72). Relative to those with neither condition, those with concurrent HD and ADRD experienced 42% ($e\beta$=1.42; 95% CI=1.07-1.87) and 89% ($e\beta$=1.89; 95%CI=1.10-3.23) higher healthcare expenditures over one-year and two-year periods, respectively. This estimates to approximately an additional $484.15 (one-year) and $2,256.96 (two-year) dollars for beneficiaries with concurrent HD and ADRD.

Conclusions: In a nationally representative survey of Medicare beneficiaries, those with concurrent self-reported hearing difficulty (HD) and presence of Alzheimer's Disease and Related Dementias (ADRD) had greater utilization of acute inpatient services compared to those with neither condition. Those with concurrent HD and ADRD may represent a particularly vulnerable population in the healthcare system. The findings are limited by subjective measures of our exposure variables as well as potential unmeasured confounding. However, initial findings support future research with greater statistical power and objective measures of HD and ADRD to better tease the observed relationship and whether it differs by important socio-demographic factors.

Category: Hearing Loss / Rehabilitation

Poster #: 044

Associations between Hearing Loss and Healthcare Utilization: Evidence from NHATS

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Objectives: Hearing loss may be a barrier to patient-provider communication and engagement with the healthcare system. In addition, hearing loss has been associated with social isolation and other mental health conditions, which in turn could lead to increased healthcare utilization.Previous work has examined hearing loss and healthcare utilization in large claims datasets. However, it has been limited by identifying hearing loss from record claims which may underestimate the prevalence of the exposure. In this analysis, we used prospective survey data linked to claims to estimate the association between hearing loss and healthcare utilization. We hypothesize that compared to those with normal hearing, participants with hearing loss experience a higher number of inpatient hospitalizations, emergency department visits, and days spent in a hospital over a 6-year period.

Design: This study used longitudinal data from adults enrolled in the 2011 cycle of the National Health and Aging Trends Study (NHATS). NHATS is a nationally representative study of community dwelling Medicare beneficiaries over 65 years of age. Participants' data were linked to fee-for-service Medicare claims from 2011 through 2016. Hearing loss was measured using self-report questions about participants' use of hearing aids and difficulty hearing on the telephone, and in quiet/noisy situations. Those who reported any difficulty hearing or reported hearing aid use were categorized as having hearing loss. Healthcare utilization measures (derived from claims data) are: number of inpatient hospitalizations, number of Emergency Department visits, and total number of days spent in a hospital per calendar year. One-to-one propensity score matching with replacement on sex, age, race, income, and number of hospital visits at baseline was performed for each participant with hearing loss during the first three cycles of the study (2011-2013) to a participant without hearing loss. Generalized estimating equations were used to estimate the association between healthcare utilization and hearing loss. Given propensity matching, unadjusted and adjusted (sex, race, income, and number of chronic health conditions at baseline) models were performed.

Results: A total of 2,464 participants (ages 65-74 (26.6%), 75-84 (41%), and 85+ (32.4%) years, 13.8% black, and 52% female) were identified as having hearing loss during the 2011-2013 NHATS cycles. Adjusted models among matched participants revealed that, compared to participants without hearing loss, those with hearing loss had 21% (Incidence Rate [IR]=1.21; 95% Confidence Interval[CI]= 1.06,1.37) and 48% (IR = 1.48; 95% CI: 1.20,1.82) significantly higher number of emergency department visits and number of days spent in a hospital over the 6-year period from 2011-2016, respectively. No association was found between hearing loss and the number of hospitalizations.

Conclusions: In a nationally representative sample of community dwelling older Medicare beneficiaries, we found that hearing loss was associated with a higher rate of emergency department visits and nights spent at a hospital. These finding suggest that those with hearing loss may be a vulnerable population for increased healthcare utilization. Future work should assess interventions such as the use of hearing aids as a means to reduce healthcare utilization and associated expenditures for older adults in the U.S. Medicare program.

Category: Hearing Loss / Rehabilitation

Poster #: 045

Motivating Diverse Adults to Take Action for Better Hearing Health

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Objectives: Hearing loss can have detrimental effects on an individual's communicative behavior, social-emotional wellbeing, and quality of life. Although hearing aids (HAs) are usually considered the most preferred solution to these problems, less than 50% of the individuals that could benefit from them actually use them. Research has demonstrated that individuals who identify as belonging to racial and ethnic minority backgrounds are even less likely to move toward taking action for their hearing losses compared to Caucasian adults. Efforts should be made to further our understanding of the barriers to hearing interventions specifically experienced by racially diverse individuals with hearing difficulties who have not taken action to resolve their hearing problems and explore the specific assistance that these individuals believe they would need to progress to the next steps. This study aimed to shed light onto these issues, and set out to answer several questions, including: "What barriers are shared by individuals with hearing loss who have not pursued hearing-healthcare? What facilitators could motivate them towards seeking hearing help? How do barriers and facilitators differ between individuals who identify as African American and Caucasian?"

Design: An interpretive phenomenological approach was used for data collection and analysis. Ten adults (ages 51-76) with hearing difficulties and no experience with HAs, and identifying as belonging to one of the two largest racial/ethnic groups in Memphis, Tennessee (5 African American and 5 Caucasian), were selected from a pre-existing database of older adult research participants. Researchers used a pre-established guide structured around the Transtheoretical Model of Change (TTM) to facilitate the interview. The results of the qualitative content analysis were compared to the COM-B model of behavioral change to highlight the primary components that participants identified as most important to impacting their hearing health behaviors and explore how they differed between individuals of the two racial/ethnic groups.

Results: Similar to previous research, our participants experienced barriers to hearing-healthcare, such as cost, lack of information, and stigma. However, individuals from African American backgrounds identified additional challenges, specifically in the areas of physical and social opportunities, to accessing hearing-healthcare services. Participants indicated that having regular access to information about hearing-healthcare could not only improve awareness of available services, but also could reduce social stigmas surrounding hearing-healthcare. In addition, these participants suggested that policies surrounding education and insurance coverage of HAs would facilitate hearing aid adoption.

Conclusions: This study highlighted shared barriers to hearing-healthcare seeking among non-hearing aid adopters in Memphis, Tennessee. Many of these were shared by all participants. However, the COM-B model highlighted the additional barriers experienced by participants of color and provided a framework to explore potential actions to improve disparities in these areas. These results suggest that targeted efforts to improve community awareness surrounding hearing loss and hearing treatment, and policies designed to improve education and access to affordable hearing-healthcare are critical to improving outcomes for all individuals but could be particularly salient for individuals who identify as belonging to minority racial/ethnic groups.

Category: Hearing Loss / Rehabilitation

Poster #: 046

Hearing Screenings in Primary Care Annual Wellness Visits

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Objectives: The primary goal of the current study was to describe the annual hearing screening process of older adults who attended annual wellness visits in primary care from 2017-2022. We hypothesized an association between increased exposure to hearing screenings in primary care and referral patterns for hearing health care. We also hypothesized that those with poorer general health would receive fewer hearing screenings and referrals.

Design: The current study consisted of a secondary retrospective chart review of 780 patients who were eligible to participate in our parent study, which was a pragmatic clinical trial that focused on hearing screening in primary care from 05/30/2017 through 07/09/2018. Of the 780 eligible participants, 660 older adults participated in the parent study, while 120 were eligible but declined participation and serve as a control group for this secondary chart review. The 660 original participants were provided a study information sheet, offered a hearing screening, and provided written education about hearing loss via a brochure. The 120 eligible participants who declined participation received the study information sheet, but no educational brochure. At the time of the parent study, all participants were aged 65-75 years of age with no history of hearing aid use or diagnosis of hearing loss. We herein refer to the parent study as the baseline visit for the secondary chart review. Data from this IRB-approved secondary chart review study will include demographic characteristics (e.g., gender identity, race, ethnicity, marital status, and insurance status); comorbidity data (e.g., all components of the Charlson comorbidity score from each primary care annual wellness visit reviewed); and primary care visit data (e.g., frequency of annual wellness visits since the baseline visit, frequency of hearing screening, type of screening completed, and outcome of visits including referrals for hearing health care).

Results: Participants were similar in age at the baseline visit, 69.3 years for the experimental group and 69.5 years for the control group, with similar sex (35.9% male vs 30.8% male) and racial (59.1% vs 57.5% White; 35.3% vs 39.2% Black or African American) group makeup, respectively. Further results will describe the demographics of the two groups, along with the frequency of annual wellness visits in primary care, number and methods of hearing screenings, and referral patterns. Non-parametrics will be used to assess group differences and regression modeling will used to determine the associations among screening frequency and referrals.

Conclusions: Data extraction is anticipated to be completed by 12/31/2022 with the analyses completed in January 2023. Conclusions will focus on describing demographics, frequency of screening for hearing loss, frequency of referral to hearing healthcare, and Charlson comorbidity scores. In addition, conclusions from regression modeling will be made to assess our hypotheses.

Category: Hearing Loss / Rehabilitation

Poster #: 047 **Mentored Student Research Poster Award**

HCHS/SOL Ototoxic Exposures and Occupational Noise-Induced Hearing Loss

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Objectives: Our study seeks to determine the prevalence of occupational noise exposure and associated risk factors for hearing loss using data from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). Hypotheses included: 1) More prevalence of noise exposure in male participants in "blue collar" jobs, 2) Occupational noise and ototoxic agent exposure, smoking, cholesterol level and blood pressure will be associated with poorer hearing, and 3) hearing protective devices will be associated with better hearing.

Design: The Hispanic Community Health Study/Study of Latinos (HCHS/SOL) is a population-based cohort study focused on identifying and investigating health risk within the Hispanic/Latino population. Analyses were performed using baseline data from the HCHS/SOL collected between 2008-2011. Individuals were aged 18 to 74 years old and were randomly selected from 4 field locations across the U.S. A total of 12,851 participants met inclusion criteria with 40% reporting occupational noise exposure "sometimes" or "frequently". Participants included adults with a complete hearing examination who also responded to the question, "At your job, how often is it or was it noisy (you needed to speak in a raised voice or louder to be heard when a person was two feet away)?" The hearing exam consisted of pure-tone air-conduction thresholds from 0.5 to 8-kHz and bone-conduction thresholds at 0.5-, 2-, and 4-kHz. Participants completed a questionnaire regarding longest-held occupation, occupational noise exposure, ototoxic agent exposure, hearing protective device use and recreational noise exposure for determining exposures. The composite Framingham Risk Score for Hard Coronary Heart Disease was used to estimate the 10-year risk of heart attack.

Results: Our study revealed significant relationships between longest held occupation, workplace noise exposure, cardiovascular disease risk, sex, age, and occupational noise-induced hearing loss and results are similar to previous studies of primarily white, non-Hispanic/Latino groups and national representative samples. Occupation type was significantly associated with poorer hearing and those in jobs other than "Professional/Office Worker" had higher worse-ear pure-tone averages. However, occupation type was not associated with self-reported workplace noise exposure. Self-reported occupational noise exposure was not associated with higher incidence of hearing impairment and may be due to the relatively young cohort and the impact of noise exposure to affect over time (i.e. with age). Cardiovascular risk score was significantly associated with worse-ear pure-tone average which is consistent with other studies suggesting cardiovascular disease as a risk for hearing loss. Of those exposed to occupational noise "sometimes" and "frequently," 30.2% did not use hearing protective devices. Similar to other studies, there was no relationship between hearing protective device use and worse-ear pure tone average. Finally, no interactions were found between noise, other ototoxic agents and pure-tone average.

Conclusions: Risk factors for occupational noise-induced hearing loss in Hispanic/Latino participants are consistent with other previously examined groups. Hearing conservation programs using hearing protective devices should consider individualized training for care and insertion of earplugs to maximize noise attenuation. In light of the Hispanic/Latino population growth trend, efforts should be made to address cultural and linguistic needs of Hispanic/Latino workers for minimizing noise-induced hearing loss risk.

Category: Hearing Loss / Rehabilitation

Poster #: 048

Prevalence and Hearing Assistive Device Use in Hidden Hearing Loss

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Objectives: Relatively little focus has been on individuals with self-reported hearing complaints despite a normal clinical audiogram. These individuals represent a population with an understudied condition, hidden hearing loss (HHL). While recent investigations have demonstrated some efficacy in hearing assistance for those with HHL; the pursuit of hearing device assistance for HHL has not been quantified on a population level. We aim to describe the prevalence of both HHL and hearing device usage for HHL, and to elucidate risk and protective factors for HHL in a nationally representative sample.

Design: We examined adult participants (aged 20-69 years) of the 2015-2016 cycle of the National Health and Nutrition Examination Survey (NHANES), a nationally representative sample of the United States population. Participants were considered to have objective hearing loss if their four-speech frequency (0.5, 1, 2, 4 kilohertz [kHz]) pure tone average, calculated in the better-hearing ear, was greater than 25 decibels (dB). Sensitivity analyses were conducted with the threshold at 20 dB. Individuals were considered to have subjective hearing loss if they self-reported "a little trouble", "moderate hearing trouble", or "a lot of trouble" hearing. Subjectively deaf (n=2) individuals were excluded. Those with subjective but not objective hearing loss according to these criteria were considered to have HHL. Hearing aid (HA) and assistive listening device (ALD) lifetime usage was queried via questionnaire. Multivariable-adjusted logistic regression models were used to model the cross-sectional association between HHL and hearing device usage, adjusting for known demographic and cardiovascular risk factors in hearing loss.

Results: 4,272 participants were included with complete audiometric hearing and complete covariate data. Overall population prevalence of audiometric HL is 7.3% and HHL is 14.7%. Among those with audiometrically normal hearing (n=3,918), prevalence of HHL is 15.9%. Older individuals (OR: 1.024, 95% confidence interval [CI]: 1.016, 1.032 per year) and those with hypertension (1.82 [1.42, 2.32]) had greater adjusted odds of HHL while White (Black non-Hispanics: 0.44 [0.34, 0.56], Hispanics: 0.63 [0.50, 0.79], and Other Race: 0.53 [0.31, 0.92]) females (0.75 [0.56, 0.99)]) had lower adjusted odds of HHL vs. normal hearing. Prevalence and adjusted odds of HA (6.1% vs. 0.03%, 168.72 [101.72, 279.96])), ALD (7.0% vs. 2.2%, 3.73 [2.17, 6.40]), or either device usage (6.3% vs. 2.2%, 6.00 [3.95, 9.13]) was greater in those with HHL vs. normal hearing. Sensitivity analysis with a 20 dB HL threshold did not change inferences but overall population audiometric HL and HHL prevalence changed to 12.8% and 12.1%, respectively.

Conclusions: In this exploratory hypothesis generating study, prevalence of HHL is high within the general US population. Those who are older, male, White, and have hypertension have greater odds of having HHL, and individuals with HHL are considerably more likely to use a hearing device than those without. Further work is needed to understand the efficacy of hearing assistance for HHL and the longitudinal implications of HHL.

Category: Hearing Loss / Rehabilitation

Poster #: 049

Low-Income Hearing Help Seekers' Willingness-to-Pay for Hearing Aids and Services

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Objectives: The US Food and Drug Administration established a new class of over-the-counter (OTC) hearing aids to increase the affordability and accessibility of amplification. The purpose of this study was to assess low-income hearing help seekers' (LIHHS) willingness-to-pay (WTP) for one digital hearing aid, services, and an OTC device and to conduct benefit-cost analyses. Another aim was to determine what factors (age, monthly income, sex, race, educational level, employment status, number in household, self-reported hearing difficulty without amplification [quiet and noise], hours/day hearing aid use, and satisfaction with services) predict WTP for hearing aids and services.

Design: A cross-sectional survey was sent to 106 LIHHS who had been fit with digital hearing aids and received bundled services at $400/instrument with many patients receiving grants to help with purchase. Participants read a short description about digital hearing aids, services, and OTC devices prior to indicating their WTP on a closed-response scale. Descriptive statistics were computed for all variables. Categories were collapsed for multiple variables due to small cell count. Initially, univariate models were created for each outcome and explanatory variables. Significant and near significant variables ($p<0.10$) from univariate models were used in a multivariate model. A backwards selection process was used to find the most parsimonious multivariate model. If there were no significant associations in univariate models, then no multivariate model was constructed. Benefit-cost ratios and net social benefit for one digital hearing aid, services, and one OTC device were calculated and respective confidence intervals were derived using a bootstrapping approach. All statistical tests assumed a significance level of 0.05 and SAS 9.4 was used for all computations.

Results: Forty-eight surveys were returned for a response rate of 51% (48/[106 - 12 return-to-sender]). Monthly income was the only variable that was significantly associated with WTP for one new digital hearing aid (Median=$250). After adjusting for covariates, the odds of WTP $500 or more for one new digital hearing aid increased 0.3% (95%CI: 0.1%, 0.05%) for every dollar of increased monthly income. Age was the only variable significantly associated with WTP for hearing aid services (Median=$250). The odds of WTP greater than $100 for all hearing aid services were 8.9% (95%CI: 1.8%, 15.6%) lower for each increased year of age ($p=0.0156$). None of the variables were associated with WTP for OTC hearing aids and 61.7% (29/47) would not be willing to pay any amount for an OTC device. Benefit-cost ratios were less than one for a digital hearing aid, services, and one OTC device. Sensitivity analysis indicated that a cost of $235, $150, and $35 for one new digital hearing aid, services, and one OTC device, respectively, would lead to an average benefit-to-cost ratio > 1.0.

Conclusions: LIHSS' median WTP for were comparatively low compared to market values for a digital hearing aid and services. The finding that age predicted WTP for hearing services may be due to the elderly having less disposable income available as they age. The large majority of LIHSS fit with digital hearing aids through traditional service-delivery models would not purchase OTC devices.

Category: Hearing Loss / Rehabilitation

Poster #: 050

Bringing the ICF Core Sets for Hearing Loss into Audiology Practice via the HEAR-COMMAND Tool: An International Approach to Enhance Hearing Healthcare

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Objectives: Failure to address hearing loss (HL) and HL-related communication problems from a biopsychosocial framework and offer an array of healthcare intervention options targeted to patients' needs, pre- and post-intervention with hearing devices, was found to be a significant factor contributing to favorable outcomes in audiology practice. That is, the biological characteristic of HL can change an individual's behavior, and behavior can be changed further by the interplay between personal determinants, context, daily functioning, and perceived disability. Nationally and internationally, the healthcare delivery model for HL is biomedical, which is a justifiable and necessary framework for addressing HL and HL-related communication problems. To enhance the efficiency and effectiveness of the biomedical model of HL, there is a significant need to bring the World Health Organization's International Classification of Functioning, Disability, and Health framework (ICF) Core Sets for HL (CSHL) into audiology practice. It is well-accepted that the ICF CSHL can facilitate the paradigm shift in hearing healthcare. In attempts, a team from Germany, the USA, the Netherlands, and Egypt collaborated on the development of a questionnaire named the "HEAR-COMMAND" Tool to address hearing and HL-related communication problems via the lens of the ICF CSHL.

Design: The categories listed in the ICF CSHL were transferred into a theory-supported, manageable concept in an audiology practice in the form of a questionnaire in English, German, and Arabic languages. The validation studies were conducted in the USA (Auburn University), Germany (H√∂rzentrum Oldenburg gGmbH), and Egypt (Sohag University) with an overall of 109 respondents for the initial and 143 for the revised version.

Results: The questionnaire contains 90 ICF-based and 30 additional questions regarding personal factors and HL covering 85% and 44% of the brief and comprehensive ICF CSHL categories, respectively. The outcome showed positive results concerning the tool's validity (e.g., content), reliability, and value in quantifying impaired daily functioning and the experience of disability from the perspective of individuals with HL.

Conclusions: The HEAR-COMMAND Tool can have the capability to bring the ICF CSHL into audiology practice, facilitate the paradigm shift in hearing healthcare, and, ultimately, enhance the hearing healthcare delivery model for HL at the national and international levels.

Category: Hearing Loss / Rehabilitation

Poster #: 051

Hearing Loss and Physical Activity Associations: Results from NHATS

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Objectives: Hearing loss, a highly prevalent condition among older adults, is associated with frailty and poorer physical function. Lower physical activity may explain these findings. Using data from the National Health and Aging Trends Study (NHATS), we hypothesized that older adults with hearing loss are less physically active than those with normal hearing. Furthermore, we investigated whether these associations varied by sex and hearing aid use.

Design: The NHATS is a nationally representative cohort study of Medicare beneficiaries ages 65 and older in the US. We analyzed cross-sectional data from 509 participants (57% female, 81% White, 9% Black) with complete physical activity and hearing assessments from the Round 11 (2021), excluding hearing aid users from our primary analyses. The outcome of interest was physical activity. Objective data on physical activity was collected through wrist accelerometry (ActiGraph CentrePoint Insight Watch). Participants wore the device for 3-7 consecutive days. We used three objective measures: 1) total activity counts (TAC), 2) daily active minutes, and 3) active-to-sedentary transition probability (ASTP, %; higher % is worse, representing more fragmented activity). Subjective measures of physical activity included self-reported participation in 1) vigorous activities and 2) walking for exercise the past month. We analyzed these measures as binary outcomes.Hearing was assessed using pure-tone audiometry. We calculated the better ear 4-frequency (0.5, 1, 2, and 4 kHz) pure-tone average (BPTA) and categorized participants into normal hearing (<25 decibel hearing level [dB HL]), mild (≥25 to<40 dB HL), moderate + (≥ 40 dB HL) hearing loss (HL).We used linear regression models to compare objective physical activity measures across hearing categories and logistic regressions for subjective measures. Our models accounted for sampling weights and adjusted for age, sex, race, education, BMI, and self-reported hypertension and diabetes. In secondary analyses, we tested whether hearing aid use was associated with higher physical activity among participants with hearing loss.

Results: There were 245 (48%) participants with mild HL and 96 (19%) with moderate + HL. In adjusted models, participants with moderate+ HL, compared with those with normal hearing, had lower TAC (-177.0 K [95% CI -349.2, -4.8]), daily active minutes (-40.6 [95% CI -77.1, -4.02]), and more fragmented activity (3.2% [95% CI 0.17, 6.2]), while associations with subjective physical activity measures were not significant. In sex-stratified analyses, the findings were only significant for men. Among participants with hearing loss (n=348), hearing aid users (n=92), compared to nonusers, had higher odds of reporting walking for exercise in the last month (OR = 2.29; 95% CI 1.11, 4.73).

Conclusions: Moderate+ hearing loss was associated with less physical activity by an average of 41 minutes per day, and more fragmented activity reflecting reduced endurance capacity. These associations were stronger among men. Hearing aid users were more likely to perceive higher levels of physical activity, while this was not

reflected objectively suggesting they may be more likely to engage in volitional physical activity, but their overall quantity of daily movement does not differ compared to nonusers.

Category: Hearing Loss / Rehabilitation

Poster #: 052

Predictors of Hearing Aid Outcomes Including Social Networks, Mental Health and Service Delivery Models

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Objectives: Factors influencing hearing aid outcomes such as hearing sensitivity, age and gender have been widely studied but factors such as social networks, mental health and service delivery models have limited investigations. This study aimed to identify and describe factors that influence hearing aid outcomes including social networks, mental health and service delivery models.

Design: A prospective cross-sectional survey design was used to explore factors that predict hearing aid outcomes. An online Qualtrics survey was sent to hearing aid users on an online platform (www.hearingtracker.com) between October and November 2021. The survey contained questions on patient demographics, audiological, general health and social factors, and self-reported hearing aid outcomes using the International Outcome Inventory for Hearing Aids (IOI-HA). Regression models evaluated potential predictors of hearing aid outcomes on the IOI-HA.

Results: 398 hearing aid users completed the survey with an average age of 66.6 (13. SD) years of which 59.3% were male. Hearing aid benefit and satisfaction (IOI-HA total score) was predicted by social networks of people with hearing loss with (p<.010; 0.03 Exp B [0.01-0.1 95% CI])/without hearing aids (P<.001; -0.1 Exp B [-0.3-0.1 95% CI]), mental health (P< 0.05; 0.6 Exp B [0.01-1.2 95% CI]), service delivery model (P<.003 Exp B[-2.6-0.5 95% CI]), work situation (p<.001; 1.9 Exp B [0.7-2.8 95% CI]), quality of life (P<.005; 1.2 Exp B [0.3-1.1 95% CI]) and self-reported hearing difficulty (P<.02; 0.8) Exp B [0.2-1.5 95% CI]).

Conclusions: Social networks defined as exposure to persons with hearing loss using hearing aids, mental health, service delivery models and work situations have been identified as important factors predicting hearing aid outcomes. These newly identified factors can inform and support optimal with hearing aid outcomes.

Category: Hearing Loss / Rehabilitation

Poster #: 053

Asking About and Providing Information on Mental Well-Being During

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Objectives: Hearing loss not only affects a person's ability to hear, but also to communicate, which can result in social disconnection, emotional distress, and reduced mental wellbeing. To identify the barriers and facilitators of hearing healthcare clinicians (HHC): (i) asking about, (ii) providing general information about, and (iii) providing personalized support for the mental health impacts of hearing loss.

Design: We conducted semi-structured individual and group interviews involving 15 HHCs with between 2 and 25 years of clinical experience (mean 9.3). Both the interview guide and the deductive process of data analysis were based on the COM-B model (Capabilities, Opportunities and Motivations required for Behaviour change).

Results: Psychological capability barriers included lack of knowledge relating to mental health signs and symptoms, management options available, referral processes, and resources/tools to assist discussion of options; as well as lack of skills relating to how to open conversations about mental wellbeing and the appropriate language to use within these conversations. Social opportunity barriers included clients' lack of openness to receive mental health-related information from their HHC. Physical opportunity barriers included limited time and resources. Automatic motivation factors included feeling uncomfortable and helpless when discussing mental health. Reflective motivation factors included clinicians' limiting beliefs concerning their role and responsibilities regarding provision of mental health support, beliefs about the potential consequences of raising mental wellbeing, and doubts about whether mental health services are truly beneficial for clients with hearing loss.

Conclusions: Application of the COM-B model for behaviour change identified factors that need to be addressed to increase the frequency with which HHC ask about and provide information on mental health within the audiology setting.

Category: Hearing Loss / Rehabilitation

Poster #: 054 **Mentored Student Research Poster Award**

Adult Hearing Care by Community Healthcare Workers Using mHealth

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Objectives: The rising prevalence of hearing loss is a global health concern. Professional hearing services are largely absent within low- and middle-income countries where appropriate skills are lacking. Task-shifting to

community healthcare workers (CHWs) supported by mHealth technologies is an important strategy to address the problem. This study aimed to evaluate the feasibility of a community-based rehabilitation model supported by mHealth technologies to provide hearing aids with a mHealth acclimatization and support program to adults in low-income communities using CHWs.

Design: Using mHealth technologies for hearing aid assessment and fitting, adults aged 18 and above from two low-income communities in the Western Cape, South Africa, were provided services by trained CHWs. A mHealth acclimatization and support program in the form of 20 different voice notes accompanied by graphical illustrations via WhatsApp or 20 different short message service (SMS) text messages was provided to participants immediately after the hearing aid fitting. The 20 messages were sent over 45 days. A quantitative approach with illustrative open-ended questions was utilized to measure and analyze hearing aid outcomes and participant experiences, perceptions, and opinions on the community-based rehabilitation model. Data was collected through initial face-to-face interviews, telephone interviews, and face-to-face visits post-fitting. Responses to open-ended questions were analyzed using inductive thematic analysis. The International Outcome Inventory - Hearing Aids questionnaire determined standardized hearing aid outcomes.

Results: Of the 152 adults in the community who self-reported hearing difficulties, 148 weresuccessfully tested by CHWs during home visits. Most had normal hearing (39.9%), 24.3% had bilateral sensorineural hearing loss, 20.9% had suspected conductive hearing loss, and 14.9% had unilateral hearing loss, of which 5.4% had suspected conductive loss. Forty adults met the inclusion criteria to be fitted with hearing aids. Nineteen of these were fitted bilaterally.Positive hearing aid outcomes and minimal device handling challenges were reported 45 days post-fitting and were maintained at six months, with participants describing the mHealth program as helpful, supportive, informative, sufficient, and clear. Only three participants reported that the program did not answer all their questions about the use and maintenance of hearing aids. All hearing aid management issues, such as feedback, battery use, and pain, were successfully addressed by the CHWs. The majority (73.7%) of participants were still using their hearing aids during the six-month follow-up.

Conclusions: Implementing a hearing healthcare service-delivery model facilitated by CHWsin low-income communities is feasible. mHealth technologies used by CHWs can support scalable service-delivery models with the potential for improved access and affordability inlow-income settings.

Category: Hearing Loss / Rehabilitation

Poster #: 055

Association Between COVID-19 and Sudden Hearing Loss in Military Veterans

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Objectives: COVID-19 is a new infectious disease with high morbidity and mortality, especially among older Veterans. Several case studies and case series have reported new onset and progression of hearing loss and tinnitus after COVID-19. However, robust, well-controlled, studies in individuals with and without COVID-19 are lacking. The purpose of this study was to examine the association between COVID-19 and sudden hearing loss in Veterans.

Design: We conducted a retrospective cohort study using Department of Veterans Affairs (VA) electronic health record data between March 2020 and October 2022. The study sample includes Veterans who were tested for sudden acute respiratory syndrome coronavirus 2 (SARS-Cov-2), the causative virus for COVID-19, and were free from a history of sudden hearing loss at the time of the first test. Veterans were classified as either having a negative test result, a positive test result without hospitalization within 30 days of the test date, or a positive test result with hospitalization within 30 days of the test date. Veterans were then followed forward in time for incident sudden hearing loss. Sudden hearing loss was measured using diagnostic codes from the health record data. Adjusted incidence rate ratios (aIRR) and 95% confidence intervals (CI) were estimated using binary logistic regression.

Results: Among 2,014,313 Veterans with SARS-Cov-2 test results, 548,908 (27.25%) had a positive test without hospitalization and 72,818 (3.62%) had a positive test with hospitalization. In this cohort we identified 1,422 cases of sudden hearing loss. The unadjusted incidence rate for sudden hearing loss among individuals testing negative for SARS-Cov-2, testing positive without hospitalization, and testing positive with hospitalization was 45.56, 41.43 and 70.04 per 100,000 person-years, respectively. In a model adjusted for age, sex, race, and ethnicity, Veterans with a SARS-Cov-2 positive test and hospitalization had a 40.2% increased risk of sudden hearing loss (aIRR: 1.40, 95% CI: 1.07-1.84) compared to those with a negative test. There was no increased risk of sudden hearing loss among Veterans testing positive but without hospitalization compared to Veterans with a negative test (aIRR: 0.95; 95% CI: 0.84-1.09).

Conclusions: It is critical to understand the risks of COVID-19 to auditory function, especially as the clinical emphasis shifts from life-threatening concerns to long-term adverse sequelae. These results suggest an increased relative risk, but low absolute risk, of sudden hearing loss among Veterans hospitalized for COVID-19. However, mechanisms behind the increased risk remain unclear. Further examination of the relation between moderate/severe COVID-19 and sudden hearing loss will improve our understanding and management of the multiple, long-term outcomes of the disease.

Category: Hearing Loss / Rehabilitation

Poster #: 056

Longitudinal Effects of Families on Spoken Language in DHH Children

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Objectives: Despite relatively similar family environments, deaf and hard-of-hearing (DHH) children's spoken language is more sensitive to family environment and dynamics than those of typically hearing (TH) children. Specifically, more enriched homes with toys and activities that promote intellectual development, that are organized in time and space, have lower levels of conflict and control, and higher levels of support tend to have DHH children with better language. One limitation of these studies is that directionality of the effects is difficult to establish because child language and family data were collected at the same time. The current study examines longitudinal data to test the hypothesis that structure and dynamics of family environment contribute to DHH children's spoken language.

Design: Two groups of children (57 TH, x ÃÖ=5.8 years; 53 DHH, x ÃÖ=6.6 years, 25 with hearing aids, 28 with cochlear implants) were evaluated twice on standardized measures of spoken language comprehension and receptive vocabulary, and a standardized measure of family environment (Family Environment Scale [FES], completed by the primary caregiver). Only participants who had complete data for both intervals were included. All children passed a non-verbal IQ screening and had a goal to learn spoken language. Both groups had comparable levels of parental education.

Results: A language composite score was calculated for each child at T1 (intake) and T2 (10-14 months later) from performance on the Peabody Picture Vocabulary Test, Following Directions/Concepts subscale of the Clinical Evaluation of Language Fundamentals-5/P, and the Sentence Comprehension subscale of the Comprehensive Assessment of Spoken Language-2. Partial correlations (controlling for age) between T1 FES subscales and T2 language composite were carried out on each group. T1 FES-Intellectual/Cultural Orientation was positively associated with T2 language in both groups (DHH: r=.450, p<.001; TH: r=.276, p=.039). In the DHH group only, T1 FES-Achievement Orientation was negatively associated with T2 language (r=-.447, p<.001) and there was a trend for T1 FES-Active-Recreational Orientation to be positively associated with T2 language (r=.261, p=.062). Hierarchical linear regression revealed that T1 FES-Achievement Orientation accounted for additional variability in T2 language above and beyond T1 language (β=-.155, p=.027). The interaction between group and T1 FES-Achievement Orientation was assessed, revealing that only for DHH children did T1 FES-Achievement Orientation contribute to T2 language beyond T1 language (β=-.280, p=.015). Consistent with the partial correlations, T1 FES-Intellectual/Cultural Orientation contributed to variability in T2 language above and beyond T1 language (β=.205, p=.048), with no interaction between hearing group and FES-Intellectual/Cultural Orientation.

Conclusions: These results provide important, novel evidence of the directional influence of family environment on language in DHH children. Specifically, mutual family interactions and values with an emphasis on intellectual, political, and cultural activities support spoken language development one year later, while an emphasis on competitive achievement has the opposite effect on children's language. Notably, these associations remain significant and sometimes are stronger in the DHH sample even when baseline language is controlled, indicating these specific family environmental attributes at baseline predict change in DHH children's language over a one-year period.

HEARING SCIENCE / PSYCHOACOUSTICS

Category: Hearing Science / Psychoacoustics

Poster #: 057

Behavioral and Electrophysiological Measures of Age-Related Minimum Audible Angles

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Objectives: Sound localization depends, in part, on sensitivity to interaural timing differences. Age-related degradations in temporal processing are therefore likely to undermine localization acuity. One measure of localization acuity is the minimum audible angle (MAA) - the smallest angular separation in the azimuthal plane that can be discriminated. The purpose of this study was to measure MAAs for low frequency sounds as a function of listener age using both behavioral and electrophysiological techniques. MAA was measured behaviorally for multiple reference locations on the azimuthal plane. Acoustic change complexes (ACCs) were measured for fixed angular shifts away from a midline reference. The hypothesis was that MAA acuity decreases with increasing age, especially for more lateral reference angles. A second hypothesis was that ACC amplitude depends on the magnitude of fixed angular shift and exhibits an age-related decline.

Design: MAAs were measured in adults (18-55 years) with bilaterally normal hearing (≤ 20 dB HL at 250-8000 Hz). The stimulus for all tests was a 200-Hz-wide band of Gaussian noise centered at 500 Hz (independently sampled for each presentation). Generalized head-related transfer functions were used to promote a spatialized sound, and all testing used ER2 insert phones. For behavioral MAAs, reference angular locations re midline were 0°, 18°, 36°, 52°, and 72°. Each interval in a two-down, 1-up 3-alternative forced-choice trial (71%) contained a sequence of three 500-ms noise bursts separated by 10 ms. In the target interval, the middle noise burst was shifted in azimuth. For the ACC, stimuli were constructed of two sequential 400-ms noise-band segments where the 10-ms off ramp of the leading segment (always the 0° referent) overlapped with the 10-ms on ramp of the spatially shifted lagging segment, creating a perceptually seamless transition. The lagging segment was shifted in azimuth by fixed angles of 4.5°, 9°, 13.5°, 18°, or 36°. Single-channel recordings were made from vertex re linked earlobes using a Neuroscan system and, for each angular shift, 220 sweeps per average were collected.

Results: MAAs increased from a mean of about 6˚ for a midline reference to about 15˚ for a reference location of 54˚. There did not appear to be a decline between young and middle-aged listeners. Across-subject variability was notable and may be due, in part, to the use of generalized head-related transfer functions. The amplitude of the ACC decreased systematically with decreasing azimuthal shift. Responses were rarely observed for shifts of 9° or less, suggesting that the electrophysiological measure underestimates behavioral sensitivity.

Conclusions: Results to date do not support age-related changes in spatial hearing across the age range tested (young to middle-aged adults). Although perceptually salient angular shifts elicited an ACC, the response was not evident for less salient, but still supra-threshold, angular shifts. Additional planned ACC testing includes angular shifts from reference locations off midline. Future work will extend this study to the older population as well as listeners with moderate cochlear hearing losses.

Category: Hearing Science / Psychoacoustics

Poster #: 058

Novel Combined Speech-In-Noise and Localization Testing for Single-Sided Deafness

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Objectives: Single-sided deafness (SSD) refers to the clinical scenario in which hearing loss in one ear is non-serviceable with traditional amplification due to profound degree or poor word recognition abilities. The traditional audiometric battery fails to adequately characterize the performance deficits experienced by individuals with SSD, such as optimizing speech in noise understanding and sound localization. Here, we propose a novel testing paradigm combining speech-in-noise and localization while monitoring head position and ear-level acoustical cues in order to characterize behavioral adaptations and quantify resultant changes to binaural cues to better understand the impact of SSD on complex binaural task performance.

Design: Eligible subjects include individuals with normal hearing and SSD. Subjects undergo testing in a hemi-anechoic chamber with 24 speakers aligned 15 degrees apart. The stimuli from the novel speech-in-noise localization task are the CID Everyday Sentences presented from a single speaker in the array. Background multi-talker babble is generated from Connected Speech Test sentences presented at random by four speakers. The SNR begins at zero and gradually increases until the subject reaches the presentation level at which they can reliably identify 100% of the target speech. Subjects are encouraged to move their head as they would naturally in everyday listening situations to optimize their listening ability. A head-worn position tracking system captures their real-time compensatory head movements. Simultaneously, in-ear measurements via probe tube microphones placed in the subjects' ear canals will capture the auditory input to each ear.

Results: Head movement patterns will be compared between subjects with normal hearing and those with SSD. The impact of head movement on binaural cues as characterized by ear-level measurements of the auditory input will be quantified according to ear-specific signal-to-noise ratios. We will also examine performance on sentence identification relative to spatial separation of signal and noise by comparing the level at which subjects can reliably repeat 50% of the sentences.

Conclusions: Compared with normal hearing individuals, those with SSD demonstrate maladaptive patterns of head movement that favor optimization of the signal-to-noise ratio in the better-hearing ear. We hypothesize that this novel paradigm will functionally differentiate individuals with normal hearing from those with SSD and provide a meaningful metric for evaluation of prosthetic device performance benefit for rehabilitation of SSD.

Category: Hearing Science / Psychoacoustics

Poster #: 059

Interaural Asymmetry, Binaural Fusion, and Interaural Time Difference Sensitivity

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Objectives: Differences in electrode array insertion depths can lead to interaural asymmetry in terms of stimulation location in the two ears, resulting in mismatched neuron populations stimulated across ears. Interaural time differences (ITDs), a binaural cue essential for localization, is especially sensitive to this asymmetry, however binaural fusion appears to be affected for only a subset of individuals and only when there is a large interaural asymmetry. The goal of the study is to determine if sensitivity to interaural asymmetry is correlated across tasks.

Design: Normal hearing adults participated in two experiments: ITD thresholds were measured using a descending series procedure. The center frequency of the stimuli in the left ear was fixed and that of the stimuli in the right ear was altered across conditions. Participants completed a four interval, two alternative forced-choice task, identifying which of the middle two stimuli had a non-zero ITD. Fusion was measured by having participants indicate the perceived number and spatial diffuseness of images they heard using a dial to alter an oval on an image of a head. For both tasks, the center frequency of the stimuli in the left ear was fixed and that of the stimuli in the right ear was altered across conditions.

Results: Preliminary results suggest that NH listeners are sensitive to interaural asymmetry for both ITD sensitivity and binaural fusion.¬†Additional data is needed to determine the relationship between the two.

Conclusions: Interaural asymmetry degrades both ITD sensitivity and binaural fusion. This may indicate a shared mechanism for both tasks, potentially with the effects of interaural asymmetry on ITD sensitivity mediated by the effects on binaural fusion.

Category: Hearing Science / Psychoacoustics

Poster #: 060

Effects of Hearing Loss and Blast Exposure on the Population Statistics of N0Spi Detection

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Objectives: Both hearing loss and blast exposure negatively affect the performance on binaural hearing tasks. In research studies, performance differences between two groups are generally evaluated in terms of differences in mean performance. However, for clinical evaluations, the ability to identify individual patients who perform below normal limits is critically important. While not typically considered, decrease in the percentage of individuals with above normal performance may be helpful for identifying dangerous exposures and successful treatments. Here we investigate differences in the distribution of performance on a variety of metrics of N0Spi detection for normal hearing individuals, hearing impaired individuals, and blast exposed individuals.

Design: Military Service Members (N = 11663), including those with elevated hearing thresholds (32%) and a history of blast exposure (27%), completed an 18-trial binaural detection task with a 500-Hz signal. Performance was characterized in terms of ten metrics based on the responses and a fitted psychometric function. For each metric the first 4 moments about the mean and the 5, 25, 50, 75, and 95th percentiles were calculated for the different groups. For each metric and statistic, normalized differences between the normal hearing and hearing impaired group and the blast exposed and no blast exposure groups were compared.

Results: The average threshold for the hearing impaired group was 1.2 dB worse than the normal hearing group and the average threshold for the blast exposed group was 0.7 dB worse than the non-blast exposed group. Both hearing loss and blast exposure caused small differences in the average performance of all the metrics. In addition to these changes in the first moment about the mean, hearing loss and blast exposure caused differences in the other moments as well as the percentiles, although the changes were less universal. In almost every case, if hearing loss caused a change in the statistic of a metric, then blast exposure also did. For example, both blast exposure and hearing loss increased the likelihood of having a hit rate below the 5th percentile. A notable

exception is that there was a reduction in the number of hearing impaired subjects that had hit rates above the 95th percentile but no corresponding reduction in the number of blast exposed individuals with hit rates above the 95th percentile.

Conclusions: Blast exposure and hearing loss have an effect on both overall performance and the shape of the underlying psychometric on an N0Spi binaural detection task. The effect was not simply a shift in the population performance, but rather a complex change in the distribution of the population. The commonality of the changes in the population suggest that the effects of blast exposure and hearing loss on N0Spi detection may share a common pathway. Important insights into the relationship between hearing loss and blast exposure and possible treatments for blast-exposed listeners with hearing difficulty may be missed if only changes in the mean performance or the performance of the bottom 5th percentile are considered.

Category: Hearing Science / Psychoacoustics

Poster #: 061 **Mentored Student Research Poster Award**

Effects of Temporal and Spectral Smearing on Consonant Discrimination in Children and Adults

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Objectives: The objective of this study was to estimate the associated effects of temporal and spectral smearing on discrimination of minimal word pairs distinguished by either vowel or consonant information in school-age children and young adults with normal hearing. In general, vowels support recognition of prosody and syntax, as well as talker identification. Cues provided by consonants facilitate lexical access, vocabulary acquisition, and development of the underlying phonological structure needed for additional vocabulary growth and word recognition. In adults with normal hearing, temporal smearing disproportionately affects consonant recognition compared to vowels, while spectral smearing is more detrimental to vowel recognition than consonants. Importantly, we know little about how spectral and temporal smearing affect phoneme recognition in children. We hypothesized that, in addition to effects of child age, temporal smearing would largely affect discrimination of minimal pairs distinguished by consonants while spectral smearing would predominantly affect vowel discrimination. Evaluation of the acute consequences of spectral and temporal smearing on phoneme discrimination in children with normal hearing is a first step to improving our understanding of the long-term effects of degraded acoustic-phonetic access contributing to speech recognition and language outcomes for children with hearing loss.

Design: Participants to date are 7 adults (19 - 29 years) and 7 children (7 - 13 years), all with normal hearing sensitivity. Data collection is ongoing. Study tasks include (1) adaptive psychophysical threshold estimates of spectral ripple discrimination and temporal gap detection, and (2) noise-masked word discrimination for three minimal pairs: Net/Nut; Sick/Stick; Coat/Goat. All threshold estimates are calculated using a 3-down, 1-up stepping rule (79.1%). Adults provide psychophysical threshold estimates with and without smearing to verify the effectiveness of the temporal and spectral smearing strategies; children provide psychophysical thresholds for un-smeared stimuli. All listeners complete speech discrimination testing in three stimulus conditions: unmodified, temporally smeared, and spectrally smeared.

Results: Results to date are as follows. Psychophysical thresholds improve with child age for all measures. In adult listeners, gap detection thresholds are poorest for temporally smeared stimuli compared to the spectrally smeared and no smearing conditions. Spectral ripple discrimination thresholds are highest with spectral smearing followed by the temporal smearing and no smearing conditions. For both child and adult listeners, spectral smearing has the greatest effect on discrimination of the minimal pair distinguished by vowel content (Net/Nut). Temporal smearing has the greatest effects on discrimination of the consonant minimal pair distinguished by the presence/absence of a stop phoneme (Sick/Stick) and the pair distinguished by voiced and voiceless stops (Coat/Goat).

Conclusions: Similar to previous literature reported in adults, acute degradations to temporal and spectral cues have different effects on discrimination of consonant and vowel information in children. Future research will investigate the long-term consequences of childhood hearing loss by evaluating phoneme discrimination, receptive vocabulary, and phonological awareness in groups of children with normal hearing and two types of hearing loss: auditory neuropathy and cochlear hearing loss.

Category: Hearing Science / Psychoacoustics

Poster #: 062

Usability of a Gamified Spatial Release from Masking Test

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Objectives: The objective of this study is to describe the user experience or usability of a gamified psychoacoustic task via the Portable Automated Rapid Testing (PART) iPad application among participants ranging in age, hearing-level, and Traumatic Brain Injury history (TBI).

Design: A test battery consisting of two Spatial Release from Masking (SRM) tasks were delivered in a quiet office room over calibrated headphones via the PART iPad application. The SRM tests used target and masking sentences picked from the Coordinate Response Measure (CRM) speech corpus (Bolia et al., 2000). Thirty-seven participants completed a gamified version of the SRM (using design elements of a video game environment) and a non-gamified version in random order. After completing the game, all participants completed the usability survey, assessing their experience with the gamified task. A subset of participants (n = 27) provided open-ended feedback. Quantitative and free-response data were analyzed to identify potential patterns in factors such as age, hearing loss, and TBI history. Results were also descriptively compared to a recent study from our research group that used similar methods but included data from a group of undergraduate students with normal hearing.

Results: Performance on non-gamified and gamified versions of the SRM task were similar in both the colocated ($r = 0.49$, $p < 0.002$) and separated ($r = 0.65$, $p < 0.001$) conditions. The difference between the conditions (SRM) was also similar ($r = 0.66$, $p < 0.001$) in both tests. No significant associations were identified in terms of participants' experience and their age, TBI history, self-reported hearing loss, or objective (audiometric) hearing loss. Survey data revealed that most participants enjoyed their experience playing the game ($M = 3.51$, $SD = 1.07$) and most reported they felt engaged with the story of the game ($M = 3.43$, $SD =$

1.07). Positive correlations between survey items (e.g., I like how the game looks and I felt engaged with the story of the game; $r = 0.78$, $p < 0.001$) indicated a potential relationship between reported enjoyment of visual elements of the game and positive user experience. The most common free-response experiences reported were that the gamified SRM task had unclear instructions (n = 13), distracting elements (n = 7) and that it was challenging (n = 9). Some participants mentioned diagnoses of Post Traumatic Stress Disorder and Autism Spectrum Disorder in their free-responses, suggesting that these dimensions may have played a role in participant results.

Conclusions: The data in this study will help inform future iterations of gamified psychoacoustic tests. Future studies which optimize a human-centered design process, particularly when including populations, such as those with Post Traumatic Stress Disorder, Autism Spectrum Disorder, and TBI might be warranted.

Category: Hearing Science / Psychoacoustics

Poster #: 063

Characteristics of Binaural and Spatial Hearing with Advancing Age

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Objectives: Typically characterized by a peripheral high-frequency sensorineural hearing loss, age-related changes to auditory function likely also include alterations to the central auditory pathway. Central processing deficits can be present even without peripheral loss and may negatively affect listening in adverse settings such as poorer signal-to-noise ratios and when there are multiple competing sound sources e.g., in a cocktail party. We hypothesize that these binaural processing deficits may be partly caused by poorer temporal precision of neural activity along the sound localization pathway and/or other deficits in the processing of complex stimuli in the central auditory nervous system. Changes along the central auditory pathway may be reflected in both behavioral and physiological auditory assessments. These changes may also be further influenced by cognitive capacity such as working memory across age, or by factors such as extended high-frequency hearing loss.

Design: Inclusion criteria include subjects aged 21-89 years old, all with bilateral, normal hearing or only a mild hearing loss from 250-4000 Hz, inclusively. Exclusion criteria include mild or greater cognitive impairment, non-native English speakers, conductive pathology, and neurodegenerative disease. A variety of assessments are used to capture performance within 5 sessions conducted at the University of Colorado Anschutz Medical Campus. Primary behavioral assessments include adaptive tests of speech understanding in noise and spatial acuity in a hemi-anechoic sound chamber, temporal fine structure sensitivity, spectro-temporal modulation sensitivity, and working memory capacity. Primary physiological assessments include the auditory brainstem response (ABR) and the calculated ABR binaural interaction component (BIC), and electrocochleography. Participants will also undergo a complete audiologic examination including measurements of extended-high-frequency (EHF) thresholds, otoacoustic emissions, and wideband acoustic immittance. Subjective questionnaires documenting hearing handicap and noise exposure are also completed. Presented in this poster are selected findings from this ongoing study. To date, 78 participants have been enrolled, with an end goal of 200 overall.

Results: Results obtained to date indicate significant relationships between age and certain assessments including working memory capacity, auditory brainstem response characteristics, temporal and spectral

sensitivity, speech-in-noise (SIN), and spatial acuity performance. Age effects are most apparent in the toughest listening conditions (ex., -12 SNR for SIN, 30-degree phase shift for TFS, off-axis listening for spatial acuity). When measurable, the latency of the main component of the ABR BIC appears to increase with age, although the sample size for these data is limited due to difficulty obtaining a replicable BIC in many subjects across ages. Potential confounding factors such as EHF hearing loss will also be examined, as well as any interactions between the various measures.

Conclusions: Age-related impacts are observed across a variety of auditory assessments and indicate there may be multiple potential contributions to listening difficulties seen with advancing age. This poster extends our understanding of hearing deficits that may be present despite normal to mild peripheral hearing thresholds, and factors that should be considered in a clinical setting, particularly with elderly patients. [Support: NIH-NIDCD R01 DC017924 (PIs: Tollin and Klug)]

HEARING TECHNOLOGY / AMPLIFICATION

Category: Hearing Technology / Amplification

Poster #: 064

Blast-Exposed Veterans: Speech Perception Benefits of Wearing Low-Gain Hearing Aids

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Frederick Gallun, PhD, Oregon Health and Science University, Portland, OR
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Objectives: This study examined the impact of fitting high-frequency, low-gain hearing aids on a group of blast-exposed Veterans who had substantive hearing handicap despite normal results on standard audiometric testing. The Veterans were assumed to have mild traumatic brain injuries and demonstrated difficulty hearing and processing speech and language in adverse listening situations. This poster will focus on changes in their speech perception performance across a 6-month hearing aid treatment trial.

Design: The participants consisted of 37 military Veterans (aged 20 - 50) recruited from a larger study that examined auditory functions, hearing, speech and language processing and executive functions in blast-exposed Veterans. In addition to elevated hearing handicap and normal audiometric test results, 18 of the Veterans also had substantive Post-traumatic Stress Disorder (PTSD). Thirty of the Veterans were assigned to an immediate treatment group and 7 were assigned to a delayed treatment group. The Veterans in the immediate treatment group were fitted with bilateral high-frequency, low-gain BTE hearing aids and asked to wear the hearing aids at least 4 hours a day for 6 months, whereas the delayed treatment group was monitored for 6 months and then fitted and wore their hearing aids for an additional 6 months. Along with common hearing aid outcome measures, the California Consonant Test (in quiet and babble) and an assessment of phonetic context sensitivity were administered pre-, 1-week-post, and 6-months-post hearing aid fitting.

Results: Twenty-two of the 30 Veterans in the immediate treatment group and all the Veterans in the delayed treatment group completed the study. The delayed treatment group showed no changes in speech perception across the delay interval, suggesting no substantive learning effects. However, the Veterans in both groups demonstrated improved performance across the 6-month treatment interval on the California Consonant Test in the babble condition but not in quiet. Precision on the phonetic context effect task also improved across the 6-month treatment interval. The Veterans co-morbid for PTSD tended to benefit more from amplification than those with limited or no PTSD, but their baseline performance also was lower and less influenced by ceiling effects.

Conclusions: The Veterans in this study reported situational benefits, in that the benefits were most noticeable in noisy and demanding listening conditions. The speech perception results were consistent with those reports in that improvements were limited to a noise condition and a demanding listening task. Of note was that the improvements in speech perception increased across the treatment interval.

Category: Hearing Technology / Amplification

Poster #: 065

Longitudinal Changes in Hearing-Related Burden Post Hearing Aid Uptake

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Objectives: Previous work demonstrating auditory-specific benefits of hearing aid uptake among adults has mostly been conducted within the narrow context of hearing care in clinical populations, which may result in response and selection bias. There is a paucity of observational data representative of the full population, including racial minorities and economically disadvantaged groups, examining the effect of hearing aid uptake on hearing-specific burden. In this study, we used representative cohort data to investigate: (a) risk factors of hearing-related burden at the study baseline; (b) the changes in burden post hearing aid uptake; and (c) whether the impact of hearing aids differs by socioeconomic variables.

Design: National Health and Aging Trends Study (NHATS) is an annual nationally representative, longitudinal cohort study of Medicare beneficiaries 65+ years that began in 2011. We identified 694 participants who initiated hearing aid use during the study period (2011-2021). Hearing-related burden was measured using two self-report questions: "{If applicable}, when using a hearing aid, do you hear well enough to…" (1) "…use the telephone?" (2) "…carry on a conversation in a noisy room?" First, multilevel mixed-effects logistic regression models with random intercepts were used to examine the baseline and change in odds of reporting hearing burden after initiating hearing aid use. Models were adjusted for multiple socioeconomic variables and health characteristics. Second, stratified analyses on race, education, and income were conducted to assess whether socioeconomic variables modified the change in odds of reporting hearing-related burden. A sensitivity analysis was conducted by additionally adjusting for pure-tone average (PTA) on participants who completed the 2021 study visit where audiometric measures were first introduced (n=271).

Results: At study baseline, Black participants (Odds Ratio [OR]=2.72, 95% Confidence Interval [CI]=1.22-6.04) and participants with advanced education (OR=2.68, 95%CI=1.32-5.46) exhibited substantially higher odds of difficulty carrying on conversations in noisy environments. Over a mean follow-up of 6.1 years after

initiating hearing aid use, participants experienced an annual decrease in odds of reporting hearing-related burden relative to the baseline measures when using the telephone (OR=0.92, 95%CI=0.84-1.01), and when carrying on conversations in noise (OR=0.81, 95%CI=0.76-0.86). In stratified analysis, slight but statistically insignificant changes in the decline of odds of burden were found across racial (White: OR=0.81, 95%CI=0.76-0.86; Black: OR=0.86, 95%CI=0.69-1.06) and educational subgroups (Advance education: OR=0.76, 95%CI=0.68-0.85; Basic/Intermittent education: OR=0.83, 95%CI=0.77-0.89). Similar patterns were found by income categories. After adjustment of PTA, the sensitivity analysis suggested no annual change (OR=0.99, 95%CI=0.84-1.16) in difficulty using the telephone, and a milder change (OR=0.84, 95%CI=0.77-0.91) in difficulty carrying on conversations in noise.

Conclusions: In a nationally representative sample of Medicare Beneficiaries from 2011-2021, those who initiated hearing aid use experienced significant decreases in hearing-related burdens. Baseline differences in burden were observed by racial and socioeconomic characteristics. However, no significant evidence was found regarding potential modifiers. Longitudinal analyses by racial and socioeconomic subgroups may be limited by sample sizes due to barriers to obtaining hearing aids. These findings support the hearing-specific benefit of hearing aids. Future research may include prospective trials targeting underrepresented populations to better understand the impact of hearing aids.

Category: Hearing Technology / Amplification

Poster #: 066 **Mentored Student Research Poster Award**

Reasons for Hearing Aid Uptake: A Qualitative Study

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Objectives: This study aimed to explore the main reasons adults with hearing loss take up hearing aids as well as their recommendations to others with hearing difficulties.

Design: A cross-sectional survey design was used with open-ended questions analyzed using qualitative content analysis. Participants (n=642) included hearing aid users in the United States recruited from the Hearing Tracker website community and the Lexie Hearing user database.

Results: Participants had a mean age of 65.4 years (13.7 SD) and included 62% males, 38% females and 0.5% others. Reasons for hearing aid uptake were categorized into three domains (personal impact, social difficulties and auditory difficulties), containing 11 main categories and 48 sub-categories. Recommendations to others with hearing difficulties constituted 8 main categories (timely help, trial period, support, affordability, technology, direct-to-consumer hearing aids, adjustments and advocacy) and 32 sub-categories.

Conclusions: Hearing aid uptake was influenced by intrinsic factors like reduced quality of life and extrinsic factors such as the availability of finances. The most frequent recommendation was not to delay seeking hearing help and to get hearing aids. Our findings may assist hearing healthcare professionals in facilitating behavior change and improving hearing aid uptake.

Category: Hearing Technology / Amplification

Poster #: 067

Optimizing and Evaluating Hearing-Aid Self-Fitting Methods Using Population Coverage

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Objectives: Over-the-counter (OTC) can allow users to self-fit their hearing aids. An optimal self-fitting should enable any user to find a gain-frequency response that provides appropriate audibility and their preferred sound quality. How to design a self-fitting method that can serve this purpose and how to evaluate it presents a challenge. In this study, two common approaches to hearing aid self-fitting are considered and compared: the 2-slider approach and the preset approach. We investigate the trade-off between the number of presets and slider steps and the population coverage and how this trade-off is impacted by the algorithms used to determine the presets.

Design: Audiograms from the National Health and Nutrition Examination Surveys (NHANES) were identified based on the target market for OTC hearing aids. For each of the identified audiograms, the NAL-NL2 real-ear insertion gain targets were computed. To account for user preferences that differ from NL2 prescription, transfer functions accounting for the known deviations of preferred settings from NL2 targets were superimposed on the targets. This yielded 160,299 total gain-frequency configurations that need to be covered by self-fitting. To investigate the trade-off between number of presets or slider steps and the population coverage, configurations were reduced using principal components analysis (PCA). Preset optimization was determined by applying different algorithms (genetic, greedy, and k-means clustering) to the PCA space and varying the number of presets. Slider optimization was determined by changing the number of steps each slider in a 2-slider interface was mapped to. Population coverage for each approach was then calculated. A user was considered covered if an approach covered their potential preferred configurations within 5 dB at all frequencies. Weights, based on the distribution of preferred gain-frequency responses relative to NL2 targets were applied to the set of configurations. Weighted configurations were then used to calculate the population coverage for some preset or slider configuration.

Results: Population coverage increased with number of presets and slider steps. For presets, the genetic algorithm performed the best. With 20 presets, the genetic algorithm produces presets that cover 60% of the population, and at 40 presets approximately 85% of the population is covered. Improvement in coverage above this number of presets is small. A user interface with two sliders showed little improvement in coverage above 10 steps per dimension on each slider. Ten steps on each slider provided a population coverage of 78.24%. For the same number of parameters that could need to be adjusted by the user, the preset approach yielded higher population coverage than the slider approach. Including demographic information to refine the target population yielded significant improvements in coverage.

Conclusions: We proposed a novel approach to designing gain-frequency presets and slider mapping for hearing aid self-fitting. We also used a novel metric - population coverage - to evaluate, compare, and optimize preset-based self-fitting methods. We found that presets identified using the genetic algorithm out-performed other methods in determining self-fitting gain-frequency responses.

Category: Hearing Technology / Amplification

Poster #: 068 **T35 Research Trainee Poster**

Feasibility of Low-cost Ear Scanning Technologies

Sarah Kendall Coreas, BS; Todd Ricketts, PhD, Vanderbilt University Medical Center, Nashville, TN

Objectives: Current ear-scanning technologies have emerged as an efficient and safe alternative to traditional earmold impressions which preclude the need for shipping physical impressions. These technologies, however, are not ubiquitous due, in part, to their proprietary status and high price point. While non-custom coupling has become increasingly popular, particularly for receiver-in-canal and over-the-counter devices, this is not the optimal solution for some hearing aid wearers because of suboptimal/inconsistent fit, poor retention, or both. This project assessed the viability of a low-cost smartphone-based ear scanning technology to produce successful semi-custom earpieces and compared their performance to current non-custom solutions.

Design: The project included 22 adult volunteers that responded to an email inquiry. Participants' ears were scanned with the Xyken smartphone app and the resulting 3D files were used to produce semi-custom silicone earpieces. The semi-custom silicone earpieces were subsequently compared to receiver-in-canal style devices with non-custom domes, and non-custom foam tip earpieces. The three solutions were presented in counterbalanced order with instructions to insert, remove, and reinsert each option. Participants then assessed each solution relative to subjective ease of insertion, comfort, retention, own-voice quality, and tightness via a 9-point Likert style scale.

Results: Results: The Xyken semi-custom option and two non-custom solutions performed comparably in 3 of the 5 categories. All three solutions received similar mean subjective ratings in the retention, tightness, and ease-of-insertion categories. The semi-custom solution however, received the highest average comfort and own-voice quality ratings.

Conclusions: Conclusion: Overall, the results indicate that the Xyken silicone earpieces can provide a customized fit with fit-related outcomes that were similar or better than current non-custom solutions. This includes a lack of the bothersome occlusion effect present in some unvented custom and non-custom devices. This supports that this technology has potential as a viable option for limited-depth ear-scanning and may have important implications for rapid prototyping/manufacture of low-cost custom coupling.

Category: Hearing Technology / Amplification

Poster #: 069

Offering Over-the-Counter Hearing Aids in a Community Hearing Aid Bank

Jayden M. Sarabia, BS; Emily Carter, BS; Carole Johnson, AuD, PhD, HERO Lab; University of Oklahoma Health Sciences Center, Oklahoma City, OK

Objectives: The US Food and Drug Administration created a new class of over-the-counter (OTC) hearing aids to increase the accessibility and affordability of amplification. These devices are to be sold directly to consumers with mild and moderate hearing losses who must self-fit the instruments. The United Way Hearing Aid Bank (UWHAB) offers hearing aids at $400/instrument that includes a hearing evaluation, hearing aid fitting, two follow-up appointments and 90 days of free services to low-income hearing help seekers (LIHHS: Annual Incomes< 170% of the US Federal Poverty Level when accounting for household size) living in central Oklahoma. Our aims were to determine the proportion of LIHSS who are potential candidates for OTC devices and obtain their impressions of this new class of hearing aids. We hypothesize that a significant proportion of the LIHSS would be suitable candidates for but may have reservations about OTC devices.

Design: A retrospective chart review was conducted to determine the proportion of 300+ LIHSS patients who were potential candidates for OTC devices. Candidacy required a four-frequency pure-tone average of < or = 60 dB HL in both ears. Exclusion criteria were having: (1) asymmetry of hearing loss, (2) having clinically significant tinnitus, and/or (3) balance disorders when initially presenting to the UWHAB. Interviews elicited LIHSSs' impressions of OTC hearing aids regarding intent to purchase (pharmacies, online, and from the UWHAB), perceived ability to self-fit, importance of help from an audiologist, willingness-to-pay (WTP) and other concerns (cosmetics, physical fit, purchase of batteries, and sound quality).

Results: Thirty-seven percent of LIHSS who participated in the UWHAB were potential candidates for OTC hearing aids. Results of 25 LIHHS interviews indicated that most (>75%) would not purchase an OTC device from a pharmacy or online but some may obtain them from an audiologist. More than half reported a lack of confidence in their ability to self-fit and had reservations about the sound quality provided by and the noticeability of these devices. The large majority (>75%) would not purchase OTC hearing aids.

Conclusions: The high prevalence of potential candidates warrants inclusion of counseling about and consideration of OTC hearing aids as a treatment option in the UWHAB. Negative attitudes indicated a need for extensive informational counseling about benefits to be derived from the use of OTC hearing aids. Based on the results of this study, counseling and rehabilitative protocols were developed and will be shared.

Category: Hearing Technology / Amplification

Poster #: 070

Pharmacists' Preparedness to Assist Consumers with Over-the-Counter Hearing Aids

Caroline Muegge; Bethany Rose; Carole Johnson, AuD, PhD, HERO Lab; University of Oklahoma Health Sciences Center, Oklahoma City, OK

Objectives: The US Food and Drug Administration created a new class of over-the-counter (OTC) hearing aids that are to be sold directly to the consumer to increase the accessibility and affordability of amplification. Pharmacies have been mentioned as ideal places for consumers to purchase OTC hearing aids with assistance from pharmacists. Currently, it is not known if pharmacists are prepared for this role. Our primary aim was to assess pharmacists' readiness to assist consumers in the purchase of OTC devices. A secondary aim was to

provide informational materials to pharmacists about OTC devices. We hypothesized that pharmacists knew nothing about OTC hearing aids and were not ready to help consumers in their purchase.

Design: Local and national cross-sectional surveys were conducted assessing pharmacists' knowledge about OTC devices. A local face-to-face survey was administered to pharmacists working in 75 randomly selected pharmacies in the Oklahoma City metropolitan area. A link to the same survey on Qualtrics was made accessible via listservs and Facebook pages for pharmacists from around the US. After completion of the survey, pharmacists received an informational packet about OTC hearing aids and the role they might play in assisting consumers in the purchase of these devices.

Results: Both the local and national cross-sectional surveys found that less than 5% of pharmacists knew what OTC hearing aids were nor did they know that they may be expected to assist consumers in their purchase. Few knew that OTC hearing aids were for people with mild and moderate hearing losses. Further, few knew the difference between OTC devices and hearing aids fit by audiologists or hearing aid dispensers. All pharmacists were interested in receiving information about OTC hearing aids and how to best assist consumers with hearing loss. The informational packet was well-received and contained information about: (1) OTC hearing aids, (2) candidacy for these devices, (3) how they work, and (4) when consumers should be referred to an audiologist.

Conclusions: The results of the local and national cross-sectional surveys indicated that pharmacists were not prepared to assist consumers with purchasing OTC devices and were very interested in learning about them. Informational packets about OTC hearing aids for pharmacists will be made available for visitors to our poster.

Category: Hearing Technology / Amplification

Poster #: 071

Consumer Perspectives on Hearables: Needs, Knowledge-Seeking, Self-Fitting and Benefits

Melanie Ferguson, PhD, Curtin University, Perth, Australia
Ellen Bothe, PhD; Bec Bennett, PhD, Ear Science Institute Australia, Perth, Australia
Rujia Jiang, PhD, University of Western Australia, Perth, Australia

Objectives: The over-the-counter (OTC) agenda to increase accessibility and affordability of hearing healthcare has led to a rapid increase in new consumer hearing technologies, such as hearables. Despite the discussions around these, there is little research on consumer perspectives in real-world scenarios. Hearables have the potential to improve situational hearing difficulties and to provide a gateway to conventional hearing aids. Objectives were to (i) understand what consumers want and need from hearables, (ii) investigate how consumers would search for information on hearables to guide decision-making, (iii) identify barriers and enablers for self-fitting, and (iv) assess the benefits and problems associated with hearables in the real-world.

Design: Four focus groups with adults with hearing difficulties were conducted to obtain views on what they want and need from hearables. A single focus group was also held to obtain views on hearables from audiologists. Verbatim transcripts were analysed using Inductive thematic analysis. An exploratory study was then conducted with adults with hearing difficulties who did not wear hearing aids (n=5; total planned n=10). A video-recorded, qualitative Think Aloud methodology obtained views and perspectives in real-time for both knowledge-seeking and self-fitting of Nuheara IQbuds2 Max devices, followed by a semi-structured interview to obtain additional insights. Devices were trialed in the real-world for two weeks.

Results: Adults with hearing difficulties described a strong desire for trustworthy information on hearables without pressure to make a purchase. Many expressed a preference to purchase hearables in an audiology, rather than retail, setting. Cost was generally described as minimally important relative to product quality. Audiologists' impressions of hearables were balanced between viewing them as less effective than hearing aids and viewing them as a useful tool. Audiologists did not necessarily consider it their role to participate in the provision of hearables but described having a duty to provide clients with sound advice about them. Preliminary results of the exploratory study showed that all participants sought information on product comparison/reviews, device features, and cost. Key requirements for participants were a trusted resource that provided reliable reports of features, costs and reviews. There were three barriers to self-fitting (physical, technical, cognitive), and input from a researcher was required for all participants. Fitting the earbuds, navigating the app, and understanding the hearing test results were the key barriers. Pre-post device fitting, hearing disability improved significantly. Situational used was reported by all participants.

Conclusions: People with hearing difficulties desire trusted audiological support even when considering over-the-counter devices. Current findings highlight the need for audiologists to develop effective methods to engage with clients about these products. Key components of pre-purchase knowledge are comparison of options, trusted resources and an evidence base, which will feed into a study to develop a decision support intervention for hearing healthcare. Self-fitting was often problematic, and clear, accessible guidance is needed. Hearables appear to be a potential option for those who do not want hearing aids.

Category: Hearing Technology / Amplification

Poster #: 072

High-Level Evidence on the Effectiveness of Hearing Aids and PSAPs

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David Maidment, PhD, Loughborough University, Loughborough, UK
Bec Bennett, PhD; Ellen Bothe, PhD; Kento Nakano, BS, Ear Science Institute Australia, Perth, Australia

Objectives: Systematic reviews with meta-analyses are the highest level of research evidence, with Cochrane reviews being the 'gold standard'. An influential Cochrane Review of hearing aids for mild to moderate hearing loss (MMHL) was published in 2017. In recent years, personal sound amplification products (PSAPs) have been available as a more accessible and affordable alternative to hearing aids. A previously published systematic review on PSAPs in 2018 was not able to conduct meta-analyses due to limited studies on PSAPs. The objectives were to update the previous (i) Cochrane Review on hearing aids, including two new outcome domains, cognition and mental health, and (ii) systematic review on PSAPs, comparing PSAPS with the unaided condition and conventional hearing aids.

Design: The standard methodological procedures expected by Cochrane were used, including the Cochrane Risk of Bias tool to assess study quality. Seven new randomized controlled trials (RCTs) were included, in addition to the previous five studies, and meta-analyses were conducted for each outcome domain. Twelve studies were included in the PSAP review, where the primary outcome was speech intelligibility. Meta-analyses were conducted where outcomes were compared for devices that were categorized as premium (hearing aids ≥ 16 channels; PSAPs ≥ US$270) and basic (<16 channels; US$<270).

Results: Preliminary meta-analysis of the Cochrane review data extracted to date showed that hearing aids significantly improved performance on cognitive tests that are classified as executive function (e.g. working memory, verbal fluency) for studies that are heterogeneous (p=.005, I2 heterogeneity = 0.00). However, memory measures (e.g. delayed word recall) showed there was no significant effect of hearing aids (p=0.294; I2=0.00). For mental health, there was no effect of hearing aids on depression (the key outcome) across all four included studies. However, sensitivity analysis, whereby results from the Geriatric Depression Scale were analysed separately, showed a significant effect of hearing aids (p=0.003; d=0.48; I2=.028). Further analysis of requested study data may change these results. Meta-analysis of eight comparable studies showed that speech intelligibility for PSAPs was significantly better than unaided ($p<0.001$), regardless of cost. A meta-analysis of six studies showed no differences between hearing aids and PSAPs, regardless of cost, however, 4 out those 6 studies favoured PSAPs. Premium PSAPs performed significantly better than basic hearing aids in 5/5 studies ($p\leq0.01$) but underperformed compared to premium hearing aids in 2/2 studies ($p\leq0.01$). Basic PSAPs underperformed in all conditions.

Conclusions: Building on the previous Cochrane review results that showed hearing aids are clinically effective for listening ability, and hearing-specific and general quality of life, this updated review suggests that hearing aids are also effective at improving cognition relating to executive functions, and may be effective at improving depression. PSAPs perform better than nothing (unaided) for speech intelligibility. Nevertheless, there is a hierarchy of effectiveness for speech intelligibility, where premium hearing aids perform better than premium PSAPs, and premium PSAPs perform better than basic hearing aids. Therefore, premium PSAPs are a potentially effective option for the 40% with adults with MMHL who do not want hearing aids.

Category: Hearing Technology / Amplification

Poster #: 073

Verification and Validation Comparisons of Current D2C and Traditional Hearing Devices

Mayra Rodriguez, BS; Jade Kwan, BS; Jiong Hu, AuD, PhD, University of the Pacific, San Francisco, CA

Objectives: Current Direct to Consumer (D2C) hearing devices employ advanced consumer electronics technology that have allowed manufacturers to develop self-adjustment algorithms as an integral part of their products. They are thought to have the potential to change the interactions between patients with hearing loss, clinicians, and the industry in the future. However, the clinical efficacy and effectiveness of such devices/approaches remain unclear, especially when compared to current standard of care. The purposes of this study were to 1) measure outputs from two D2C devices on the market and a traditional hearing aid (HA); 2) to verify and compare to best-practice targets (NAL-NL2); and 3) validate their perceived benefit from the patients.

Design: Twenty-two subjects were recruited. One premium level Receiver-In-the-Canal (RIC) traditional hearing aid ("big five") and two D2C devices (Eargo and Bose) were used. D2C manufacturers' self-adjusting procedures were followed by the patients. Experienced clinicians fit the traditional HA with a non-real-ear "first-fit" condition and a real-ear assisted "best-practice" condition. Real-ear measurement and verification were performed with Audioscan Verifit 2. NAL-NL2 formula based on the patients' hearing loss were used as targets. Questionnaires on various aspects of the devices' sound quality were used to validate perceived benefits from the patients

Results: Statistically significant higher Speech Intelligibility Index (SII) and lower target Root Mean Square Error (RMSE) were found in Eargo's output than "first-fit" premium hearing aids across different input sound levels. Traditional premium hearing aids however provided significantly higher SII and lower RMSE than both Eargo and Bose devices, when real-ear assisted best-practice was performed by the clinicians. One of the two D2C devices, Eargo, provided better SII and RMSE compared to targets than Bose in all conditions tested, but the differences were not significant based on number of patients in this study. No significant differences were observed amongst the three devices in majority of the questions asked in the validating the subjective perceptions from the patients.

Conclusions: In summary, the efficacy and effectiveness of self-adjusting D2C devices were shown to be able to provide adequate gain for patients with mild-to-moderate hearing loss. We further demonstrated that without well-trained Audiologists with best practice, even a premium level traditional hearing aid may not outperform those directly purchased from the market. The results of this study may inform future design and development of self-adjusting D2C and/or OTC hearing aid strategies grounded in principles of hearing science and clinical audiology.

Category: Hearing Technology / Amplification

Poster #: 074

Direct to Consumer Hearing Devices: Objective and Subjective Measurements

Jiong Hu, AuD, PhD, University of the Pacific, San Francisco, CA
Jayaganesh Swaminathan, PhD, Eargo Inc.

Objectives: Current development in advanced consumer electronics allows manufacturers to develop direct to consumer (D2C) hearing devices. Such devices are thought to be market disruptors that may change the way patients, clinicians, and the industry operate and interact in the future. However, questions remain about the clinical efficacy and effectiveness of such devices/approaches compared to current standard of care. The goals of this study were to 1) assess the accuracy and reliability of in-situ hearing thresholds measured with a D2C device (Eargo Inc); 2) to objectively verify the output of such devices and its comparison to traditional hearing aids; and 3) to compare and contrast patient's subjective feedback in using these devices.

Design: One hundred and twenty-two subjects were recruited. Severity of hearing loss and usage of hearing aids varied amongst participants. Listeners' hearing thresholds were measured via an app (Eargo's Soundmatch feature) in an anechoic sound booth and a quiet room (with minimal background noise). The subjects self-administered hearing evaluation using Eargo devices and the app. Audiometer thresholds were obtained with an ANSI Type I clinical audiometer following clinical best practice methods between 0.5 and 4 kHz. Two D2C devices (Eargo and Bose) and one premium level Receiver-In-the-Canal (RIC) traditional hearing aid ("big five") were used in the verification and validation phase. Patients followed self-adjusting procedures provided by the D2C manufacturers. Fitting of traditional HA was performed by experienced clinicians with a non-real-ear "first-fit" condition and a real-ear assisted "best-fit" condition. Output verification of all three devices were performed by real-ear measurements and compared to NAL-NL2 targets based on the patients' hearing loss. Validation of the fittings was measured by questionaries on varies aspects of the devices' sound quality and patient satisfaction.

Results: Audiometric thresholds measured using Eargo's Soundmatch were comparable to the thresholds measured using Clinical best practice methods. The mean thresholds measuring using Eargo devices/app in a quiet room had an accuracy of 90% relative to the clinical audiometer measurements. Statistically significant correlations were found between hearing thresholds obtained from Eargo in booth and the clinical audiometer ($p < 0.0001$). Real-ear verification of the Eargo device showed significantly higher Speech Intelligibility Index (SII) and lower target Root Mean Square Error (RMSE) than "first-fit" premium hearing aids across different input sound levels. With real-ear assisted best practice fitting performed by Audiologists, however, traditional premium hearing aids provided significantly higher SII and lower RMSE than both Eargo and Bose devices. Between the two D2C devices, Eargo provided better gains compared to targets than Bose, but the differences were not significant based on number of patients in this study. Subjective validation obtained from patients showed no significant differences between all three devices.

Conclusions: The accuracy of Eargo measured thresholds were within the 10 dB HL test-retest reliability range typically used in clinical practice. Overall, the results from this study suggest that hearing assessment conducted with D2C devices such as Eargo can provide accurate and reliable inference about the hearing status of individuals compared to clinical best practice methods. We also showed that the efficacy and effectiveness of self-adjusting D2C devices providing adequate amplification for those with mild-to-moderate hearing loss. The importance of the role well-trained Audiologists with best practice plays in providing hearing health care to patients in need was also demonstrated. The results of this study may inform future design and development of self-adjusting D2C and/or OTC hearing aid strategies grounded in principles of hearing science and clinical audiology.

Category: Hearing Technology / Amplification

Poster #: 075 **Mentored Student Research Poster Award**

Pharmacy Delivery of Over-The-Counter Hearing Aids: Stakeholder Opinions

Arianna Bartolome, BA; Michelle Arnold, AuD, PhD; Victoria Sanchez, AuD, PhD; Morgan Oktela Fuentes, AuD, University of South Florida, Tampa, FL

Objectives: Over-the-counter (OTC) hearing aids became FDA regulated and available for consumer purchase in 2022, largely within pharmacies. Pharmacists are a natural point of contact for patients seeking to purchase OTC hearing aids, as the role of the pharmacist has historically been vital in community health, providing patients with medical advice, vaccines, and medications. The present study sought to provide insight into the key learning needs of pharmacists and staff to effectively develop a training protocol with pertinent knowledge regarding over-the-counter hearing aids. Our primary research question was, "What are the learning needs of pharmacists and pharmacy staff regarding OTC hearing aids?" and the secondary research question was, "What are stakeholders' opinions of over-the-counter hearing aids in a pharmacy delivery model?"

Design: Semi-structured interviews and focus groups with pre-determined topics were used when interviewing stakeholders. Stakeholder groups were as follows: 10 audiologists (2 focus groups, 5 interviews), 11 audiology students (2 focus groups, 2 interviews), 5 pharmacists/pharmacy students (1 focus group, 1 interview), and 5 adults with hearing loss (1 focus group, 3 interviews). Interviews and focus groups were recorded on Microsoft Teams, transcribed, and coded using MAXQDA 2022 Analytics Pro software. Common themes within- and between- groups were extracted using a code book with subcodes, and clear definitions of topics for each

stakeholder group. Codes were then constructed into thematic networks, organizing recurring themes within and between groups, to identify major themes and relationships.

Results: Major themes found among all stakeholder groups included safety concerns, expected knowledge of the pharmacist, role of the pharmacist in OTC hearing aid delivery model, and opportunities with OTC hearing aids. Unique themes for audiology included, OTC technology questions, and other challenges and concerns. Unique themes for pharmacy stakeholders included need for effective training materials, audiology-related questions, and other challenges and concerns. In addition to shared codes with other stakeholder groups, adults with hearing loss had a unique code sharing their own experience with hearing aids.

Conclusions: The findings of this study provide insight into the critical learning needs of pharmacists and staff and will serve to inform a training protocol and reference for pharmacies to allow for knowledgeable counseling and guidance of patients with OTC hearing aids, thus, improving access to these devices for consumers.

Category: Hearing Technology / Amplification

Poster #: 076

Development of Hearing Aids Objective Outcomes for Hearing Aids Research

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Objectives: We developed a suite of Hearing Aids Objective Outcomes (written as HO2 and pronounced as [hot] /h…ë:t/) app comprising audio and audio visual stimuli using natural speech from a language in which the hearing-impaired person has competence. The old adage from business management "If you can't measure it, you can't improve it," is apt for modern hearing aids (HAs). The main goal of hearing loss (HL) intervention is to improve speech intelligibility in multiple listening environments, including multiple talkers and background noise. However current HL intervention is largely based on pure tone audiometry which is limited to spectral changes induced by HL and does not necessarily predict speech intelligibility in multiple listening environments. The overarching goal of the HO2 app is to develop a functional measure of speech understanding that would be applicable to multiple listening contexts. The mandatory (shall) requirements for HO2 are (i) to focus on the front-end transduction impairments leading to sensorineural HL, while minimizing the role of higher level (cortical) language processes, and (ii) to elicit the role of visual cues such as lip reading relied on by most hearing-impaired persons. The desirable (should) features of HO2 include (i) ability to self-administer, (ii) provide actionable information to clinicians for improving HA fitting, and (iii) potentially to provide actionable data to machine learning agents for improving the quality of over- the-counter (OTC) HAs.

Design: HO2 app is enabled by multiple software tools including (i) a multi-lingual data collection tool for audio and audio-visual stimuli based on minimal contrast sets (MCS) of words in a given language. Each word in a given subgroup of words in MCS differ in only one (acoustic) phonetic feature that results in a different meaning - phonemics of the given language. (ii) Interfaces to researchers to configure the app for (a) unaided and aided conditions; the aided conditions may comprise of different fitting strategies and multiple HA sound

processing algorithms; (c) selecting audio stimuli with and without video; (d) adding different noise types at different SNR levels; and (e) automatically generating word level accuracies, phonetic confusion matrices, and broad phonetic class confusion matrices. (iii) The confusion matrices enable researchers to use HO2 in an iterative manner by selecting stimuli that address perception errors at individual and at group levels and investigate various static and dynamic aspects of subband amplification. (iv) Ability to save the customized aided conditions in a configuration file and share with other researchers for repeatability and reproducibility. HO2 app was originally developed to run on OSP hardware devices, and a cloud-based version is available at http://nadidemo.org/ho2app.

Results: We present the feasibility of normal and hearing-impaired subjects to self-administer speech comprehension tests in multiple listening conditions.

Conclusions: HO2 app is a functional test for speech comprehension in a language of competence by a hearing-impaired user. The device- and cloud-based tools enable (i) clinicians (current best practices) and (ii) hearing-impaired users (emerging OTC HAs) to improve HA fitting.

Category: Hearing Technology / Amplification

Poster #: 077

Device Use in Spanish-English Bilingual Children with Hearing Loss

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Objectives: Consistent device use is an integral component of supporting auditory experience and auditory habilitation for children with hearing loss. Despite research examining device use in children, there are currently few studies examining device use in large samples of Spanish-English bilingual children with hearing loss. This population may lack sufficient support for consistent device use as a result of the limited number of Spanish-speaking professionals who provide early intervention in the U.S, and this lack of support may place these children at-risk for limited device use. This study sought to examine patterns of device use and predictive factors for Spanish-English bilingual children with hearing loss compared to monolingual English-speaking children with hearing loss.

Design: Two-hundred sixty-two monolingual English-speaking children with hearing loss and 210 Spanish-English bilingual children with hearing loss were recruited as part of a multi-center study to validate a novel measure of Spanish-English masked speech recognition. We examined device use based on parent report or data logging for children who used hearing aids, cochlear implants, bone conduction devices, or a combination of these devices. Factors associated with device use from previous studies were also examined as predictors of device use, including unaided hearing levels, maternal education level, and age.

Results: Spanish-English bilingual children with hearing loss had fewer hours of device use than monolingual English children with hearing loss. However, differences between Spanish-English bilingual and monolingual English children with hearing loss were smaller when the child had at least one cochlear implant or a bone

conduction device. Children who use cochlear implants had the most consistent device use for both language groups, followed by children who used hearing aids. Bone conductive device use was less than 4 hours per day on average for both language groups. Children with poorer unaided hearing, higher maternal education, and older children had more hours of device use than peers with better unaided hearing, lower maternal education, and younger children.

Conclusions: Spanish-English bilingual children with hearing loss are at-risk for limited device use, particularly when the child uses a hearing aid. Bone conduction device use was very limited for both Spanish-English bilingual and monolingual English children with hearing loss. In both groups, factors associated with device use were similar to patterns observed in previous studies, such as unaided hearing levels, maternal education, and age. Interventions to increase device use in children with hearing loss should be developed that consider the family's language and cultural background as a factor in supporting consistent device use.

PEDIATRIC AUDIOLOGY

Category: Pediatric Audiology

Poster #: 078

Understanding The Link Between Audibility and Pediatric Hearing Aid Use

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Objectives: The objective of this study was to determine how pure-tone average and the unaided and aided speech intelligibility index (SII) impact hearing aid device use in pediatric hearing aid users, 0-18 years of age. Our hypothesis is that hearing aid use (measured via datalogging) increases with age, degree of hearing loss and is correlated with unaided and aided audibility as quantified by the speech intelligibility index with reference to normative values established by the UWO-PedAMP protocol.

Design: A retrospective study was conducted to review data from pediatric hearing aid users, ages 0-18 years old, fit between October 2018 and September 2022. Over 600 pediatric hearing aid users were included if they were fit with at least one hearing aid prior to age 18 years of age. Three and four-frequency pure-tone average, unaided and aided speech intelligibility index (SII) data, and datalogging results were collected from all participants. Data was analyzed to determine the correlation between SII values and data logging and the effects of age and pure-tone average on datalogging.

Results: Data has been mined and will be analyzed to uncover the impact of pure-tone average, unaided and aided speech intelligibility indexes and datalogging. Our hypotheses as stated above will be explored. We expect that device use is linked to audibility and that as hearing loss increases and unaided audibility decreases, hearing aid wear time will increase, especially after 3 years of age.

Conclusions: Understanding the impact of hearing loss and audibility on hearing aid device use can be a useful tool for counseling parents and improving hearing aid use. When looking at trends in hearing aid fitting and use, recent studies have suggested that hearing aids should be fit when unaided SII is poorer than 80, but we have

not yet studied how consistent device use is when we use the SII to quantify audibility. If clinicians are able to identify different thresholds of device use and benefit, it may help with counseling and promote full-time hearing aid use.

Category: Pediatric Audiology

Poster #: 079

Hearing Device Use and Outcomes in Children with Cochlear Nerve Deficiency

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Matthew Fitzgerald, PhD, Stanford University, Department of Otolaryngology | Stanford Ear Institute, Stanford, CA

Objectives: Cochlear Nerve Deficiency (CND) refers to a small (i.e., hypoplastic) or absent (i.e., aplastic) cochlear nerve and is associated with sensorineural hearing loss (SNHL) ranging from mild to profound. CND is a relatively common cause of congenital SNHL in children, with prevalence rates as high as 76% in children with single-sided deafness. There is limited published data regarding hearing device use and outcomes in children with CND, which poses a challenge for evidence-based audiologic management. As such, the purpose of the present study was to investigate hearing device use and outcomes in a clinical cohort of children with CND.

Design: Retrospective chart review was conducted for 52 children 0 to 21 years of age who were identified as having CND in at least one ear. Diagnostic criteria for CND included radiology reports noting an "aplastic or hypoplastic nerve" on MRI and/or a "narrow internal auditory canal and/or stenotic cochlear aperture" on CT. Hearing device use was quantified as the proportion of children with CND using one or more of the following devices: conventional hearing aid (HA), bone conduction hearing device (BCHD), contralateral routing of signal (CROS) device, frequency modulation (FM) system, or cochlear implant (CI). Hearing device wear time was measured by datalogging within the manufacturer software. Information regarding hearing device outcomes was obtained from audiologic measures of aided audibility, speech recognition, and parent questionnaires.

Results: Of the 52 children with CND in this cohort, 34 (65%) presented with unilateral CND and 18 (35%) presented with bilateral CND. Overall, 32 (62%) of these children used hearing devices and 20 (38%) did not. The prevalence of hearing device use was found to differ based on the laterality of CND. Specifically, of the 34 children with unilateral CND, 17 (50%) used a hearing device: 3 children used a HA, 12 children used a device that routed sound to the contralateral ear (i.e., BCHD or CROS), 1 child used an FM system, and 1 child used a CI. Of the 18 children with bilateral CND, 15 (83%) used a hearing device: 5 children used a HA and 10 children used a CI. Preliminary analyses suggest there is wide variability in both hearing device wear time and outcomes across all children with CND.

Conclusions: There was a greater prevalence of unilateral CND than bilateral CND in this cohort. Hearing device use was found to differ based on the laterality of CND. Specifically, children with bilateral CND were more likely to use a hearing device than children with unilateral CND. While CIs were the most common hearing device used by children with bilateral CND, hearing devices that routed sound to the contralateral ear

(i.e., BCHD or CROS) were most frequently used by children with unilateral CND. Preliminary analyses revealed that hearing device wear time and outcomes varied widely across all children with CND. These results will be further discussed within the context of how factors such as the laterality of CND influence hearing device wear time and outcomes in children.

Category: Pediatric Audiology

Poster #: 080 **T35 Research Trainee Poster**

Audiovisual Integration and Cortical Response Patterns in Children

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Objectives: Despite significant improvements in cochlear implant technology, postoperative speech understanding is highly variable. Though there are variables known to significantly impact pediatric outcomes such as age at implantation, daily wear time, and speech/language intervention, there is emerging evidence that cortical plasticity as well as audiovisual benefit also impacts outcomes. However, these areas have received relatively little attention and have yielded mixed results to date. Specifically, there are studies documenting activation of auditory cortex in response to visual stimuli; however the effects cross-modal plasticity have only been studied in regards auditory-only speech understanding without consideration for audiovisual processing abilities. Additionally, as compared to other populations with hearing loss, there is less functional neuroimaging research in cochlear implant recipients due to contraindications for both functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) as well as electrical artifact considerations with electroencephalography (EEG). Thus the purpose of this study was to characterize audiovisual integration and cortical activation patterns in response to auditory, visual, and audiovisual speech in children with normal hearing and cochlear implants. We hypothesized that children with cochlear implants would exhibit (1) greater audiovisual benefit to speech in comparison to normal hearing peers, (2) increased cross-modal activation of auditory cortex to visual speech as compared to the control group, and (3) an inverse correlation between cross-modal activation and auditory-only speech understanding.

Design: At the time of abstract preparation, we had enrolled 10 children with bilateral cochlear implants and 16 children with normal hearing between the ages of 6 and 17 years. Speech-in-noise testing with auditory, visual, and audiovisual speech stimuli were used to characterize auditory-only speech performance and audiovisual benefit using both behavioral measures of speech perception as well as functional near infrared spectroscopy (fNIRS). Additionally, all participants completed a visual and auditory temporal order judgement task to quantify temporal acuity in both domains.

Results: As hypothesized, our preliminary results demonstrate that children with cochlear implants exhibited significantly greater audiovisual benefit than their peers with normal hearing for sentences in noise. While age had a significant positive correlation to audiovisual benefit in children with normal hearing, age was not correlated with audiovisual benefit for children with cochlear implants. We also observed a negative correlation between audiovisual benefit and speech recognition in noise for children with cochlear implants. Analysis of fNIRS data is in progress and will be presented.

Conclusions: These preliminary data suggest that the degree and development of audiovisual integration may differ between children with normal hearing and those with cochlear implants. Greater audiovisual benefit may

also be associated with poorer auditory-only speech recognition in noise for children with cochlear implants. These results suggest that audiovisual processing abilities and the underlying neural representation may contribute to differences in auditory speech understanding in children.

Category: Pediatric Audiology

Poster #: 081

Evaluating Factors Affecting Speech Perception in Children and Adults

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Objectives: The study aims to a) examine potential effects of neuro-cognitive factors, musicianship, socioeconomic status (SES) on speech recognition in noise in children and adults with normal hearing sensitivity; b) explore the effect of word position in a sentence on speech perception in noise, explicitly examining the recognition of individual words in sentences as the pitch contours of sentences are manipulated.

Design: Twenty children (7-14 years) and 11 adults (18-24 years) with audiometric thresholds< 15 dB HL at frequencies between 250 Hz and 8000 Hz participated in the preliminary study. The authors intend to divide these participants in the future presentation into groups of musicians versus non-musicians and groups with low or high SES. Standardized assessments for Nonverbal Intelligence, Receptive Vocabulary, and Auditory Short-Term Memory were carried out. Sung Speech Corpus was used to consist of naturally- and unnaturally-intonated sentences of five words in a closed-set task. Speech perception in steady-state noise was measured at the signal-to-noise ratio (SNR) of 0 or 3 dB. Stimuli were presented at 60 dBA routed through HDA200 headphones to the right ear only. Identification for each each word in a sentence was recorded in percent correct which was transformed into and analyzed in rational arcsine units (RAUs).

Results: 1. For children, results from General Linear Mixed Models showed a significant main effect of pitch contour, word position in a sentence, receptive vocabulary, and auditory short-term memory, but no significant effect of musicianship. However, the interaction of musicianship and pitch contour was significant: Musicians scored higher than non-musicians in the unnaturally-intonated conditions, but the two groups scored comparably in the naturally-intonated condition. Significant interactions were also seen between pitch contour and word position in a sentence. Word five was scored significantly higher than all the other words, and word four was significantly lower than all the other words in the unnaturally-intonated conditions. 2. Concerning adults, preliminary analyses of data showed significant main effects of word position and pitch contour along with a significant interaction between the two factors, in a similar pattern as shown in the child data. Contrary to the child data, no main effect of auditory short-term memory or receptive vocabulary was seen in adults. However, auditory short-term memory was seen to interact with word position in that the effect of auditory short-term memory was significant on the recognition for words in the middle positions of a sentence but not for words at the initial or final position. The effect of musicianship was not evaluated due to the few participants in the musician group.

Conclusions: According to the preliminary analysis, neurocognitive factors may impact children and adults differently when the pitch contours of the sentences are manipulated. Musical training may facilitate children's recognition of unnaturally-intonated speech in noise. The word-position effect was different in atypical or adverse listening conditions than in the ideal condition. The final presentation will discuss a detailed analysis of

the between-group measurements and interaction. Both age groups will also be discussed concerning the effect of musical experience and SES in detail.

Category: Pediatric Audiology

Poster #: 082 **Mentored Student Research Poster Award**

Band Importance and Level Distortion in Children's Speech Recognition

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Objectives: The Speech Intelligibility Index includes a level distortion factor based asymptotic or reduced speech recognition with increasing audibility at high intensity levels for adults. However, adults and children have different etiologies of hearing losses, which could lead to differences in whether level-dependent distortion occurs. When audiologists optimize audibility for children based on the Speech Intelligibility Index, reduced speech recognition may result if level-dependent distortion occurs. Measuring individualized frequency band importance for speech recognition may help to provide evidence for which frequency regions contribute to level distortion. Adults and children with normal hearing have highest importance weights for 2000 and 4000 Hz bands. Children who are hard of hearing show individual variability in band importance that depends on sensation level of each frequency band. This study was designed to evaluate if children who are hard of hearing show level distortion in speech recognition at higher input levels using a band importance task. Hypotheses were 1) band importance will increase as band-level audibility increases, depending on sensation level, and 2) level distortion will not occur as input level increases.

Design: Participants included 40 native English-speaking children six to twelve years-old with no disabilities or cognitive delays, 20 with normal hearing and 20 with permanent hearing loss. All participants completed a speech recognition task with 480 stimuli of unfiltered and filtered consonant-vowel-consonant words. Filtered words were divided into six frequency bands, with three random bands present for each trial. Children with normal hearing completed two conditions: 60 and 75 dB SPL. Children who are hard of hearing completed those conditions unaided and additional conditions at 60 and 75 dB SPL with stimuli pre-processed through a hearing aid simulator (aided). For each test condition, participants completed a baseline of 40 unfiltered words, followed by five sets of 40 filtered words. Accuracy was documented online, and a generalized linear mixed effects regression model was used to estimate the importance of each frequency band.

Results: Consistent with previous adult studies, children with normal hearing showed reduced speech recognition at 75 dB SPL. Children who are hard of hearing did not show consistent decrements in speech recognition at 75 dB SPL, despite lower estimates of aided audibility. The relationship between band importance weight and sensation level varied by frequency. Specifically, 250 Hz and 500 Hz showed either flat or decreasing importance as sensation level increased, whereas bands above 1000 Hz had increased importance as sensation level increased. As in previous studies, children who are hard of hearing demonstrated greatest band importance around 2000 Hz.

Conclusions: Reduced speech recognition at high intensity levels was observed for children with normal hearing but not at the group level for children who are hard of hearing. This suggests that predictions of reduced speech

audibility at high-intensity levels related to level distortion should not be routinely applied to children who are hard of hearing. Different patterns of band importance across frequency as sensation level increases could provide a framework for individualized approaches to prescribing hearing aid output.

Category: Pediatric Audiology

Poster #: 083

Effects of Audibility and Linguistic Complexity on Children's Story Comprehension

Kelsey Klein, AuD, PhD; Mark Hedrick, PhD; Jillian McCarthy, PhD, University of Tennessee Health Science Center, Knoxville, TN

Objectives: Listening comprehension, or the ability to understand and retain spoken information, is critical for children's classroom learning and academic success. As children progress through elementary school, lessons include advanced vocabulary and syntax. Children therefore need to be able to comprehend speech that includes unfamiliar words and complex syntax. Children with minimal/mild hearing loss are at risk for delays in spoken language development, including listening comprehension. However, it is unclear if minimal/mild hearing loss differentially affects children's understanding of spoken language that is lexically/syntactically "easy" versus "hard." The objective of the first phase of this study was to design a well-balanced story comprehension task, allowing for comparison of comprehension across multiple listening conditions. The objective of the second phase is to examine the relative effects of linguistic complexity and audibility on children's listening comprehension. We hypothesize that the reduced audibility caused by a simulated hearing loss will reduce comprehension more for the linguistically hard stories than the easy stories.

Design: Stimuli included eight fictional stories. Stories were edited for clarity and categorized as linguistically "easy" or "hard" based on reading level, measured by the Flesch Kincaid Grade Level and ATOS Level. The four easy and hard stories were written at 3rd and 6th grade reading levels, respectively. Twenty-five to 30 questions were developed per story. Questions required listeners to recall information related to the main point, recall details, or make inferences about the story. Stories and questions were recorded by a female adult. All recordings were amplitude normalized.To refine the question sets and ensure question sets were balanced for difficulty across stories, the first phase of this study included children who listened to all stories without degradation. Participants included 10 typically hearing children, ages 12-13. They listened to the eight stories in a randomized order and answered the questions about each story. In the second phase of this study, 24 typically hearing children ages 9-11 will be recruited through local schools. They will listen to each story either 1) without degradation, 2) through a simulated flat mild sensorineural hearing loss, or 3) through a simulated high-frequency sensorineural hearing loss.

Results: The eight stories were similar in word count (mean=1472 words, range=1453-1489 words) and recording length (mean=7.78 minutes, range=7.5-8 minutes). When all questions per story were included, average percent correct for the stories ranged from 71-92%. Next, the question sets were narrowed to 10 questions per story. These questions were chosen so that mean percent correct was exactly 80% for each story. For two stories (one easy and one hard) this was not possible; these stories were excluded from further analyses. For the six remaining stories, standard deviation ranged from 8-19% for percent correct.

Conclusions: In the first phase, we developed a story comprehension task that includes six stories that are well-balanced in terms of length and question difficulty. The results of the second phase will improve our

understanding of how minimal/mild hearing loss may affect children's listening comprehension when they are confronted with complex language in the classroom.

Category: Pediatric Audiology

Poster #: 084

Development and Validation of the Pediatric Spatial Hearing Questionnaire (P-SHQ)

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Objectives: Sound localization is an important auditory function that is difficult for children with hearing loss and often overlooked. Research indicates that children with hearing loss using hearing aids and cochlear implants have problems localizing sound compared to children with normal hearing. Validation studies show that spatial hearing questionnaires are reliable, valid, and sensitive to differences between adults with hearing loss and normal hearing. However, few studies concentrate on children. It is important that we focus on children, as spatial hearing is necessary for good awareness in their environment (e.g., hearing alarms, locating a parent's voices) and for learning in a classroom setting (e.g., hearing the teacher's voice over the classroom noise). The purpose of this study was to develop and validate a pediatric version of the Spatial Hearing Questionnaire (P-SHQ) and to compare results for children with normal hearing and to those with hearing loss.

Design: We developed the 24-item P-SHQ from the existing Spatial Hearing Questionnaire by modifying several items to be appropriate for children. After an initial test of the questionnaire's feasibility, we recruited parents and guardians of children with normal hearing and children with hearing loss from kindergarten to 8th grade to complete the questionnaire. The P-SHQ was administered as an online survey from July 2021 to September 2022 along with an 18-item demographic questionnaire and the Speech, Spatial and Other Qualities of Hearing Scale for Parents (SSQ-Parent). In total, 59 parents and grandparents of children with normal hearing and 9 children with hearing loss completed the questionnaire. The age distribution of the children was fairly equivalent from kindergarten through 8th grade. For the children with hearing loss, 6/9 had bilateral hearing loss and 6/9 used hearing aids or a hearing aid plus a cochlear implant.

Results: The highest ratings (93-95%) on the P-SHQ were for items on speech perception in quiet. Items on localization and speech in noise performance received the lowest ratings (75-80%) and had the highest variability. P-SHQ total scores were significantly lower for the children with hearing loss compared to the children with normal hearing. Comparing responses to published normative data from adults, we found consistent responses on the SHQ for children, though slightly lower across the eight subscales and for the total score. A strong correlation was found between total scores for the P-SHQ and the SSQ-Parent version, suggesting good criterion validity.

Conclusions: Similarly for adults, localization tends to be a more difficult task for children than conversation in quiet. Our preliminary results indicated lower rated spatial hearing in children with hearing loss, though more data is needed. These results suggest that the P-SHQ is a valid and sensitive tool in determining localization and speech in noise performance for children.

SPEECH PERCEPTION

Category: Speech Perception

Poster #: 085

Lexical Knowledge Facilitates Phoneme Categorization at Intermediate Noise Levels

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Objectives: In noisy environments, listeners employ a variety of strategies to assist with speech perception. One strategy to aid speech perception is to engage top-down cues, such as lexical context. Here, we examined the extent to which phoneme categorization in quiet and in speech-shaped noise (SSN) was facilitated by lexical context, a phenomenon referred to in prior literature as the word superiority effect. Our goals were to examine 1) the extent to which lexical facilitation was a function of signal-to-noise ratio (SNR) level, and 2) whether facilitation was maximal at most difficult SNR levels, known as inverse effectiveness, or at more intermediate SNR levels, which allows greater activity between phonemic and lexical stages of processing.

Design: Adult participants ages 21-55 (n = 93) completed two phoneme-in-noise categorization tasks in quiet and across a range of SNR levels with syllable or word-like contexts. One task consisted of syllable stimuli (/gi/, /ki/) and the other task contained word-like stimuli (/kiss/, /giss/). In each task, stimuli were presented in quiet and masked in SSN at 8, -2, -6, and -9 dB SNR levels. To examine the underlying perceptual and decision-making mechanisms of phoneme categorization, we used drift-diffusion models of accuracies and response times. Drift-diffusion models assume that listeners noisily accumulate sensory evidence and a decision is made once a particular threshold is reached, which can inform how efficient a listener is at accumulating evidence and whether the listener is a cautious responder.

Results: Irrespective of SNR level, lexical context facilitated faster response times for word-like stimuli. Moreover, participants were more accurate at phoneme categorization in lexical contexts at an intermediate SNR level (-2 dB) relative to more difficult SNR levels. Drift-diffusion models reveal that, relative to world-like context, listeners are more cautious responders to syllable stimuli, favoring accuracy over speed of decision-making. Interestingly, at the intermediate SNR level, the quality of evidence accumulation significantly reduced in the syllable context but increased in the word-like context.

Conclusions: Our results suggest a faciliatory effect of lexical knowledge on phonetic categorization. However, this lexical facilitation is noise level-dependent, such that it is maximally tuned for intermediate SNR levels. We contend that increased efficiency in evidence accumulation at intermediate SNR levels allows for greater integration between phonemic and lexical processing to aid speech perception. A better understanding of how a listener accumulates evidence at intermediate SNR levels could lead to the development of targeted rehabilitative approaches for speech perception in noise difficulties.

Category: Speech Perception

Poster #: 086

Acoustic/Intelligibility-Based Assessment of Patients' Listening Difficulty During the Repeat-Recall Test

Christopher Slugocki, PhD; Francis Kuk, PhD; Petri Korhonen, MS, Office of Research in Clinical Amplification (ORCA-USA) - WS Audiology, Lisle, IL

Objectives: Listeners with a hearing loss generally report speech-in-noise comprehension as more effortful than normal hearing listeners. However, it is difficult to determine how much "listening effort" reflects impaired intelligibility versus individual listener characteristics, such as cognitive capacity, personality, and/or coping strategies. The Repeat-Recall Test (RRT) is an integrative speech-in-noise test that combines intelligibility assessment at realistic SNRs with estimates of working memory capacity and ratings of listening effort and willingness to engage with communication in noise. Here, we explore the value of comparing patient performance on the different RRT outcome measures against two types of normative references: (1) acoustic-based norms derived from performance at each SNR, and (2) intelligibility-based norms derived from performance at different levels of intelligibility.

Design: We analyzed data collected from 66 normal hearing adult listeners (42 F, mean age = 59.0 years, range = 19-82) across 2730 RRT trials to establish norms of expected performance (i.e., intelligibility and memory) and subjective ratings (i.e., listening effort and tolerable time) at each of the acoustic SNRs assessed in the RRT. We contrast these acoustic-based norms with ones based on the actual intelligibility measured from patients.

Results: Judging patient performance against an intelligibility-based reference can inform the clinician whether the patient has further issues with memory, effort, or tolerance for communication in noise than would be expected for a normal hearing listener in an environment where intelligibility was similarly degraded. We highlight where each choice of reference (i.e., acoustic- and intelligibility-based) may be useful to clinicians who seek to demonstrate the efficacy of interventions, to counsel patients on realistic expectations for their hearing aids, or to better understand the nature of their patients' speech-in-noise difficulties.

Conclusions: Whereas the acoustic-based norms define the expected range of normal hearing RRT outcomes at each SNR, intelligibility-based norms re-define this range for memory, listening effort, and tolerable time outcomes at different levels of intelligibility. In this way, intelligibility-based norms allow clinicians to evaluate these outcomes after accommodating the patient's speech-in-noise deficits.

Category: Speech Perception

Poster #: 087

Evaluation of Speech Intelligibility During the Tracking of Noise Tolerance Test

Petri Korhonen, MS; Christopher Slugocki, PhD, ORCA-US WS Audiology, Lisle, IL

Objectives: How much background noise a listener is willing to accept while listening to speech is predictive of their hearing aid satisfaction. The Tracking of Noise Tolerance (TNT) test measures the amount of background noise an individual chooses to tolerate while still perceiving to understand >90% of speech. The subjective intelligibility estimates that listeners use during the noise tracking task may vary from the actual 90% performance across individuals. In this study we investigated the subjective and objective speech intelligibility used by different listeners during the noise tracking task.

Design: 22 normal hearing and 15 hearing impaired listeners participated. Noise tolerance was measured using the Tracking of Noise Tolerance test at 75 and 82 dB SPL speech levels in the presence of collocated background noise. We examined the estimated speech intelligibility during the noise tracking using objective and subjective P-I functions generated from each listener individually.

Results: The lowest noise level that both groups of listeners chose during the noise tracking task corresponded to >90% subjectively estimated intelligibility, while the intelligibility remained below 90% during rest of the tracking. For normal hearing listeners the 90% criterion was similar with objective and subjective speech intelligibility estimates. For the hearing-impaired listeners the subjective intelligibility estimate was closer than objective intelligibility to the instructed 90% at the noise valleys.

Conclusions: We examined speech intelligibility during noise acceptance tracking task. We demonstrated that normal hearing listeners followed the test instructions by selecting the noise level that resulted in >90% subjectively estimated speech intelligibility at the valleys of the noise tracking trace. The hearing-impaired listeners overestimated their speech performance and reported actual unaided speech intelligibility below 90%.

Category: Speech Perception

Poster #: 088 **Mentored Student Research Poster Award**

Effects of Linguistic Context and Speech Masker on Speech Comprehension

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Objectives: In typical hearing research paradigms, participants are asked to listen to lists of unrelated, decontextualized sentences and repeat them verbatim. In real-life communication, however, speech perception rarely happens without context. Listener comprehension, not mere repetition, of the speaker's intended message is the ultimate goal. The interactive effects of context, listener's level of comprehension, and perceptual challenges due to noise have to date rarely been examined in hearing research. To improve the ecological validity of our research outcome and clinical measures, it is critical to understand the roles that each of these factors play during speech perception. The first objective of this study was to examine the interaction between the effects of linguistic context and the perceptual interference from speech maskers during speech comprehension. Older adults are known to be slower and less efficient at linguistic processing. Even without clinically significant hearing loss, speech perception is difficult in background noise for many older adults. Our second objective was to examine how the interaction between linguistic and perceptual factors is modulated by aging.

Design: Speech stimuli consisting of two-sentence segments were developed and recorded based on prior psycholinguistic literature examining semantic context effects. Each two-sentence segment has three different word ending types, called completion types: expected exemplar, within-category violation, and between-category violation. The expected exemplar is a lexical item that fits the context of the sentence and would be predicted by most listeners. The within-category violation is in the same semantic category as the expected exemplar but does not fit the context of the sentence. The between-category violation belongs to a different semantic category than the expected exemplar and does not fit the context of the sentence. Younger adults (18-35 years) and older adults (60-85 years) with normal hearing listened to each speech segment embedded in either a six-talker babble speech masker or spectral-shaped steady-state noise. The signal-to-noise ratio was

individualized to obtain an overall speech intelligibility of 90-100%. After each speech segment, participants answered a yes/no comprehension question. Accuracy and reaction time when answering comprehension questions were analyzed as the dependent measures.

Results: Results to date from 12 younger adults showed the participants answered comprehension questions more accurately and faster with the steady-state noise compared to the speech masker, even with individualized SNRs ensuring intelligibility above 90% in both noise conditions. Further, the linguistic context had a stronger facilitatory effect in the steady-state noise than in the speech masker. In the steady-state noise condition, the segments ending with an expected exemplar were comprehended more accurately than those ending with within-category and between-category violations. Following the same protocol, data are currently being collected for the older adult group.

Conclusions: The results suggest an interaction between the perceptual effects of speech maskers and the linguistic effects of sentence context during speech perception. Theoretically, this work sheds light on the complex dynamics between perceptual and psycholinguistic properties and processes. Clinically, these findings highlight the importance of using more complex speech material in clinical speech assessment.

Category: Speech Perception

Poster #: 089

Aging, Spectral Degradation, and Cognition Predict Identification of Emotional Prosody

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Aditya Kulkarni, MS; Adam Bosen, PhD; Monita Chatterjee, PhD, Boys Town National Research Hospital, Omaha, NE

Objectives: Understanding the emotional intent of the speaker is crucial for meaningful social interactions. However, older adults are less accurate in identifying emotional prosody in speech compared to younger adults. This study attempts to better understand the underlying mechanisms for decreased vocal emotion recognition with age by exploring the relationships between vocal emotion recognition, spectral degradation, and cognition. We hypothesized that vocal emotion recognition by listeners with good acoustic hearing is predicted by decreased sensory information due to aging and spectral degradation, alongside individual variation in cognitive ability.

Design: The study included 25 adult listeners, ranging in age from 19 to 71 years old with English as their primary language. Stimuli included 12 semantically-neutral sentences spoken by an adult female talker with five emotional prosodies (happy, sad, angry, scared, and neutral) and presented in two conditions of spectral resolution (full-spectrum speech and 8-channel noiseband vocoded speech). Participants identified which emotion was being conveyed in a single interval, five alternative forced-choice paradigm. Participants also completed a cognitive working memory task (Digit Span). Linear mixed effects analysis was completed with fixed effects of age, spectral resolution, working memory, and hearing status, with subject-based random intercepts.

Results: The results replicated previous research showing a significant decline in vocal emotion recognition with age. Spectral resolution and working memory as measured by the Digit Span task were significant predictors for vocal emotion recognition performance with overall emotion accuracy decreasing in the 8-

channel noiseband vocoded condition relative to the full-spectrum condition, and with accuracy increasing with higher recall accuracy for digit sequences.

Conclusions: Increasing age and low spectral resolution both had negative impacts on the ability to identify emotions in speech. Working memory ability had a positive association with performance for both younger and older adult listeners. When assessing barriers to verbal communication, patients' sensitivity to emotional prosody should be considered along with their ability to accurately perceive segmental cues in speech. This is particularly important to consider for populations with deficits in vocal emotion recognition such as older adults who may be experiencing social isolation and/or cognitive decline, as well as cochlear implant users whose devices are not able to effectively transmit all of the acoustic cues critical for identifying emotional prosody.

Category: Speech Perception

Poster #: 090

The Development of a High-Fidelity, Multi-Directional Speech Corpus

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Objectives: Many standard speech testing materials (e.g., QuickSIN, BKB-SIN, NU-6, etc.) that are used both clinically and in hearing research were recorded decades ago using methodologies that limited the fidelity of the speech recordings. One degradation common to many speech materials is limited energy at extended high frequencies (EHFs, >8 kHz). Another commonality is that materials are often recorded from the front of a talker, resulting in speech tests that simulate target and maskers facing the listener. Thus, we currently lack speech testing materials that account for broader aspects of real-world auditory scenes such as speech directionality and EHF content that have demonstrable effects on speech perception. Here, we describe the development of a multi-directional, high-fidelity speech corpus using multi-channel anechoic recordings that can be used for future studies of speech perception in complex environments by diverse listeners.

Design: Fifteen male and 15 female talkers were recruited (21.3-60.5 years) via social media and by word of mouth to make speech recordings. The corpus consisted of four lists of the Bamford-Kowal-Bench Standard Sentence Test (BKB) sentences, digits 0-10, and a 3-minute narrative based on one of three prompts offered to the talkers prior to the recording session.Recordings were made in a 4x4x4 (interior) ETS A100 anechoic chamber with 1m free field spanning 100-20,000 Hz and acoustical noise floor< 15 dB SPL from 160-20,000 Hz. An array of 17 B&K type 4189 or equivalent (PCB Piezotronics 377B02) free field condenser microphones spanned 0¬∫ to 180¬∫ azimuth (11.25¬∫ steps) around the talker at a distance of 1 m. Recordings were captured simultaneously on all channels at 48 kHz and 24 bits using Matlab and Audacity on an iMac Pro.Post-processing included best-exemplar selection from three repeats of BKB sentences and digits, and a manual editing of narratives to remove silent pauses greater than 200 ms duration. After initial speech acoustic analyses of average fundamental frequency, EHF spectral level, and directionality characteristics, three female and three male talkers were selected to record the entirety of the BKB sentence lists.

Results: Recordings resulted in a large corpus (52 gigs) containing four BKB lists, 10 digits, and narratives produced by 30 talkers, and an additional 15 BKB lists (21 total) produced by a subset of six talkers. Initial acoustic analyses indicate that EHF level does not change dramatically across speech materials (BKB vs. narratives) within talker, although EHF acoustic characteristics do vary across talkers and facing direction.

Conclusions: The goal of this study was to create an anechoic, high-fidelity, multi-directional speech corpus using standard speech materials, like the BKB sentence materials and digits. We also recorded more naturalistic narratives, useful for the creation of babble noise and speech maskers. A large group of 30 talkers of both sexes permits researchers to select speech materials based on talker characteristics relevant to a specific task. The resulting speech corpus allows for more diverse and precise speech recognition testing, including testing effects of speech directionality and EHF content. Recordings will be made publicly available. [Supported by NIH R01-DC019745]

Category: Speech Perception

Poster #: 091

Portable Protocol Investigating Hearing and Cognition in Older Adults

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Objectives: One approach to making research studies more inclusive is to design portable protocols that increase access to participation. Our study tests a portable protocol that collects data on hearing and cognition via use of an iPad and headphones that are delivered to the participant's home. The participant follows instructions using a binder delivered with the iPad and by interfacing with the researcher via FaceTime. The objective of the current study is to test expected hypotheses of the impacts of age, hearing, and cognitive status on speech-in-noise performance via this novel data collection approach.

Design: Adults from 40-90 years old were recruited to complete a series of auditory and cognitive tasks. Hearing screening was completed with the hearWHO app, which uses a digits-in-noise (DIN) measure. The Montreal Cognitive Assessment (MoCA) was completed via FaceTime with paper documents provided in the binder for the person to complete some of the MoCA tasks (i.e., Trail Making, Cube and Clock drawings and Animal Naming pictures). The experimental tasks were developed by UCR Brain Games and include components of the Portable Automated Rapid Testing (P.A.R.T.) auditory battery and the Recollect the Study cognitive battery. There were two speech-in-noise measures included as outcomes: Dichotic Sentence Identification (DSI) and Spatial Release from Masking (SRM). The SRM task uses the Coordinated Response Measure in multitalker babble. Covariates included in the analyses were age, hearing (DIN) threshold, cognitive screening score, spectrotemporal modulation threshold, and a working memory score.

Results: To date, we have completed testing with 30 participants (40-79 years; mean = 58.2 years; SD = 10.1). MoCA scores range from 23-30 (mean = 27.8; SD = 1.6). As expected, age and hearing (DIN) were significantly correlated ($r = -0.40$, $p = .03$). A stepwise approach was taken for the preliminary data to limit the number of covariates in the models due to the small sample size. The standard covariates of age, hearing (DIN) status, and cognitive (MoCA) status were entered into linear regression models one variable at a time with DSI or SRM as the outcome measure. For DSI, only the MoCA score significantly contributed to variance in performance ($F(1,28) = 9.2$, $p=.005$). When auditory processing (based on spectrotemporal modulation

threshold) and working memory were added to the model, MoCA remained the only significant contributor in the model ($F(3,26=3.5, p=.03)$. Taking the same approach for SRM, only hearing status was significant in the initial single variable models ($F(1,28) = 4.3, p<.05$). With the addition of the auditory processing and memory variables (same as above), hearing remained the only significant contributor ($F(3,26) = 3.4, p=.03$).

Conclusions: Preliminary results suggest that hearing status predicts performance on a Spatial Release from Masking task, while cognitive status predicts performance on the Dichotic Sentence Identification task. Potential clinical implications include the idea that a competing speech task (such as Dichotic Sentence Identification) may provide some cognitive processing information to the audiologist that will inform clinical management of that individual's hearing loss. (Work supported by NIH R01DC012057 and NIH K23DC016855.)

Category: Speech Perception

Poster #: 092 **Mentored Student Research Poster Award**

Effects of Talker Variability on Speech Perception Scores

Priya Karimuddanahalli Premkumar, MS; Molly Pangestu, BS; Laurencia Santillan, BS; Delaney Skretta, BS; Michelle Hughes, PhD, University of Nebraska Lincoln, Lincoln, NE

Objectives: It is well known clinically that people with hearing loss perform better on the HINT than AzBio sentences. These tests differ in linguistic content and talker variability. The purpose of this study was to examine the relative contributions of talker variability and linguistic content to speech-perception performance. Two experiments were performed. Experiment 1 assessed the role of talker variability by comparing speech-perception scores in noise between re-recorded diverse-talker and original recordings. It was hypothesized that within a given test (keeping linguistic content constant), performance would be poorer with diverse-talker recordings than with the original recordings. Experiment 2 assessed the role of linguistic content by comparing speech-perception scores in noise obtained between the diverse-talker AzBio and diverse-talker HINT sentence tests, where both tests were comprised of the same talkers. It was hypothesized that performance would be better on the diverse HINT compared to the diverse AzBio test due to differences in sentence length and complexity.

Design: Five AzBio lists (20 sentences/list = 100 sentences) and 10 HINT lists (10 sentences/list = 100 sentences) were re-recorded using a diverse set of 20 talkers that encompassed U.S. dialects, foreign accents, adults, and children. Each talker contributed one sentence per each AzBio list and each pair of HINT lists so that no single talker was repeated within a list (AzBio) or pair of lists (HINT). Normal-hearing native-English speaking adults listened to the original and re-recorded lists in the presence of 20-talker babble. Percent-correct scores were obtained for original and diverse recordings.

Results: Data collection has just begun. Our preliminary data show poorer performance for the diverse-talker recordings compared to original recordings for both tests, consistent with the first hypothesis. When the diverse talkers were used for both tests, scores were poorer for the diverse AzBio sentences than for the diverse HINT sentences, consistent with the second hypothesis.

Conclusions: Our preliminary results suggest that increasing talker variability and linguistic content reduces speech perception performance in noise among normal hearing listeners. These results have implications for

increasing talker diversity in standardized tests to better reflect the potential range of conversation partners in everyday life. Future studies are required to empirically study the effect of talker variability and linguistic content on speech perception among hearing impaired and cochlear implant users.

Category: Speech Perception

Poster #: 093 **Mentored Student Research Poster Award**

Speech Recognition Following Abrupt Changes in Audibility Across the Spectrum

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Angela AuBuchon, PhD; Ryan McCreery, PhD; Adam Bosen, PhD, Boys Town National Research Hospital, Omaha, NE

Objectives: The audibility of speech cues across the spectrum fluctuates over time, both in natural listening conditions with fluctuations in background noise and in experiments that are designed to measure frequency importance weights. These fluctuations require the listener to track the availability of speech cues across frequencies and over time, which we hypothesize imposes a processing cost that arises from changes in cue availability and results in a reduction in speech recognition accuracy. Individual differences in this processing cost are hypothesized to be associated with individual differences in cognitive abilities that relate to speech recognition.

Design: Twenty-four young adults (ages 19-29) with normal hearing participated in the study. Participants were presented with monosyllabic words that were filtered to contain two one-octave-wide frequency bands that varied across words. To test whether orienting to changes in audible frequency bands reduced recognition accuracy, we manipulated the continuity of frequency bands across successive words. Across an equal number of trials, bands were kept the same as in the previous word, one band was switched, or both bands were switched. To test whether cuing the listener to which bands would be audible reduced the cost of band switching, in a second condition the carrier phrase "Ready" preceded each target word and was filtered to match the bands in the target word. The flanker task, Raven's Progressive Matrices, and visual free recall of word lists were used to measure individual differences in cognitive abilities.

Results: There was no effect of switching bands across successive words. The carrier phrase increased speech recognition accuracy by increasing the importance of frequency bands around 2 kHz and above. The standard deviation of random intercepts across stimulus words was about 5 times larger than the standard deviation of random intercepts across participants. Performance on the free recall and Raven's Progressive Matrices tasks was not significant predictors of speech recognition ability. Individual differences in response slowdown arising from cue conflict in the flanker task were a moderate predictor of overall speech recognition accuracy.

Conclusions: Declines in recognition accuracy produced by changes in frequency band audibility are not evident, although the carrier phrase facilitated use of high-frequency speech cues when they were available. The ability to quickly resolve sensory conflicts facilitates degraded speech recognition, as demonstrated by the association of slowdown due to cue conflict in the Flanker task with speech recognition accuracy. These findings indicate that differences in the aspects of attention that are measured by this task are likely to partially determine speech recognition outcomes in individuals with hearing loss, particularly for individuals who use hearing aids with multiband compression or cochlear implants with peak-picking processing strategies because these algorithms alter the audibility of the speech spectrum over time.

Category: Speech Perception

Poster #: 094 **Mentored Student Research Poster Award**

Working Memory Capacity and Talker Variability Effect on Adults' Story Comprehension

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Objectives: This study examines how narrator variability (i.e., number of talkers) and listener working memory capacity (WMC) interact to influence story comprehension accuracy and reaction time (RT). We hypothesize that there will be a main effect of narrator type; accuracy will be greater, and RT will be faster for listeners in the single narrator condition compared to the multiple narrator condition. Additionally, we predict there will be a main effect of WMC; individuals categorized as "high WMC" will have greater accuracy and lower RTs than "low WMC" listeners. Finally, we predict that WMC and narrator type will interact such that listeners with high WMC will out-perform low WMC listeners on the multiple-narrator story comprehension task.

Design: A 2 X 2, between-subjects experimental design was used to examine these processes. The independent variables were narrator type (single, multiple) and WMC (low WMC, high WMC) and the dependent variables were accuracy and RT. Eighty participants with typical hearing participated and were recruited via a campus-wide research database, social media, and word-of-mouth. Each participant first completed 3 shortened complex working memory span tasks to assess their WMC. Then, they listened to 10 stories, each spoken by either a single narrator or multiple narrators. Following each story, they answered 10 comprehension questions about the story. Accuracy and RT were recorded during story comprehension. Participants were individually tested at a computer equipped with headphones.

Results: When the MANOVA is complete, we predict that our results will support our hypotheses. Listening to multiple narrators will impose a greater cognitive load during perception and processing due to the talker variability. Thus, those with low WMC will have slower RTs and lower accuracy compared to high WMC participants listening to multiple narrators tell a story. We predict this to be the case despite the increased variability and cognitive load contributed by multiple narrators. Listeners with high WMC have more cognitive resources available to re-direct attentional focus despite the addition of narrators.

Conclusions: Research has demonstrated that listening to speech spoken by multiple talkers negatively impacts speech perception for various stimuli (e.g., word list recall and isolated word recall). Most explanations for this phenomenon focus on low-level processing of perceptual cues, rather than on high-level cognitive processes (e.g., WMC). Other research suggests the detrimental effect of multiple talkers on word recognition is not robust for complex listening tasks (e.g., sentence and story comprehension). However, little research has examined the impact individual WMC may have on multiple-talker story comprehension. In order to better understand how listeners perceive, process, and comprehend spoken language, we must consider potential influences of both multiple talkers and individual differences in cognition. A better understanding of these components is important when considering the effects both factors have on the ability of listeners with hearing loss to perceive and process spoken language. Improving understandings of how individual cognitive processes and talker variability work together to shape auditory outcomes has important clinical implications for counseling patients with a hearing loss (e.g., setting realistic expectations) and fitting hearing aids (e.g., slower compression ratios).

Category: Speech Perception

Poster #: 095

Language Coherence Influences Listening Effort in Listeners with Cochlear Implants

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Objectives: Listening effort is commonly reported by individuals with hearing loss as a frequent difficulty during daily communication. Listening effort is affected by an individual's knowledge of language and its structure, which enable listeners to perceive speech more accurately. Listeners expect to hear coherent utterances and typically have coherent responses guided by their prior language knowledge. Listeners extract meaning from speech guided by the expectations and constraints of the language. However, misperceptions could render a sentence nonsensical, forcing effort to reconcile the meaning. Guided by the notion that the misperception-repair experience is common for listeners with cochlear implants, we aimed to measure how the language coherence of sentences influences listening effort using pupillometry. Rather than let nonsensical perceptions occur randomly via mistakes, we simulated those perceptions directly using semantically incoherent stimuli mixed with regular coherent stimuli. We hypothesized that listening effort will be reduced for semantically coherent sentences compared to incoherent sentences in both listeners with normal hearing and cochlear implants.

Design: Older adult listeners with cochlear implants and age-matched normal-hearing peers participated in a sentence recognition task. The sentences were either semantically coherent or incoherent, but contained the same syntactic structure, vocabulary, and talker. Pupil size was measured using pupillometry as an index of listening effort over the course of each sentence presentation.

Results: Listeners with normal hearing showed speech intelligibility results that were at or near ceiling for both sentence types. Listeners with cochlear implants showed average speech intelligibility scores near ceiling for coherent sentences and minor declines in performance for incoherent sentences. For both groups, pupil size significantly decreased for coherent sentences compared to incoherent sentences, suggesting the relief from effort when there is clear coherent structure. Cochlear implant listeners' pupil responses were elevated and prolonged especially after hearing incoherent sentences, while the pupil responses for normal hearing listeners returned to baseline more quickly after the sentence.

Conclusions: Listening effort is influenced by a listener's attempt to extract meaning, impose structure, or make sense of an incoherent utterance because of their prior expectations of language and its structure. Our results align with previous work which has shown increases in listening effort when listeners with cochlear implants perceive coherent sentences but give incoherent responses. The current work prospectively elicited those incoherent perceptions to test this hypothesis, rather than letting random numbers of incoherent mistakes arise unplanned during testing. This pattern of listening effort could not be detected using isolated words where semantic coherence is not an active property.

TINNITUS

Category: Tinnitus

Poster #: 096

Investigating Peripheral Sources of Chronic Tinnitus in Young Normal-Hearing Adults

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Objectives: Large-scale epidemiological studies using nationally representative samples have revealed that about 8% of college-aged young adults experience bothersome tinnitus lasting ≥ 5 minutes in the past 12 months. Most young adults with bothersome chronic tinnitus do not seek professional help, as they commonly consider it to be a "normal" phenomenon. Yet, they often experience subclinical anxiety, depression, and poor sleep quality. Past studies investigating physiological mechanisms underlying tinnitus focused on older adults seeking professional help. However, the physiological mechanisms underlying chronic tinnitus in young adults not seeking professional help remains elusive. This population provides a unique opportunity to investigate the physiological basis of tinnitus, as the age-related confounding factors are absent (e.g., age-related hearing loss and systemic diseases). This study aimed to identify the peripheral auditory mechanisms involved in bothersome chronic tinnitus in young adults. We hypothesized that young adults with bothersome chronic tinnitus would exhibit evidence of cochlear deafferentation and elevated central gain.

Design: We screened about 5000 young adults using a questionnaire adopted from the National Health and Nutrition Examination Survey. Participants were recruited from the University of Iowa and surrounding areas. Young adults reporting no tinnitus and bothersome chronic tinnitus were invited to participate in the present study. Participants filled out a questionnaire about hearing status, tinnitus, and family, health-related, and audiological history. Individuals with hearing thresholds within clinically normal range (≤ 25 dB HL from 250-8000 Hz) in both ears were tested further. Tinnitus-related distress was evaluated using the Tinnitus Handicap Inventory and Tinnitus Functional Index. Hearing thresholds, extended-high frequency hearing thresholds, DPOAEs (F2:1-16 kHz), click-evoked auditory brainstem responses (ABR) (80 dB nHL, sweeps: 2048) were measured from both ears. Lifetime noise and firearm exposures were calculated by a standardized interview. Head size was measured. A sample of 288 participants, 199 with no tinnitus and 89 with chronic tinnitus, were included in the present study.

Results: A linear mixed model was used to evaluate the main effect of tinnitus on hearing thresholds, DPOAE amplitudes, and ABR wave I, III, and V peak-to-peak amplitude and latency measures. The linear mixed model allowed for the effects of potential confounders (such as head size, age, sex, ethnicity) and repeated measures (such as test frequencies) to be controlled while testing the association between tinnitus and audiometric measures. The results showed that individuals with tinnitus showed significantly elevated thresholds, yet no significant elevation in DPOAE amplitudes. Further, participants with tinnitus exhibited significantly reduced ABR wave I amplitudes, but no significant reduction in wave III and V amplitudes. Major confounders, such as head size, sex, ethnicity, age, lifetime noise exposure, firearm exposure, and methodological repeated measures, revealed a significant association with ABR, DPOAE, and hearing threshold measures.

Conclusions: The results suggest that young adults with bothersome chronic tinnitus exhibit subtle dysfunction in peripheral auditory mechanisms. They further suggest the role of cochlear deafferentation and abnormal elevation in central gain for tinnitus perception. Further research is needed to investigate the role of central auditory mechanisms and non-auditory structures for tinnitus generation in young adults.

Category: Tinnitus

Poster #: 097

Inconsistencies in Reporting of Auditory Symptoms Over Time

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Objectives: Conditions such as tinnitus lack measurable signs thus consistent and reliable self-report is critical both clinically and for interpreting research findings. Symptom reporting is influenced by factors not directly related to the underlying pathology. These include patient expectations and psychological state, how symptom questions are framed, type of symptom(s) being reported, and the reporting period itself. There is little research examining consistency of reporting of tinnitus and hearing difficulty over time. In this study we addressed this by comparing self-reported tinnitus and hearing difficulty at two time-points using data from large-scale online surveys.

Design: Two online surveys of the same cohort were competed in March 2019 (Wave 1) and August/September 2021 (Wave 2). Participants were eligible to participate in Wave 1 if ≥18 years and lived in the UK. Anyone who completed Wave 1 was invited for Wave 2. Among other questions, both surveys asked 'Do you have any difficulty with your hearing?' and 'Do you have tinnitus (noises in the head or ears) lasting more than 5 minutes?' Wave 1 response options were 'yes' and 'no'. The more detailed Wave 2 response options were: (i) 'Not had this symptom', (ii) 'Symptom began before March 2020', '(iii) Symptom began when I got ill with COVID', (iv) 'Symptom began a few weeks after I had COVID', (v) 'Symptom began a few months after I had COVID', (vi) 'Symptom began during the pandemic but not because I had COVID' and (vii) 'I don't know/am unsure when the symptom began.' These options allowed us to examine the timeline of reported onset relative to Wave 1. Wave 2 was completed by 66.2% (n=6,881) of the individuals who completed Wave 1.

Results: Inconsistent reporting was evident. Specifically, 5.6% of 1446 individuals who reported tinnitus and 11.9% of 1814 individuals who reported hearing difficulties in Wave 1 said in Wave 2 that they had never had such symptoms before. Further, reported new tinnitus and hearing difficulties suggested 18-month incidence rates of 13.6% and 11.7% respectively - higher than expected from other studies. Symptoms at Wave 1 were associated with reported severity (recorded at Wave 2) such that 83.6% of respondents who noticed their tinnitus 'most of the time' reported tinnitus in Wave 1, as compared with 26.8% of respondents who reported 'not noticing their tinnitus often'. Similarly, 94.3% of those who rated their hearing as 'poor' reported hearing difficulties in both waves, as compared to 30.5% of individuals who rated their hearing as good or better.

Conclusions: Reporting of tinnitus and hearing difficulty over time is inconsistent. We suggest this is due in part to the nocebo effect (new or worsening symptoms that develop in response to negative health-related information or beliefs, psychosocial factors and the context in which symptoms were reported). This should be considered when treating patients and interpreting research findings. We propose that using real-time data collection methods, could provide a better understanding of real world patient experiences of tinnitus and hearing.

Category: Tinnitus

Poster #: 098 **T35 Research Trainee Poster**

Tinnitus Ratings after Concussion using the Concussion Symptom Subtype Inventory

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Objectives: Concussions can cause a wide range of symptoms, but concussion assessment and treatment lack a gold standard in the healthcare system. Recent research shows that commonly used concussion symptom assessment surveys do not fully capture the range of symptoms concussion patients experience. To address this gap, researchers developed a comprehensive questionnaire, the Concussion Symptom Subtype Inventory (CSSI), to capture a detailed picture of concussion patients' symptoms following injury. The initial version of the CSSI questionnaire was limited in questions assessing auditory symptoms, so additional questions regarding sound sensitivity, tinnitus, and auditory processing have been added to address an auditory subtype of concussion. The purpose of this project was focused on analyzing the additional question related to tinnitus to determine how self-reported tinnitus changes pre- and post-concussion in order to deepen understanding of the relationship between concussion and tinnitus.

Design: The CSSI was administered to adult patients who were receiving care from the Oregon Health and Science University (OHSU) Concussion Clinic or who were participating in concussion-related research studies at OHSU. Responses were obtained for the item, "I have ringing in my ears." Patients rated the severity of this symptom on a scale of 0 to 6 at two time points: before the concussion, and on the day of taking the survey (after concussion).

Results: Pre- and post-injury ratings were used to determine the proportion of patients self-reporting a change in tinnitus severity after concussion, and quantify the severity and direction of change.

Conclusions: Results of this study align with current literature that shows new or worsening tinnitus after injury is common in concussion patients. Ongoing data collection will provide a better picture of the relationship between other post-concussion symptoms and post-concussion tinnitus. This can lead to improvement in concussion treatment by raising awareness about co-occurring symptoms that may need to be assessed and addressed to improve recovery outcomes.

VESTIBULAR

Category: Vestibular

Poster #: 099

Utility of Sound-Evoked Vestibular Myogenic Potentials in Preclinical Models

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Objectives: VEMPs are elicited via air-conducted sound stimuli (ACS) or bone-conducted vibration (BCV) from tonically contracted cervical muscles (cVEMPs) and extraocular muscles (oVEMPs). They are essential tools in the diagnostic test battery as an objective measure of the integrity of the vestibulothalamic pathway and assessing saccular and utricular function. Recent studies have highlighted peripheral vestibular injury following intense noise or blast (impulse noise) exposures. Given the application of VEMPs in the clinical domain, it is essential to establish standard methods and protocols, examine neural basis of the responses, and validate relevant features for interpretation and assessment of vestibular functions.

Design: We recorded cVEMPs at multiple intensities and frequencies in na√Øve, noise and blast-exposed Brown Norway rats. SmartEP evoked potentials system (IHS, USA) was used to record sound-evoked VEMPs from the sternomastoid muscle in anesthetized female and male adult rats. In a custom-designed animal positioner, the head was turned at a 90¬∞ angle to one side maintaining muscle tension. Pure tone bursts from 1 to 16 kHz (50-100 dB SPL) were delivered via the ER3A insert earphone. The myogenic signals were amplified (x100k) and band-passed (30-1000 Hz). Each recording consisted of 256 sweeps, acquired at a rate of 5 per s with an alternating phase, and sampling rate of 200 ¬µs. cVEMPs were characterized by the presence of a positive (P1)-negative (N1) waveform at 3-5 ms from the stimulus onset.

Results: Within the cohort, reliable and replicable cVEMP responses were obtained at all frequencies down to 50 dB SPL. A cubic fit was performed on cVEMPs' wave I (P1-N1) amplitudes (R2=0.96) and 5th order polynomial was fit for P1 latencies (R2=0.98) at 90 dB SPL across frequencies (1-16 kHz). The cVEMP responses were grouped based on the stimulus tone. Amplitude and latencies of myogenic potentials were averaged in low (1-4 kHz), mid (6-10 kHz), and high frequency (12-16 kHz) ranges. The responses evoked by stimuli in the mid-frequency range were significantly larger (7.9±0.3 mV, $p<0.01$) and faster (3.4±0.04 ms, $p<0.001$) than the ones obtained at lower frequencies. However, no significant difference was observed when both amplitude and latency of mid-frequency responses were compared with cVEMPs from the 12-16 kHz frequency range. Mean P1 amplitudes were 6.3±0.3 mV for 1-4 kHz and 7.2±0.3 mV for the 12-16 kHz range. Mean P1 latencies were 3.7±0.03 ms for 1-4 kHz and 3.5±0.03 ms for 12-16 kHz. Sex differences were observed in latency but not with the amplitude. Results further show characteristic changes in cVEMPS with noise and blast-exposures. Histology was performed to compare and contrast hair cell counts.

Conclusions: This work details the characteristics of ACS-evoked myogenic potentials in a pre-clinical rat model. The results will guide the development of optimal cVEMP test protocols that is standardized and reproducible to elucidate pathophysiological characteristics of vestibular dysfunctions. Supported by NIH R01DC01379801A1, 5R44DC019586-02 and 1I01RX003532-01A2.

Category: Vestibular

Poster #: 100 **Mentored Student Research Poster Award**

Frequency Amplitude Ratio of cVEMPs and oVEMPs: Effects of Age

Jesus David Gomez, AuD; Raghav Jha, MS; Erin Piker, AuD, PhD, James Madison University, Harrisonburg, VA

Objectives: Cervical and ocular vestibular evoked myogenic potentials (cVEMP and oVEMP) measure the functional integrity of the saccule and utricle. VEMPs are typically elicited using an air conducted tone burst at

500 Hz, the stimulus that yields the largest amplitude response in young adults. In some pathologies such as Meniere's disease (MD) the largest amplitude is elicited at a higher stimulus frequency around 1000 Hz. Due to this upward shift in frequency tuning, the frequency amplitude ratio (FAR) of 1000/500 Hz has been suggested to be a biomarker for endolymphatic hydrops, the pathological mechanisms implicated in MD. However, in older adults there is also an observed shift in the frequency tuning of cVEMPs and oVEMPs with a proportion of older adults showing greater results at 750 and/or 1000 Hz. This makes it difficult to discern whether changes in the VEMP FAR are secondary to endolymphatic hydrops in MD or due to biological processes, such as increased stiffness, that occur during the natural state of aging. The objectives of this study are to 1) assess the effects of age on the FAR of three different stimulus frequencies for both the cVEMP and oVEMP, and 2) assess the effects of EMG and amplitude correction on the FAR in the cVEMP.

Design: A total of 106 participants were divided into three groups: young (N=40, 20-39 years), middle (N=35, 40-59 years), and older (N=31, >60 years) adults. All participants had a negative history of vestibular illness, neurological complaints, or middle ear pathologies and normal immittance audiometry. All participants were administered cVEMPs and oVEMPs using an air conducted 4 ms tone burst at 500, 750, and 1000 Hz at an intensity of 125dB pSPL. The FAR was calculated as a ratio of the cVEMP and oVEMP peak-to-peak amplitudes for the following frequencies: FAR1 = 1000/500, FAR2 = 1000/750, FAR3 = 750/500. This was completed for both the EMG corrected and uncorrected cVEMP amplitudes.

Results: For both the uncorrected and corrected cVEMP amplitudes, significant effects of aging were seen on FAR1 and FAR2 but not on FAR3. This effect was largely due to the upward shift in frequency tuning from 500 Hz to 1000 Hz observed in middle age and older adults. For the oVEMP, all of the FARs were larger in older adults compared to young and middle-aged adults, however results were not statistically significant. Age based normative data for multiple FARs will be provided in tables to assist with clinical interpretation.

Conclusions: Our findings demonstrated a significant age effect on the FAR of the cVEMP but not for oVEMP. These findings were consistent across both the EMG corrected and uncorrected cVEMP amplitudes. Our findings also suggest that 1000Hz elicits a significantly higher cVEMP amplitude in older adults. Clinically this is of great importance because it indicates that the use of the traditional 500 Hz toneburst may not be the best stimulation frequency to elicit a cVEMP response in older adults, and the FAR must be interpreted using age-based normative data in patients with Meniere's disease.

Category: Vestibular

Poster #: 101 **Mentored Student Research Poster Award**

Effects of Age on the AMcVEMP Temporal Modulation Transfer Function

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Objectives: Cervical vestibular evoked myogenic potentials (cVEMPs) reflect saccular stimulation resulting in an inhibitory muscle reflex recorded over the sternocleidomastoid muscle. These responses are used to study basic vestibular function and in clinical applications. For decades, cVEMPs have used transient stimuli such as clicks and tonebursts to evoke onset responses. Recently, amplitude-modulated tones have been used to elicit cVEMPs (AMcVEMPs), which reflect phase synchrony and nonlinearities from the human otolith reflexes that cannot be tapped using other existing testing techniques. AMcVEMP temporal modulation transfer functions

(TMTFs) of different analysis techniques have been established for young, healthy adults but there is no information regarding the effects of age-related degradation in the vestibular system. The purposes of this study are to 1. Characterize the effects of age for AMcVEMP TMTF, and 2. Determine evidence of vestibular non-linearity in young, middle-aged and older adults for a range of modulation frequencies (MFs).The hypotheses of the current study are 1. AMcVEMP TMTF will get narrower as an effect of aging. 2. We might see evidence of reduced non-linearity as an effect of aging for a range of MFs.

Design: We included 16 young (20-39 years),17 middle-aged (40-59 years) and 16 older adults (>60 years) with no history of vestibular lesions or middle-ear pathologies. Stimuli were amplitude-modulated tones with a carrier frequency of 500 Hz and MF: ranging from 11 to 397 Hz. Stimuli were presented using a B81 transducer at 65 dBHL. AMcVEMPs were recorded from the sternocleidomastoid muscle using surface electrodes. Response analysis used an FFT-based approach; analyses included amplitude, signal-to-noise ratio (SNR) and phase coherence. For non-linearity, responses rates were calculated at the harmonics of the MFs.

Results: Significant age-related degradation in the amplitude, SNR and phase coherence measures were seen. AMcVEMPs were elicited across a wide range of MFs (11-263 Hz) for young adults; in middle-aged and older adults, amplitude, SNR and phase coherence were robust only across a narrower range of MFs, resulting in a narrower TMTF. The shape of the AMcVEMP TMTF varied for different measures across the groups. Details will be discussed. Most robust AMcVEMP responses were seen at 79 Hz MF among the young and middle-aged but not among older adults. Robust responses were also present at the harmonics of MFs in most young, some middle-aged and fewer older adults indicating loss of vestibular non-linearity as an effect of aging.

Conclusions: Aging causes a significant decline for the AMcVEMP response; however, the effect of aging is not uniform across measures and across MFs. AMcVEMP TMTF gets narrower with age. The MF that can elicit most robust AMcVEMP changes as an effect of aging. AMcVEMP can also be used to determine evidence of vestibular non-linearity. Our data suggest a loss of vestibular non-linearity as a function of aging. Results from this study enhance our understanding of age-related changes in vestibular system and, expansion of AMcVEMP to clinical population may lead to a deeper understanding of the pathophysiology of the vestibular disorders.

ANATOMY and PHYSIOLOGY

Category: Anatomy and Physiology

Poster #: 102

Dynamics of Noise-Induced Dopamine Upregulation in Lateral Olivocochlear Neurons

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Objectives: Noise exposure can damage the inner ear, eliciting downstream compensation or protection mechanisms in the central auditory system. The lateral olivocochlear (LOC) efferent system may help prevent noise-induced excitotoxicity at the synapse between inner hair cells and auditory nerve fibers. Moderate environmental noise and high level acute exposures can increase expression of tyrosine hydroxylase (TH), an enzyme involved in dopamine synthesis, in cholinergic LOC neurons. However, the time course and dose-

dependence of this LOC plasticity is not well-described. We investigated changes in LOC neurotransmitter expression in mice following single, short-duration noise exposures of different intensities at different post-exposure time points.

Design: Young adult mice (C57BL/6J, 4 wks old, male and female) were exposed to broadband noise (2-20kHz) for 15 minutes at a level of 94, 97, 100, or 103 dB SPL. Auditory brainstem responses were measured in anesthetized animals to clicks and tonebursts (4, 8, 12, 16, 24, 32kHz) at one day, one week, and three weeks post-exposure. Cochlea whole mounts and brain sections through the lateral superior olive (LSO) were labeled using fluorescent immunohistochemical markers for cholinergic (choline acetyltransferase, ChAT), dopaminergic (TH), and other neurotransmitter pathways. Cochleas were also labeled for hair cell (Nissl or myosin, Myo7a) and presynaptic ribbon (c-terminal binding protein, CtBP2) markers. Confocal microscopic images were analyzed to quantify TH expression, hair cell loss, and synapse counts.

Results: The 94 and 97 dB SPL exposures caused no significant threshold shifts. The 100 and 103 dB SPL exposures caused 25-50 dB temporary threshold shifts, which mostly resolved within one week (100 dB SPL) or resulted in high frequency permanent threshold shifts (103 dB SPL). Sham and 94 dB SPL exposed subjects had variable TH expression in cholinergic LOC neurons that was usually minimal and restricted to high frequency regions (cochlear base and medial LSO). Following the 97, 100, and 103 dB SPL noise exposures, LOC TH expression in the cochlea and LSO core increased with exposure intensity and persisted for at least one week post-exposure. The time course and tonotopicity of LOC dopamine upregulation will be described in the context of ABR threshold shifts, hair cell loss, and ribbon synapse counts.

Conclusions: Noise exposure induces a dose-dependent increase in TH expression in cholinergic LOC neurons that lasts for at least one week following exposure, despite resolution of temporary threshold shifts. Dopaminergic transmission by LOC neurons may support inner ear recovery following acoustic injury and may represent a therapeutic target for noise-induced hearing loss.

Category: Anatomy and Physiology

Poster #: 103

Basilar Membrane May Not be the Source of Human TEOAEs

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Objectives: Traditionally, otoacoustic emissions (OAEs) were believed to originate from the basilar membrane (BM), and the BM was the only route by which OAEs could travel to the external ear canal. If this view is valid, then the suppression tuning of OAEs should match the tuning of the expected region of origin on the basilar membrane. However, recent studies using animal models challenge the traditional view by demonstrating that OAEs can be suppressed by tones in a range of frequencies wider than predicted by the tuning of the BM. This suggests that OAEs may originate in the organ of Corti instead of the BM and be coupled to the middle ear through the fluids. Our study explored the existence of this phenomenon for the first time in humans.

Design: We measured transient-evoked otoacoustic emissions (TEOAEs) in participants with normal hearing sensitivity. A tone-pip stimulus centered at 4 kHz was delivered at 60 dB peFPL. Pure-tone suppressors were used to separate TEOAEs from the stimulus. The suppressor level was set to 70 dB FPL. The suppressor

frequency was increased from 4.2 kHz until no emission was detectable. We determined the frequency range within which the suppressor could effectively suppress the emission and compared this across individuals.

Results: We observed that suppressors with frequencies up to about one half-octave higher than the emission frequency could suppress the 4 kHz emission and result in measurable TEOAEs with a delay much shorter than expected for the BM. This demonstrates that the broad suppression tuning of OAEs reported in animal studies also exists in humans.

Conclusions: The current study and recent animal studies support the notion that BM may not be the primary source of OAEs. These findings challenge our understanding and interpretation of OAEs and may change how we interpret this important objective measurement of cochlear function.

COCHLEAR IMPLANTS

Category: Cochlear Implants

Poster #: 104

Effort and Fatigue While Listening: Sustained Speech-Processing with Cochlear Implants

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Objectives: Listening-related fatigue is a significant problem for many adults with hearing loss. While the mechanisms responsible for this increased fatigue remain unclear, qualitative research suggests that increased listening effort might be a driving factor. This research is the first to use subjective and behavioral measures to examine the fatigue experienced by cochlear implant (CI) users during a sustained, speech-processing task. CI users results while listening in omnidirectional or directional processing mode will be compared to a control group of adults without hearing loss (NH). In addition, associations between the short-term effort and fatigue experienced during/following the speech task and a long-term measure of listening-related fatigue will be examined. The study design and preliminary findings will be discussed.

Design: Participants will include 30 adults- 15 CI users (bilateral or bimodal) and 15 NH adults recruited from our clinic population and the surrounding community. Participants complete a 40-minute, cognitively demanding, dual-task while seated in a reverberation chamber (RT30 ~430 ms). The primary task is word recognition in noise. The secondary task is noun identification. Speech is presented from a front loudspeaker at individually adjusted levels. Levels are chosen such that single-task word recognition-in-noise scores are approximately 65% of a participants' score in quiet. The overall noise level from four surrounding loudspeakers is fixed at 60 dBA. Participants repeat the word they hear and press a button if that word is a noun. Word recognition and noun identification response times are monitored over the 40-minute task. Decrements in performance over time provide behavioral evidence of fatigue. Behavioral fatigue is also measured by comparing Psychomotor Vigilance Task (PVT) performance before and after the dual-task. During the PVT, participants remain vigilant for a visual marker and press a button as quickly as possible whenever it appears. Slower PVT performance indicates more fatigue. Finally, participants subjectively rate their "right now" fatigue prior to, during, and after completing the dual-task. CI participants complete these tasks, counterbalanced on separate days, using omnidirectional and directional microphone processing. Participants without hearing loss

complete the task once. Long-term listening-related fatigue is quantified using the 40-item, Vanderbilt Fatigue Scale (VFS-A-40).

Results: Preliminary subjective and behavioral data suggests that the 40-minute dual-task is fatiguing. Consistently across participants and conditions, CI users' "right now" fatigue ratings increased over the course of the task from ~18 to 79 (on a 100-point scale). Likewise, post-test PVT response times were slower (average ~32 ms), consistent with degraded vigilant attention- a behavioral marker of fatigue. In contrast, word recognition scores and noun identification response times improved over time suggesting a possible learning effect. Currently, the small number of participants precludes analyses of effects of omni/directional processing on listening-related fatigue or associations between short- and long-term fatigue; however, data collection is ongoing. Preliminary results will be reported.

Conclusions: This study investigates speech-processing related fatigue in CI users and its association with those users' long-term listening-related fatigue experience- a largely unexplored research area. In addition, the potential benefits of directional processing on CI user's effort and fatigue are explored.

Category: Cochlear Implants

Poster #: 105

Spatial Unmasking in Reverberation for Children with Bilateral Cochlear Implants

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Objectives: To understand the impact of realistic indoor reverberation on spatial unmasking by children who use bilateral cochlear implants (CIs). Reverberation is unique to indoor environments such as classrooms where children spend most time learning. When tested in free-field environments, some children with bilateral CIs demonstrated access to auditory spatial cues, namely interaural time and level differences (ITD and ILD) and monaural head shadow, carried in the signal envelope for spatial unmasking - a phenomenon in which a target speech benefit is achieved by spatially separating it from the competing speech maskers. However, indoor reverberation distorts the auditory spatial cues in the acoustic inputs to the CI speech processors. How realistic reverberation affects spatial unmasking for children with bilateral CIs remains unknown to reflect their everyday listening experiences. Here, we hypothesize that children's performances on spatial unmasking deteriorate when tested in reverberant environments as compared to free-field due to reduced ILD and less salient ITD available in the signal envelope through electrical hearing. We further explore individual differences in how children with bilateral CIs process monaural and binaural auditory cues for spatial unmasking in reverberation with clinical implications for personalizing CI fitting.

Design: Spatial unmasking was assessed using a novel measure of minimum angular separation (MAS) needed to capture a 20% improvement in target speech accuracy with a spatial separation from the speech masker. The target talker was always fixed at 90-degree on the side of the better ear, if identified. MAS was measured by adaptively moving the masker, with a final possible range of MAS between >0-degree and 180-degrees. MAS was measured in free-field and again in a low-reverberant environment that mimics a typical classroom based on ANSI standard recommendation. Auditory virtual reality was introduced to create virtual classrooms with standard head-related transfer functions, with audio directly streamed to the CI speech processors. Eight bilateral CI users were tested, all bilaterally activated by 3 years of age. Individual differences were

characterized using the MAS magnitude: (1) ≤ 90-degree, children only needed envelope ITD/ILD cues for spatial unmasking, whereas (2) > 90-degree, children needed additional monaural head shadow.

Results: All bilateral CI users showed larger MAS thresholds or poorer spatial unmasking when tested in reverberation than in free-field. Younger children with bilateral CIs< 10 years old showed MAS generally > 90-degree regardless of the acoustic environment. Three older bilateral CI users had consistently < 90-degree MAS in both free-field and reverberation, whereas two users with < 90-degree MAS in free-field but > 90-degree in reverberation.

Conclusions: Preliminary results suggest that early bilateral CI users can access auditory spatial cues for spatial unmasking in reverberant environments that mimic classrooms designed to room acoustics standards. There exist individual differences in these children's need for additional monaural head shadow beyond ITD/ILD that may be dependent on age and the severity of reverberation. This initial finding provides indications on personalizing CI fitting to preserve auditory spatial cues for maximal spatial unmasking performance for the pediatric population.

Category: Cochlear Implants

Poster #: 106

Psychophysical Tuning Curves in Cochlear-Implant Listeners: Comparing a Fast, Novel Method to Traditional Approaches

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Objectives: Psychophysical tuning curves (PTCs) are one measure of spectral resolution that can be obtained in cochlear-implant (CI) listeners and are thought to be sensitive to the quality of the electrode-neuron interface (ENI). The quality of the ENI is related to the health and density of the target auditory neurons and the distance between the electrodes and the neurons. Differences between the sharpness of PTCs are often observed for different electrodes, even within the same CI listener. Traditional methods of obtaining PTCs are quite slow, so here our objective was to compare PTCs for two electrodes in each CI user, as measured with traditional and a new faster approach. The goal of the study is to begin to validate a new and more efficient method for measuring PTCs in CI users.

Design: Adult CI users with the Advanced Bionics CI system were recruited to participate (N=4 ears, 1 bilateral participant). The traditional method of measuring forward-masked PTCs uses direct stimulation, while the new approach uses audio stimulation via a Bluetooth connection. Absolute thresholds across each electrode array were measured for each listener using focused stimulation (0.9-steered quadrupolar, sQP) via a sweep method. The electrodes between 3 and 13 with the highest and lowest focused thresholds were selected as probe electrodes for PTC measurements to maximize the difference between PTCs. The forward-masking paradigm used a 200-ms masker with a 20-ms gap and a fixed low-level 20-ms probe. For the direct stimulation method, the sQP mode with a 0.5-sQP focusing coefficient was used for both masker and probe. Thresholds and maximum comfortable loudness levels were determined for all stimuli in both stimulation modes. Forward-

masked thresholds were measured for PTCs using a 3-interval 3-alternative forced-choice procedure with a fixed probe level and adaptively varying masker level. For the audio-stimulation method, the same temporal parameters for the pure-tone masker and probe were selected, but no measurements of masker thresholds or comfort levels were needed. The pure-tone frequencies were selected to stimulate the main and neighboring electrodes at 75% and 25%, respectively through the listeners' speech processor. The forward masker was presented at a fixed level above that needed to mask the fixed-level probe when the masker and probe were at the same frequency. The masker frequency was then adaptively varied to directly find the 6- and 10- or 12-dB bandwidths of the PTC.

Results: Threshold differences between the two selected channels with the highest and lowest 0.9-sQP thresholds were 4.8 dB (ranging from 3.23 to 6.75 dB). PTCs were quantified in terms of the slopes of the best-fit line of each side of the PTCs from the tip/probe electrode. We observed steeper electric PTC slopes for the probe channels with lower absolute 0.9-sQP thresholds (mean = 25.5% masker dynamic range/electrode, ranging from 13.8 to 39.8) than high threshold channels (12.38 % masker dynamic range/electrode ranging from 4.2 to 18.5). A similar trend was observed for low (4.60 dB/electrode from 3.7 to 6.8) and high (3.9 dB/electrode from 2.2 to 5.0) threshold channels using the Bluetooth audio stimulation approach.

Conclusions: In this small sample of adult CI listeners, sharper tuning was observed for lower focused-threshold channels with both methods of PTCs measurement. These pilot data support the further exploration and validation of this more efficient way to measure PTCs via Bluetooth stimulation.

Category: Cochlear Implants

Poster #: 107

Interaural Cross Correlation After Cochlear Implant Processing

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Objectives: Objectives: In tasks involving binaural hearing, such as source localization, bilateral cochlear implant (CI) users typically perform worse than normal hearing (NH) listeners. Binaural fusion - the ability of the auditory system to combine the signals from the two ears - depends on two factors. One factor is interaural cross-correlation (ICC; a measure of how statistically similar the signals received by the two ears are). The other factor is interaural symmetry (i.e., the extent to which the same position in the left and right cochlea are stimulated). The reduced binaural benefits observed in CI users are partially attributed to issues with this second factor, caused by a mismatch between the insertion depths of the electrode arrays in the two ears, which leads to differences in place of simulation across the two ears. Additionally, the interaural asymmetry typical with CIs also results in the degradation of ICC at interaurally symmetric locations. ICC is also altered by CI processing. The aim of this study is to determine the effect of various degrees of interaural asymmetry on ICC after CI processing. A negative correlation between the two is predicted because the within-signal correlation is expected to gradually reduce when comparing distant spectral regions.

Design: Binaural recordings were first recorded with a Knowles Electronics Manikin for Acoustic Research (KEMAR) in two acoustic setups - with and without acoustic reflectors to one side of KEMAR. These acoustic reflectors introduced reverberation and decreased ICC further. AzBio sentences were played from 13 loudspeaker positions between 0-180 degrees azimuth angle in both these setups. Using the ICC values from these recordings as reference, CI recordings were made at a selected few speaker positions and conditions. An

implant-in-a-box was used to record the electrodograms for each ear. To assess the effect of interaural asymmetry, a reference electrode was selected, and ICC was calculated for interaurally symmetric and every possible interaurally asymmetric electrode pairing for a given acoustic setup and source signal position. Pearson correlation between the level of asymmetry and median ICC across all relevant electrode pairs was analyzed.

Results: An overall significant negative correlation between interaural asymmetry and ICC after CI processing was obtained. The ICC value had the highest drop at the first level of asymmetry followed by a gradual decrease with a few small peaks thereafter with increasing asymmetry. Comparing the ICC obtained from the binaural recordings and CI electrodograms, preliminary results show that CI processing increases the ICC.

Conclusions: The negative effect of asymmetry is mediated both by the CI processing and the within-signal correlation across the spectrum. The increase in ICC values compared to those from binaural recordings shows that CI processing reduces the existing differences between the signals arriving at the two ears.

Category: Cochlear Implants

Poster #: 108

Predicting Post-Operative Speech Perception for CI Candidates with Residual Hearing

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Objectives: As outcomes for cochlear implants have improved, patients with significant residual hearing who receive limited benefit from amplification may now be candidates. Given that they will be potentially losing residual hearing, it is important to be able to predict outcomes for these patients after implantation. We hypothesize that tests of suprathreshold auditory abilities, such as spectrotemporal resolution, are better predictors of speech outcomes post-implantation than the audiogram.

Design: We tested adult patients with steeply sloping hearing pre-operatively on the spectro-temporally modulated ripple test (SMRT) using their acoustic hearing. As part of their candidacy evaluation, subjects also had an audiogram and aided speech evaluation using CNC words and AzBio sentences in quiet and noise (+10 dB SNR). At least 3 months post-operatively, speech perception in the everyday listening condition. This was using electroacoustic stimulation (EAS) for those who preserved hearing and electric only for those who did not. An unaided audiogram was also measured.

Results: SMRT was correlated with speech outcomes for all three tests, while pre-operative and post-operative audiograms were not. Preoperative audiograms and SMRT were correlated. Pre-operative speech perception was correlated with post-operative speech for AzBio +10 only.

Conclusions: SMRT appears to predict postoperative speech, regardless of hearing preservation. Spectro-temporal resolution may be a predictive factor for outcomes with a cochlear implant in patients with residual hearing. While the mechanism underlying this is unclear, it seems that suprathreshold auditory abilities are related to cochlear health and the "quality" of residual hearing.

Category: Cochlear Implants

Poster #: 109

Cochlear Implant Listeners Perception of Temporal and Spectral Voicing Cues

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Objectives: Perception of voice onset time (VOT) is often used as an index of auditory temporal processing. However, some VOT stimuli are less appropriate for this goal because of the vowel that follows the consonant. For example, there are complementary frequency cues for the low vowel /…ë/, but not for the high vowel /i/, meaning choice of vowel context affects studies on timing perception. For people who use cochlear implants who have residual aidable hearing, perception of those frequency cues could be a key benefit, but could also pose a problem for researchers who are looking to determine the ability to perceive timing cues. We hypothesize that VOT perception will be better when the following vowel is /…ë/, because it contains both temporal and spectral cues for voicing, whereas /i/ provides only temporal cues. We further hypothesize that low-frequency hearing will enable listeners to exploit that benefit when the signal is degraded.

Design: Listeners with cochlear implants or with normal hearing completed a task in which they categorized words varying by VOT between /d/ and /t/, where vowel formant transitions naturally covaried with VOT duration. The following vowel was either /…ë/, which allowed perception of spectral contours, or /i/ which did not. The onset consonant of each word was categorized as voiced or voiceless and modeled using a binomial statistical model that included VOT, vowel and hearing as fixed main and interacting effects.

Results: Both listener groups reliably categorized voicing contrasts. Performance was better in the /…ë/ context, suggesting use of spectral cues. When adding low-frequency cues to a degraded signal, voicing perception was improved when the vowel was /…ë/ but much less when the vowel was /i/, likely due to differences in the availability of formant transitions.

Conclusions: Spectral cues in vowels can play a role in perceiving voice onset time. Vowels that contain formant contours can create a confounding variable when studying VOT perception. Perception of formant transitions can interfere with measuring auditory temporal perception but could potentially be useful for measuring the benefit of residual low-frequency hearing.

Category: Cochlear Implants

Poster #: 110 **Mentored Student Research Poster Award**

Repeated Moments of Listening Effort Build to Listening Fatigue

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Objectives: People with hearing impairment who wear a cochlear implant (CI) report listening effort as a major barrier to successful social communication. Effort appears to underlie increases in listening-related fatigue, but previous work has examined listening effort and fatigue separately with different experimental methods, leaving the mechanistic connection between effort and fatigue unknown. One primary mechanism of momentary increases in listening effort is mentally repairing misperceived words when perceiving speech. We hypothesize

that repeatedly needing to mentally repair words will lead to greater levels of fatigue, as indicated by increases in reaction time and decreases in sentence recognition memory.

Design: CI and normal hearing (NH) listeners completed a series of three tasks: 1) pre-test reaction time; 2) a speech perception task; and 3) post-test reaction time. Reaction times were measured for an inhibition task involving visual judgments, accompanied by a subjective fatigue questionnaire. During the speech perception task listeners heard blocks of sentences including some that were normally produced, and some where a single context word was masked by noise and recoverable based on context. Pupil dilation was measured during the listening task to assess momentary effort. Following the listening phase, participants completed a sentence recognition memory task, where a sentence was presented as text and participants were asked if it was presented during the previous listening block; success was defined as correctly recognizing stimuli that were heard and rejecting novel stimuli that were not heard. After the speech perception experiment, listeners completed the reaction time task and fatigue questionnaire to measure how sustained effortful listening impacted fatigue. This three-phase testing sequence was completed four times in total.

Results: Preliminary results show reaction times increased more strongly after listening to blocks of sentences that required mental repair. Participants showed poorer recall of mentally repaired sentences after the first block, while recall of fully intact sentences remained constant throughout the experiment. Pupillometry results show larger increases in pupil dilation and slower decay of pupil size over time when needing to mentally repair a missing word compared to intact sentences.

Conclusions: These preliminary results indicate the potential impact of repeated moments of elevated listening effort on accumulated fatigue. Fatigue has typically been captured using measures of self-report, and the mechanisms of how momentary increases in listening effort can lead to accumulated fatigue are unclear. This study provides a novel approach in evaluating the connection between effort and fatigue, and the results have implications for future development of rehabilitation strategies to address patient concerns of effort and mental fatigue.

Category: Cochlear Implants

Poster #: 111 **Mentored Student Research Poster Award**

Is Across-Test Variability in CI Speech Perception Mediated by Cognition?

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Objectives: Speech perception scores vary across adult cochlear implant (CI) users and across tests within users. However, factors underlying the cross-test variability within CI users have not been systematically investigated. It is possible that executive functions such as verbal working memory, linguistic processing, and inhibition-concentration might contribute to the magnitude of differences in scores across test types within listeners. The hypotheses for this study were: 1) CI users with better linguistic processing will have larger differences between scores for sentences in quiet versus monosyllabic words due to their ability to use contextual cues to fill in missing information from a degraded speech signal. 2) CI users with better verbal working memory will have smaller differences between scores for sentences in quiet versus in noise due to their ability to manipulate and store auditory information allowing for more accuracy in understanding a complex speech signal. 3) CI users with better inhibition-concentration will have smaller differences between scores for sentences in quiet versus in noise due to their ability to ignore unwanted auditory stimuli and attend to the desired signal.

Design: Data have been collected for 15 adult CI users aged 20-90 years. Inclusion criteria were adults with ≥6 months' CI use and spoken English proficiency. Participants completed the following tests using their daily listening configuration: AzBio sentences in quiet and in noise (+15 SNR, multi-talker babble), CNC words in quiet, Revised Speech in Noise test (R-SPIN; to test linguistic processing), Digit Span Backward (to test verbal working memory), and the Stroop Color and Word test (to test inhibition-concentration). Linguistic processing was quantified as the percent correct for low-probability sentences on R-SPIN and compared to the difference in scores between AzBio sentences in quiet and CNC words in quiet. Verbal working memory was quantified as the maximum string of digits correctly recalled on the Backward Digit Span test and compared to the difference in scores between AzBio sentences in quiet versus in noise. Inhibition-concentration was quantified as the difference between incongruent and congruent response times on the Stroop test and compared to the difference between AzBio sentences in quiet and in noise. Correlation analyses were used to assess these relationships.

Results: There were no significant correlations ($p > 0.05$) between any of the measures. For the first hypothesis, the correlation between percent correct on R-SPIN and the difference between monosyllabic words and sentences in quiet was in the predicted direction but failed to reach statistical significance ($p = 0.06$).

Conclusions: The lack of significant correlations could be due to several factors including variations in duration of daily wear time, daily listening configuration (unilateral CI, bimodal, bilateral CI), inadequate SNR, or composition of background talkers (multi- versus 2-talker babble). More research is needed on a larger number of participants to determine if across-test variance in speech perception scores is mediated by specific cognitive functions.

Category: Cochlear Implants

Poster #: 112

The Effect of Peripheral Encoding Precision on Alternating Speech Integration in Unilateral Cochlear Implant Simulations

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Objectives: Patients with single-sided deafness (SSD) present with significant interaural asymmetry. Although CI recipients with SSD (i.e., "SSD-CI") can hear through both ears, their ability to integrate acoustic and electric stimulation from the typical and implanted ears, respectively, is highly variable. Given that multiple etiologies can induce SSD, there is variability in how well the implanted ear can encode auditory inputs. This variability is hypothesized to be reflected in the ability of SSD-CI users to fuse speech information arriving at the two ears. Further, we are interested in how well SSD-CI users can encode speech information presented to the two ears either simultaneously or in an alternating manner between ears with variable rates of switching. Previous work in normal hearing (NH) participants suggests that there is a 'U-shaped' performance function, whereby at fast switch rates listeners perform well if they can integrate the information rapidly switching between ears (i.e., due to perceptual closure). Listeners also perform well if they can either fuse signals across ears (i.e., no switching) or alternate attention between the ears (i.e., switching at low rates). However, at intermediate rates, these perceptual strategies generally fail, leading to poorer performance. Here, the objective

was to investigate how these effects generalize to NH participants who receive an unprocessed acoustic signal in one ear and an acoustic signal emulating a CI in the other.

Design: Unprocessed IEEE sentences were presented to one ear and IEEE sentences processed through a vocoder were presented to the contralateral ear. Twenty NH adults participated. CI processing was simulated using a gaussian-envelope tone (GET) vocoder, with varying pulse rate and envelope characteristics including rate of decay, to approximate peripheral encoding that varies in precision and spread of excitation across electrical channels. The task utilizes an alternating speech paradigm to switch presentation of recorded sentences between ears at eight switch rates [0, 1, 2, 4, 6, 8, 12, 16 Hz]. Performance in the dichotic switching condition will be compared to performance of each ear alone (i.e., monotic presentation with periodic silent intervals at the same rates as the dichotic condition).

Results: Preliminary results show that, compared with prior studies in which both ears receive an unprocessed acoustic signal, in the simulated SSD-CI configuration, integration across the ears follows unique trends regarding both how well participants perform overall, and the temporal window that characterizes poor integration across the ears. The effect of simulated peripheral encoding will be analyzed to better understand limitations arising in SSD-CI listening.

Conclusions: For patients with SSD, the successful integration of electric and acoustic stimulation is of paramount importance, especially when communicating in complex acoustic environments. We intend to apply this design in a study with CI recipients who have various contralateral hearing modalities (e.g., patients with SSD-CI, bimodal hearing, or bilateral CIs) to better understand the impact of asymmetric electrical signal encoding on bilateral integration.[Work supported by NIH-NIDCD R01DC003083 to RYL, NIH-NIDCD R21DC020532 to ZEP, and a core grant from NIH-NICHD (U54HD090256 to Waisman Center)]

Category: Cochlear Implants

Poster #: 113

The Lexical Bias Effect in Adult Cochlear Implant Users

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Objectives: Lexical bias is an established phenomenon in which an ambiguous speech sound tends to be perceived in line with the word context in which it is heard. Previous research demonstrated that the lexical bias effect may be strong when the acoustic signal is degraded, as in the case of cochlear implant users. The purpose of this project was to (1) replicate previous research examining the lexical bias effect in normal hearing listeners with noise-vocoded speech, (2) examine the malleability of the lexical bias effect following a period of auditory training, and (3) relate individual difference measures of cochlear implant use and language experience to the magnitude of the lexical bias effect in cochlear implant users.

Design: In Experiment 1, 75 normal hearing listeners were recruited using online methodology. Participants completed a phonetic categorization task for clear and spectrally degraded continua. In the phonetic categorization task, listeners were presented with six speech sounds along a /b/ - /g/ continuum concatenated with either "_ack" or "_ap," (e.g., "back" -"gack" and "bap" - "gap"). On each trial, listeners categorized the item as "bap" "gap" "back" or "gack." For the ambiguous speech items that fell in the middle of a continuum,

the selection of a real word over a nonword was interpreted as the listener relying on the lexical context to identify the speech sound. In Experiment 2, a different group of 75 normal hearing listeners completed a training task and a phonetic categorization task. First, listeners participated in a training task where they completed a same/different phonetic discrimination task with feedback for two acoustically degraded items along the /b/- /g/ test continua presented in Experiment 1. Following the phonetic discrimination training phase, listeners completed an identical phonetic categorization task as presented in Experiment 1 for the /b/ - /g/ test continua. In Experiment 3, 18 adult cochlear implant users were recruited using online platforms. Participants completed the same phonetic categorization task for clear speech and a hearing history questionnaire. The hearing history questionnaire included self-report answers on the age of implantation, duration of cochlear implant use, and cochlear implant wear time.

Results: In Experiment 1, listeners categorized more of the continua in line with the lexical item for degraded auditory input relative to clear input, consistent with previous research. In Experiment 2, following auditory training, we observed a reduction in lexical bias on phonetic categorization for degraded speech signals, such that listeners categorized fewer items along the continua as the lexical item. In Experiment 3, we observed a larger lexical bias effect in cochlear implant users relative to normal hearing listeners that was related to age of implantation and self-reported auditory experience.

Conclusions: Our results suggest that structured experience with degraded speech can alter reliance on lexical bias for categorization. Our findings suggest that the lexical bias effect is malleable and dynamically changes in line with either trained experience or self-reported auditory experience. The findings have implications for developing outcome metrics to track phonetic sensitivity and reliance on lexical context during the cochlear implant adaptation process.

DIAGNOSTIC AUDIOLOGY / OTOLOGY

Category: Diagnostic Audiology / Otology

Poster #: 114

Bone-Conduction Reference Threshold Levels - a Multicenter Study

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Objectives: Previous studies revealed that bone-conduction thresholds at frequencies > 2000 Hz are lower than air-conduction thresholds, resulting in air-bone gaps in listeners with normal hearing and sensorineural hearing loss. This study was undertaken to establish normal bone-conduction thresholds with methods prescribed by ISO 389-9. That standard requires that reference threshold levels should be based on thresholds for "otologically normal" subjects. In this study, both normal-hearing and sensorineural hearing loss (SNHL) subjects were tested.

Design: Data were collected at three sites - Arizona State University, Cincinnati Children's Hospital and Medical Center, and the University of South Florida. Twenty normal-hearing listeners and ten listeners with SNHL were tested at each site. Air-conduction thresholds were tested in both ears with circumaural earphones (Radioear DD450) at standard octave and interoctave frequencies (250 - 8000 Hz). Bone-conduction thresholds were tested in one ear at the same frequencies.

Results: Normal Listeners. Mean air-conduction thresholds for all frequencies ranged from 2-6 dB HL (mean = 4 dB HL). Mean bone-conduction thresholds range from 2-6 dB HL for frequencies 250 - 2000 Hz (mean = 4 dB HL). At frequencies 3000 - 8000 Hz mean bone-conduction thresholds range from 0 to -8 dB HL (mean = 5 dB HL). Average air-bone gaps range from -3 to 0 dB HL at 250 - 2000 Hz (mean = 0 dB HL) and 5 - 12 dB at 3000 - 8000 Hz (mean = 8 dB). The mean 4-kHz air-bone gap is 9 dB.SNHL Listeners. Mean air-conduction thresholds range from 18 to 55 dB at 250 - 8000 Hz. The mean air-bone gap at 250 Hz is 10 dB, resulting from an occlusion effect produced by the circumaural earphone at that frequency. Mean air-bone gaps at 500 - 2000 Hz range from -4 to 0 dB (mean = -1 dB). Mean air-bone gaps at 3000 - 8000 Hz range from 7 to 30 dB (mean = 17 dB). The mean 4-kHz air-bone is 16 dB.The 4-kHz air-bone gap increases with the magnitude of the air-conduction hearing loss from about 11 dB for a 30 dB air-conduction threshold to 25 dB for a 70 dB air-conduction threshold.

Conclusions: Standard bone-conduction calibration results in air-bone gaps above 2000 Hz for normal and SNHL listeners. These air-bone gaps probably result from erroneous reference threshold levels that were derived from early studies using the artificial mastoid calibration device. Earlier studies had determined that normal bone-conduction sensitivity decreases with frequency with a slope of -12 dB/octave. The reference threshold levels however, depart from that relationship with reference thresholds that increase rather than decrease above 2000 Hz. Correcting high-frequency reference threshold levels to conform with the -12 dB/octave slope eliminates erroneous high-frequency air-bone gaps. The increase in air-bones gap with the magnitude of the hearing loss suggests that high-frequency bone-conduction thresholds for normal-hearing subjects are elevated by the noise floor - an inevitable result of the -12 dB/octave slope. This finding indicates that results from listeners with sensorineural hearing loss should be considered in the determination of reference equivalent threshold force levels for bone-conduction stimuli.

Category: Diagnostic Audiology / Otology

Poster #: 115

Effect of Chirp Probe Intensity on Wideband MEMR Measures

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Objectives: Measuring the middle ear muscle reflex (MEMR) using a wideband (WB) paradigm has recently been shown to be a useful assay of subclinical auditory injury. Optimizing measurement parameters of the WB MEMR remains an important area of investigation. In the current study, we examined the effect of ipsilateral chirp probe intensity on the contralateral MEMR. Given that the MEMR is a bilateral response, we expected a more intense ipsilateral probe signal to interact additively with a contralateral elicitor, obfuscating the contralateral response by introducing a binaural interaction component. Consequently, we predicted greater overall MEMR growth and lower MEMR threshold when using a higher-intensity chirp probe.

Design: Subjects included adults aged 18-34 years (n=20) with normal audiometric thresholds and without significant noise-exposure histories. Left and right ears were randomly assigned to serve as the ipsilateral probe ear. Ipsilateral chirps were presented at 60 and 70 dB SPL, and the contralateral broadband noise elicitor was presented at 50-90 dBA in 5-dB steps. Presentation order was randomized. The MEMR was recorded as the change in normalized relative ear canal pressure between a probe-only and a probe-plus-elicitor condition from 0.7-6 kHz. Relative pressure change was compared across conditions to assess the effects of ipsilateral probe intensity on MEMR growth. If the ipsilateral probe did not contribute to the MEMR and change tympanic membrane impedance, then the normalized relative pressure change would not differ with varying probe levels. Thresholds of MEMR activation were independently determined by three individuals familiar with WB MEMR measures who were blinded to the measurement parameters.

Results: In nearly all cases, normalized relative pressure change was significantly greater when the ipsilateral chirp probe was presented at 70 dB versus 60 dB SPL. Mean relative pressure change was significantly higher across elicitor levels for a 70 dB probe compared to a 60 dB probe. Moreover, "contralateral" MEMR thresholds were lower in the higher-intensity chirp condition. Thresholds obtained with a 70 dB probe were, on average, 10 dB lower than those obtained with a 60 dB probe.

Conclusions: These findings demonstrate that an ipsilateral chirp probe can contaminate a contralaterally elicited MEMR. The ipsilateral probe can have an additive effect on overall MEMR growth, resulting in a binaurally elicited response, yielding a lower MEMR activation threshold. Researchers should consider this effect when designing experiments using the WB MEMR.

Category: Diagnostic Audiology / Otology

Poster #: 116

Clinical Utility of the Standardized Word Recognition Scores

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Objectives: An unexpectedly low word recognition (WR) score may be taken as evidence of poor aural rehabilitation potential or an increased risk for retrocochlear disease. We sought to develop evidence for or against using computational methods to determine when a WR score is unexpectedly low. We retrospectively compared the sensitivity and specificity of the standardized WR score (sWR), a computational method that estimates when a word recognition score is unexpectedly low, against raw WR scores in detecting retrocochlear tumors. The sWR is a z-score expressing the difference between an observed word recognition score, and a Speech Intelligibility Index-based predicted word recognition score. We hypothesized that the sWR would detect tumor-induced poor WR performance more accurately because it controls for audibility and test variation associated with word list length. Previously, we developed a 6-frequency pure-tone asymmetry (6-FPTA) calculation optimized to detect retrocochlear tumors. We hypothesized that a regression model incorporating the 6-FTPA calculation and the sWR would more accurately detect retrocochlear tumors relative to regression models that included a four-frequency (AAO) pure-tone asymmetry measure and a standard WR score.

Design: Retrospective data from all patients seen in the audiology clinic at our institution in 2016 were reviewed. Cases with retrocochlear tumors were compared with a reference group with noise- or age-related

hearing loss or idiopathic sensorineural hearing loss. Two base PTA logistic regression models (6-FPTA and AAO) were created. Into these base models, word recognition variables (WR, sWR, WR asymmetry [WRΔ], and sWR asymmetry [sWRΔ]) were added. Tumor detection performance for each regression model was compared twice: first, using all tumor and reference group cases (N=61 and 2332, respectively), and second, using a filtered dataset that excluded hearing asymmetries greater than would be expected from noise- or age-related hearing loss (N= 25 and 2208, respectively). The area under the curve (AUC) and the DeLong test for significant receiver operating curve differences were used as outcome measures.

Results: The 6-FPTA model outperformed the AAO model with and without WR or WRΔ variables. The WR or WRΔ variables were strongly correlated with hearing asymmetry and did not significantly improve disease detection performance. The sWR was weakly correlated with hearing asymmetry. The best performance was achieved with the 6-FPTA + sWR model, which had the highest AUC in the full and filtered data sets. The contribution of sWR to disease detection was most evident in the filtered data set, which did not have large pure-tone hearing asymmetries. The base AAO + sWR model performed comparably to the 6-FPTA + sWR model.

Conclusions: WR performance correlated with pure-tone hearing asymmetry even when audiologists selected presentation levels intended to achieve maximum speech recognition ability. This highlights the problem of recognizing when WR performance is unexpectedly poor from suprathreshold (i.e., tumor-related) changes in auditory fidelity. Combining the 6-FPTA and sWR overcame this problem and maximized tumor detection performance. These results support using the 6-FPTA and sWR computational methods to improve clinical decision-making.

Category: Diagnostic Audiology / Otology

Poster #: 117 **T35 Research Trainee Poster**

Survey of Clinical Audiologists' Ability to Serve Spanish-Speaking Patients

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Objectives: As of 2020, 43.8 million people report speaking Spanish at home. The focus of this research was to determine which audiometric speech tests clinicians use for their bilingual/monolingual Spanish-speaking patients, as well as to identify in which language they administer these tests. Additionally, by collecting information about the speech tests administered to Spanish speakers, we sought to assess the uniformity and variability in how these patients are currently assessed.

Design: A short, online survey was created and administered using Qualtrics. The survey was composed of multiple choice, matrix table, and text-entry question types. Practicing audiologists across the country were invited to complete the anonymous survey. Qualitative analyses of the survey responses were performed.

Results: Preliminary data from respondents located across the US reveal that the majority of respondents see Spanish speaking patients in clinic at least half the time. Despite few individuals reporting themselves as proficient Spanish speakers, about half of all respondents report being comfortable administering and scoring tests in Spanish. Less than half of all respondents report using recorded speech material all the time, which

indicates a lack of standardization across providers. Notably, the most widely used test for assessing bilingual Spanish-English and monolingual Spanish-speaking patients is the CNC word list in English - a test that is also available in Spanish. When asked to report which tests clinicians wish they had access to in Spanish, many respondents reported speech-in-noise tests as a valuable assessment they are missing.

Conclusions: Based on survey responses thus far, we draw three main conclusions: First, there is currently no standardized protocol for the assessment of bilingual Spanish-English and monolingual Spanish speaking patients in the US; therefore, such an assessment protocol should be developed and validated. The use of English-language tests to assess a native Spanish speaker's auditory status is not appropriate. Second, audiologists who are not native Spanish speakers should be able to demonstrate sufficient Spanish proficiency and may require additional training or certification to administer and score tests in Spanish. Third, anytime an audiologist is not a native or proficient speaker of Spanish (or any other language) they should use a qualified interpreter to minimize the potential for misdiagnosis due to language barriers.

Category: Diagnostic Audiology / Otology

Poster #: 118

Threshold Determination Using Simultaneous Binaural Multifrequency Auditory Evoked Brainstem Response

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Objectives: To use a chained-stimuli approach which interleaves several discrete stimuli between the two ears in a fashion that maximizes acquisition efficiency while minimizing response adaptation by testing several frequencies at the same time.Since early identification and characterization of hearing loss is important, only objective estimates of frequency-specific hearing thresholds need to be obtained. In particular, audiologists may schedule an auditory brainstem response (ABR) test - a test that can require up to an hour or two, and necessitate a separate appointment, causing delays in diagnosis. Additionally, time taken to record frequency-specific ABRs usually exceeds the time made available by patient sedation/cooperation. Previous attempts of reducing test-time have not been popular in clinical settings due to expensive hardware and software requirements. In the current study, we examined the potential of an ABR acquisition paradigm that can significantly shorten testing-time without sacrificing accuracy. This simple and intuitive technique does not require additional equipment.

Design: Thirty normal hearing young adults participated in the study (male=10; age range=18-35years). The ABR-eliciting stimuli was a train of either tone-bursts or narrow-band-iChirps (4000Hz, 2000Hz, 1000Hz, and 500Hz) sequentially placed (from high to low frequency to avoid neural adaptation and upward spread of excitation) and presented in an interleaved manner to each ear. The stimuli train was jittered (5%) in time to avoid any neural entrainment to periodicity. ABR responses were recorded simultaneously from two inverting sites- 7th cervical vertebrae (C7) and linked mastoids. Responses were recorded at stimulus levels of 40, 30, and 20 dBnHL.

Results: Both the tone-burst and narrow-band-iChirp stimuli elicited replicable ABR waveforms at all stimulus levels tested. Two-way interactions between intensity and stimulus revealed that the response amplitude was significantly larger for the narrow-band-iChirp stimulus, compared to the tone-burst stimulus, especially at

threshold ($F = 4.74$, $p < .01$). By design, chirp stimuli can produce greater neural synchrony (and therefore larger response amplitude) since it removes the desynchronizing effects of different traveling wave delays associated with a click stimulus. Due to this enhanced neural synchrony, responses can be identified even at lower stimulus levels compared to responses elicited by tone-burst stimuli. The C7 electrode site resulted in better SNRs, waveform morphology, and thus larger response amplitudes than the linked mastoid site ($F = 54.11$, $p < .001$). C7 electrode site yielded responses less contaminated by post-auricular muscle artifacts. Thus, we were able to record frequency-specific ABRs by interleaving the stimulus, without compromising the responses.

Conclusions: In effect, our method and stimuli put together creates a recording paradigm/protocol that can yield binaural ABR thresholds in closer to 22 minutes, which is 1.8 times quicker compared to the conventional threshold determination using the ABR clinically. This novel recording paradigm is thus a quick and effective clinical tool in threshold determination.

Category: Diagnostic Audiology / Otology

Poster #: 119

Test-Retest Reliability of Auditory Brainstem Responses to Continuous Speech

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Objectives: The auditory brainstem response (ABR) is widely used to non-invasively assess hearing function for infants to adults in both research studies and the clinic. These responses to very brief sounds are highly repeatable and useful for determining hearing acuity, but they do not correlate well with suprathreshold behavioral measures of speech understanding. Recently the "peaky speech" method was developed for deriving ABRs to continuous speech (e.g., audiobooks) to investigate underlying neural processing of communication. This method holds great potential for new studies of speech processing and for new clinical tests that use more ecologically salient stimuli. However, no studies to date have evaluated the reliability of these measures - a metric that is very important for ensuring consistent and repeatable results, as well as for translation into clinic. This study aimed to evaluate the test-retest reliability of ABRs evoked by continuous speech. We hypothesized that broadband speech ABRs would be as reliable as click ABRs, and the multiband speech ABRs would be most reliable for the high-frequency responses.

Design: ABRs were recorded in two visits from 14 adults aged 19 to 29 years, who had confirmed normal hearing thresholds from 250 to 8000 Hz. Most participants completed the two visits within 10 days (range 1 to 35 days). The same stimuli were used for each visit, and included 3.5 minutes of randomized clicks at an average rate of 40 Hz and 57 minutes of the audiobook "Alice in Wonderland"; 12 minutes of broadband peaky speech, and 45 minutes of multiband peaky speech. ABR waveform morphology between visits was compared using Pearson correlations over a 10 ms latency range starting at a lag that captures wave V, and the reliability of wave V peak amplitude and latency were compared using intra-class correlation.

Results: ABRs to broadband peaky speech and clicks were highly correlated between visits (median $r > 0.92$) and were similarly reliable (Wilcoxon signed-rank test, $p = 0.63$). For multiband peaky speech, the mid/high frequency ABRs were highly correlated across visits (median $r > 0.8$), but the lower frequency ABRs were moderately correlated (median r of 0.66 for 500 Hz and 0.72 for 1000 Hz bands).The intraclass correlation coefficient for absolute agreement (ICC3) was greater than 0.71 for each type of stimulus, indicating good agreement between visits for chosen wave V peaks.

Conclusions: Taken together, these results suggest that continuous speech-evoked ABRs can be reliably recorded across visits. This work provides an important step to increasing the feasibility of using both broadband and multiband peaky speech ABR paradigms for future studies of speech processing and implementation into clinical protocols of suprathreshold hearing function.

Category: Diagnostic Audiology / Otology

Poster #: 120

Extended High Frequency Bone Conduction Thresholds in Normal Hearing Subjects

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Objectives: The measurement of bone conduction (BC) hearing thresholds at extended high frequencies (EHF; above 8 kHz) is of clinical interest but is technically complicated by limitations in standard BC transducer output, a lack of calibration standards and sparse human subject data reporting threshold force levels. Herein, we use Tascam HP-F200, a magnetostrictive BC transducer, with sufficient high frequency output, to measure BC thresholds in normal hearing subjects at EHF. Using a recently described BC transducer calibration paradigm (Remenschneider et al, JASA 2022), we report EHF BC thresholds in dB re 1¬µN. We hypothesize that we will obtain BC thresholds in a similar range to those previously reported with the Practitronic KH70, a historical BC transducer no longer available.

Design: Prospective human subjects study. Fifteen volunteers with standard frequency (250-8kHz) air (AC) and bone (BC) conduction thresholds ≤20dB were recruited for EHF AC and BC testing with Sennheiser HDA 200 earphones and a calibrated Tascam HP-F200, respectively. A clinical audiologist obtained thresholds at 8, 9, 10, 11.2, 12.5, 14 and 16kHz for AC in both ears and unilateral unmasked BC thresholds in the left or better hearing ear. BC threshold force levels (in dB re 1µN) were derived from computed audiometer output voltages using our calibration scheme.

Results: Six female and nine male volunteers, mean age 32 years (range 18-45), met inclusion criteria and were enrolled. We identified median force thresholds in dB re 1µN at 8kHz: 42dB, 9kHz: 41dB, 10kHz: 44B, 11.2kHz: 43dB, 12.5kHz: 33dB, 14kHz: 41dB and 16kHz: 58dB. The full range of EHF BC thresholds increased with increasing frequency, but generally was within 5 to 10 dB of the median in the ±25% range. AC thresholds showed a similar increased variability with increasing frequency between volunteers. In four volunteers who underwent repeat EHF BC testing on separate days, test re-test variability was within 5-10dB at all frequencies.

Conclusions: EHF BC thresholds are obtained and reported in terms of transducer force output in dB re 1¬µN using the Tascam HP-F200. A range of EHF AC and BC thresholds are observed across individuals with normal standard frequency thresholds. Test-retest variability of EHF BC thresholds appear similar to EHF AC threshold variability. Our reported EHF BC thresholds are consistent with several historical reports in similar subjects using an alternative BC transducer. Measurement of EHF BC thresholds may assist in differentiating etiologies of EHF hearing loss.

Category: Diagnostic Audiology / Otology

Poster #: 121 **Mentored Student Research Poster Award**

Effects of Stimulus Type on Thresholds at Extended High Frequencies

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Objectives: Extended high frequency (EHF; >8 kHz) thresholds are used for diagnosis and management of ototoxicity, noise exposure, and presbycusis. EHF audibility also supports source localization and masked speech recognition. Previous work in our lab showed that whereas 8-kHz thresholds were similar for FM-tone and pure-tone stimuli for children and young adults with audiometrically normal hearing, lower 16-kHz thresholds were obtained for frequency modulated (FM) tones than pure tones. Better 16-kHz FM-tone thresholds could be due to the opportunity for off-frequency listening in the presence of a steeply sloping EHF audibility curve. The objective of this study was to determine whether the slope of hearing sensitivity as a function of frequency might explain differences in EHF thresholds across stimuli. We predicted larger stimulus effects for listeners with steeper audibility curves.

Design: Participants were 19 adults (18 - 52 years) with thresholds ≤ 20 dB HL from 250 - 8000 Hz. Testing included three threshold estimation procedures: a traditional Hughson-Westlake procedure on a clinical audiometer, a psychophysical two-alternative forced choice (2AFC; 3down, 1up; 79.1%), and a modified Bekesy tracking procedure. Thresholds were measured at 11.2 and 16 kHz on the audiometer using 5-dB steps with three stimuli: pulsed pure tones, FM tones, and narrowband noise. The 2AFC procedure estimated thresholds for these three stimuli and two others: steady tones and pediatric noise. Bekesy tracks were completed with pulsed tones that swept up or down in frequency, in the range of ± 1/3 octave around 16 kHz; some participants also completed Bekesy testing at lower frequencies.

Results: For audiometric and psychophysical thresholds, spectrally wider stimuli (FM tones and narrowband noise) produced better thresholds than pure-tone stimuli at 11.2 and 16 kHz, but not at 4 and 8 kHz. The magnitude of this stimulus effect varied substantially across participants. There were also marked individual differences in the slope of the audibility curve around 16 kHz, as measured by Bekesy tracking. As predicted, participants with steeper audibility curves in the 16-kHz frequency region had larger stimulus effects for both psychophysical and audiometric thresholds

Conclusions: Participants with steep 16-kHz audibility curves had lower thresholds for FM tones and narrow band noise than for steady tones or pure tones. These results resemble published data at lower frequencies indicating stimulus effects for listeners with steeply-sloping hearing losses. Stimulus effects may be particularly pronounced at EHFs due to the prevalence of EHF hearing loss and to the steep decrease in audibility, even in the absence of hearing loss. This work has clinical implications for EHF testing and monitoring; pulsed and steady pure tones should be used preferentially to obtain accurate frequency-specific thresholds, particularly at EHFs where a steeply sloping audibility curve is likely.

Category: Diagnostic Audiology / Otology

Poster #: 122

Validation with a Conical Horn of Ear-Canal Acoustic Reflectance

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Objectives: Ear-canal reflectance is fundamental to wideband acoustic immittance and is clinically important for (1) the specification of sound levels in the ear canal and (2) the assessment of middle-ear pathology. Reflectance is essential for methods that compensate for standing waves when measuring sound levels in the ear canal. Acoustic absorbance, which is defined in terms of reflectance magnitude, has been shown to reveal useful information about the status of the middle ear. Despite their utility, no verification method for reflectance measurements and their associated Thevenin calibrations currently exists. An acoustic horn with a conical flare has been suggested as a method for verification of reflectance measurements because its theoretical reflectance is calculable. Maximum absolute deviation (MAD) from ideal reflectance magnitude is suggested as a convenient metric for quantifying the accuracy of reflectance measurement devices.

Design: Reflectance measurements were performed in an acoustic horn with two different devices: (1) Etymotic Research ER10X with custom software and (2) Interacoustics Titan with custom research-platform software. In addition to the standard probe tip, ER10X measurements were also performed with a beveled front tube, which is known to reduce the presence of evanescent waves at the microphone port. The acoustic horn was designed to have a 1 and 2.5 cm cylindrical sections at its mouth and throat, respectively, with an intermediate 12 cm conical flare. To facilitate comparison between measured and ideal reflectance, the measured reflectance is truncated, first in the frequency domain to avoid device limitations, then in the time domain to avoid contributions from the distal end of the horn.

Results: Maximum absolute deviation (MAD) from ideal reflectance magnitude was defined to be over a frequency range 0.1-8 kHz. Conical-horn reflectance measured by the ER10X with a standard front tube initially achieved MAD=0.068. Agreement with ideal reflectance magnitude was improved to MAD=0.048 by post-processing the measured reflectance to remove the evanescent wave. The ER10X reflectance was further improved to MAD=0.035 by replacing the standard front tube with a beveled front tube. Reflectance measured with the Titan had negligible evanescent waves and achieved MAD=0.020.

Conclusions: The conical acoustic horn has the potential to serve as (1) a reference standard for specifying the accuracy of Thevenin calibrations and (2) a convenient reflectance-probe check to ensure the validity of existing Thevenin calibrations.

Category: Diagnostic Audiology / Otology

Poster #: 123

Audiologic Profile Fluctuations and Short-term Prognosis of Otitis Media

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Objectives: The objective of this work is to examine the stability of audiologic profiles of children with otitis media with effusion (OME) in the weeks prior to tympanostomy tube surgery, and to identify how hearing status relates to effusion characteristics and short-term prognosis. Based on the trends that have emerged from current literature, it is expected that ears with the greatest degree of hearing loss will be identified having as full effusions, which are least likely to improve or spontaneously resolve, resulting in the most stable audiologic profiles in the weeks leading up to surgery. Conversely, ears with slight or mild degrees of hearing loss and thus, more favorable audiologic profiles, will have effusions less prone to progression and more likely to resolve spontaneously.

Design: Twenty-three children aged nine months to seven years with OME were recruited from medical clinics. Clinical audiologic results from the day of tube candidacy assessment were obtained retrospectively from medical records. On average, surgery was scheduled 19.26 days after the initial medical visit, and children completed a supplemental research audiologic evaluation 1-3 days prior to their tympanostomy procedure. The audiologic test battery consisted of otoscopy, tympanometry, otoacoustic emissions, and ear-specific pure tone audiometry. Each participant's middle ear status was also evaluated on the morning of surgery, using tympanometry, to ensure no clinically significant change had occurred in the time between the research evaluation and surgical confirmation of effusion characteristics. Effusion volume was categorized as clear, partial, or full by the operating otolaryngologist during surgery, following inspection of the tympanic membrane via binocular surgical otomicroscopy.

Results: Hearing status changed in 5/13 (38%) of ears with OME in the short time between when tympanostomy tube placement was recommended and when surgery occurred. Between visits, ears with clear and partial effusions exhibited a trend of improvement in 4-frequency pure tone averages, while ears with full effusions revealed negligible changes in audiometric thresholds. These findings suggest that ears with the most favorable audiologic profile at the initial visit were most likely to spontaneously resolve, or have hearing improve prior to surgery. Conversely, ears with full effusions at the time of surgery presented with greater degrees of hearing loss at the initial visit and had stable hearing or hearing loss that worsened between visits. Despite limitations associated with retrospective data collection and small sample size, the results of this study convey that hearing status-presumably moderated by effusion volume-may be predictive of short-term prognosis outcomes for children with OME. Given these interesting findings, a new prospective study designed to collect the same outcome measures at both time points is underway. Prospective data will supplement this retrospective analysis, as available.

Conclusions: The trends of this investigation suggest that hearing status at the initial clinical evaluation may be predictive of short-term prognosis of OME episodes in children, thus supporting timely medical management in ears with moderate hearing loss (a profile consistent with full effusions) and a watch-and-wait approach in ears with normal or near-normal hearing (a profile consistent with clear ears or partial effusions).

ELECTROPHYSIOLOGIC RESPONSES

Category: Electrophysiologic Responses

Poster #: 124

Tones-in-Noise Auditory Brainstem Response Correlates in Carboplatin-Treated Chinchillas

Ariella Rush; Celia Escabi, AuD; Jessica Sickels, BS; Andie Zang, BS; Monica Trevino, AuD; Edward Lobarinas, PhD University of Texas at Dallas, Dallas, TX

Objectives: The primary auditory diagnostic measure is the pure-tone audiogram. However, speech-in-noise performance can vary dramatically, even among individuals with similar hearing thresholds. Additionally, data from animal studies have shown the audiogram lacks sensitivity to selective inner hair cell (IHC) pathology, including loss of IHC or their afferent synaptic connections. Such cochlear lesions are thought to underlie auditory deficits like poorer speech-in-noise understanding. It has been shown that carboplatin, an ototoxic drug, causes severe selective IHC loss in the chinchilla. Our lab has previously shown chinchilla auditory brainstem response (ABR) thresholds remain relatively stable following carboplatin treatment. In contrast to threshold outcomes, suprathreshold ABR wave-I amplitudes are greatly reduced in the presence of selective IHC loss, supporting its use as the established biomarker for afferent synaptic pathology. However, because wave-I amplitudes are variable across patients, this measure lacks clinical application. Alternatively, the human wave-V is considered robust and reliable and may be used to differentially assess cochlear pathology.ABRs are typically used to assess auditory neural responses to simple stimuli, such as clicks or tone bursts, that may not tax the auditory system. In comparison, complex auditory brainstem responses (cABR) can be used to assess higher-order auditory abilities by utilizing more complex signals to evoke responses, like tones-in-noise stimuli. The tones-in-noise cABR has been suggested as a potential objective measure of IHC pathology and may better indicate functional hearing-in-noise ability. In this study, we assessed suprathreshold cABR wave-1/4 latencies using tones-in-noise stimuli and tone-burst ABR wave-1 amplitudes following carboplatin-induced selective IHC loss in the chinchilla. We hypothesized that IHC loss would reduce ABR wave-1 amplitudes and increase cABR wave-1/4 latencies.

Design: Free-feeding, adult male and female chinchillas were used for this study. Sedated distortion product otoacoustic emissions (DPOAE) and ABR thresholds were obtained as a measure of hearing sensitivity. Suprathreshold ABR wave-1 amplitudes were measured bilaterally at 90-, 80-, and 70-dB SPL with 1, 2, 4, 8, and 12-kHz tone bursts. Suprathreshold cABR wave-1/4 latencies were measured bilaterally at 90-, 80-, and 70-dB SPL with 1, 2, 4, 8, and 12-kHz tone-bursts embedded in broadband noise of varying intensities with signal-to-noise ratios (SNR) ranging from +10 to -5 dB SPL.Following baseline measures, animals were treated with 75 mg/kg of carboplatin (i.p., by body weight), a dose reliably shown to produce 50-80% IHC loss with minimal outer hair cell (OHC) loss. Post-carboplatin assessments were performed four weeks following treatment.

Results: Selective IHC loss had no significant effect on DPOAE and ABR thresholds, suggesting survival and function of OHC. Suprathreshold transient ABR wave-1 amplitudes were substantially reduced, consistent with IHC pathology. cABR wave-1/4 latency changes were minimal and may reveal central gain and compensation occurring prior to wave-5.

Conclusions: The results of this study suggest cABR wave-1/4 latency intervals may be a sensitive measure for IHC loss.This research was supported by NIDCD of the National Institute of Health under award number R01DC014088.

Category: Electrophysiologic Responses

Poster #: 125

Masked Auditory Brainstem Response Correlates in Carboplatin-treated Chinchillas

Celia D. Escabi, AuD; Ariella Rush, BA; Jessica Sickels, BS; Andie Zang, AuD; Monica Trevino, AuD; Edward Lobarinas, PhD, University of Texas at Dallas, TX

Objectives: The auditory brainstem response (ABR) is a widely used clinical measure for objectively assessing pathologies affecting the brainstem pathway and to estimate hearing sensitivity. Short, simple stimuli, such as clicks and tone bursts, are typically used for ABR evaluation. Yet, several pre-clinical physiological studies measuring ABR outcomes using simple stimuli have shown little-to-no change in thresholds following selective loss of inner hair cells (IHC) or synaptopathy. In contrast, such cochlear lesions have been shown to reduce the amplitude of the ABR wave-1, even in the absence of elevated thresholds. These findings suggest that wave-I of the ABR could be used to detect IHC loss and damaged afferent connections. However, wave-I amplitudes are known to vary greatly in human patients, limiting their use as a physiological biomarker of IHC lesions in patients with minimal hearing loss or auditory complaints without threshold elevation. Conversely, ABR wave-V has been found to be a robust and repeatable measure in humans that allows for measures within background noise. Wave-V arises from the lateral lemniscus and inferior colliculus, and due to central gain compensation, wave-V amplitudes are often not reduced by selective damage or loss of IHCs. However, increasing levels of background noise result in a shift in wave-V latency and these latency shifts are believed to correlate with perceptual measures of fine-temporal coding. The ABR can also be recorded in response to complex stimuli (cABR), including noise, speech, and music. The cABR provides an objective measure of subcortical speech processing and allows for more precise assessments of temporal and frequency representations relative to traditional ABR threshold measures. For the current investigation, we evaluated the relationship among suprathreshold ABR wave-1 amplitudes using tone-bursts and cABR wave-4 latencies using tones-in-noise before and after carboplatin-induced selective IHC loss in the chinchilla. We hypothesized that IHC loss would reduce ABR wave-1 amplitudes and increase cABR wave-4 latencies.

Design: Young-adult chinchillas were used to evaluate effects of selective IHC loss on suprathreshold cABR measures before and after carboplatin-treatment. Distortion product otoacoustic emissions (DPOAE) and ABR thresholds were obtained to assess the status of cochlear nonlinearity and as a measure of overall hearing sensitivity. Following baseline measures, animals were treated with a single dose of 75 mg/kg of the anticancer drug carboplatin, a dose known to reliably produce 50 - 80% IHC loss with little-to-no outer hair cell (OHC) loss. Post-carboplatin assessments were performed four weeks following treatment to allow for recovery time.

Results: As expected, carboplatin-treatment had no significant effect on ABR thresholds and DPAEs, suggesting survival and function of OHCs. ABR wave-1 amplitudes were substantially reduced, even in the absence of elevated thresholds. Wave-4 of the cABR showed differences following carboplatin, specifically, latencies shifted as a function of cochlear pathology.

Conclusions: Data suggest that IHC lesions degrade the coding of temporal cues in suprathreshold sound and, thus, ABR measures in background noise could be used as a possible sensitive diagnostic assay for loss of IHC.

Category: Electrophysiologic Responses

Poster #: 126 **Mentored Student Research Poster Award**

Changes in Auditory Brainstem Response in Model of Chronic Migraine

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Objectives: The goal of this study was to use an established preclinical model of chronic migraine to investigate changes in hearing sensitivity and auditory brainstem integrity by measuring neural activity of the auditory brainstem before and post migraine. Little is known about the link between migraine and phonophobia and hearing loss. We wanted to test the hypothesis that migraine pathology would cause hearing loss and hyperexcitability of the auditory brainstem.

Design: To induce a chronic migraine state, male and female Sprague Dawley rats were subjected to three human risk factors including neck muscle tension and REM sleep deprivation that promote latent sensitization, and exposure to a pungent odor, which acts as a trigger to stimulate trigeminal activation and pain signaling. Rats were re-exposed to the pungent odor after 21 days. Mechanical nocifensive thresholds in the orofacial region were determined using von Frey filaments at baseline and one day, 14 days, and 21 days after exposure to the pungent odor, and one day after the second exposure to the odor. Tone-burst auditory brainstem responses (ABRs) were measured using the Duet Intelligent Hearing System to determine effects of migraine pathology on brainstem auditory pathway in male and female rats at the same timepoints as mechanical testing. ABRs were recorded in each ear to 4 kHz, 12 kHz, 22 kHz, and 32 kHz stimuli. To determine hyperexcitability of the brainstem, suprathreshold ABRs were recorded at 80 dB SPL to assess waveform morphology, amplitude, and latency. To determine hearing threshold, ABR was recorded at 50 dB and 20 dB and then at 30 dB or 10 dB depending on the response at 20 dB. The threshold value was defined as the lowest intensity to elicit a reliable wave II, the largest wave in rats.

Results: At baseline, rats had low levels of mechanical nociception. Exposure of sensitized animals to the pungent odor caused a significant increase in the average number of nocifensive responses to mechanical stimuli, which persisted for the duration of the study (21 days). At baseline, the suprathreshold ABR morphology exhibited the presence of waves I, II, and IV, with wave II being the most prominent wave. As frequencies increased from 4 kHz to 32 kHz, latencies decreased and amplitudes increased with larger amplitude in the right ear than the left ear, suggesting right ear advantage. Normal ABR thresholds were observed at all frequencies. After induction of migraine pathology, changes were observed on day one including earlier latency at 22 kHz and 32 kHz, and enhanced amplitude at 4 kHz but decreased amplitude at higher frequencies. A 10-20 dB increase in thresholds, with greater increases at 22 kHz and 32 kHz.

Conclusions: Our findings in a chronic migraine model provide evidence of mild hearing loss and earlier latency and enhanced tone-burst ABR amplitude suggesting a faster neural conduction and hyperexcitability at the brainstem level. Hence, migraine should be considered a possible cause of idiopathic hearing loss and phonophobia, and treatment of these conditions should include migraine therapy

Category: Electrophysiologic Responses

Poster #: 127 **Mentored Student Research Poster Award**

Auditory Brainstem Changes in Preclinical Chronic Temporomandibular Joint Disorder Model

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Objectives: The goal of this study was to use an established preclinical model of chronic temporomandibular joint disorder (TMD) to investigate changes in hearing sensitivity by measuring neural activity of the auditory brainstem before and post TMD.

Design: To promote sensitization of trigeminal neurons, adult female Sprague Dawley rats were injected with complete Freund's adjuvant in the neck (trapezius) muscles. After 8 days, animals were subjected to near maximal jaw opening for 20 minutes. Withdrawal responses to mechanical stimulation over the masseter to von Frey filaments were determined at baseline and one day and 14 days after jaw opening. Some animals received 0.5% solid MegaNatural-BP Grape Seed Polyphenol Extract (GSE) dissolved in their drinking water one week prior to neck muscle injections since GSE had been shown to inhibit pain signaling in the TMD model. Tone-burst auditory brainstem responses (ABRs) were measured using the Duet Intelligent Hearing System to determine the effects of TMD pathology on the brainstem auditory pathway at baseline (na√Øve) condition and at day one and day 14 following jaw opening. Suprathreshold and threshold ABRs were recorded in each ear to 4 kHz, 12 kHz, 22 kHz, and 32 kHz stimuli. Suprathreshold ABRs were recorded at 80 dB SPL to assess waveform morphology, latency, and amplitude. To determine the threshold, ABRs were recorded at 50 dB and 20 dB and then at 30 dB or 10 dB depending on the response at 20 dB. The threshold value was defined as the lowest intensity to elicit a reliable wave II, the largest wave in rats.

Results: Muscle inflammation and near maximal jaw opening increased the average number of nocifensive responses to mechanical stimuli over the masseter for 14 days. This increase was significantly attenuated by dietary supplementation with GSE. At baseline, the 80 dB ABR morphology exhibited the presence of waves I, II, and IV, with wave II being the most prominent wave. As frequencies increased from 4 kHz to 32 kHz, latencies decreased and amplitudes increased with larger amplitude in the right ear than the left ear. ABR thresholds were within normal, with decreased ABR thresholds at higher frequencies (22 kHz and 32 kHz) than lower frequencies (4 kHz and 12 kHz). After induction of TMD pathology, ABR changes were observed including earlier latency, enhanced amplitudes at all frequencies, and a 5-10 dB increase in the hearing thresholds, with the greatest increases at 12 kHz and 22 kHz. Animals receiving daily supplementation of GSE had similar hearing changes to control animals.

Conclusions: Our findings provide evidence of mild changes in hearing sensitivity and faster neural conduction as shown by earlier tone-burst ABR latency and enhanced amplitude responses. These results help to provide a better understanding of the pathophysiology of auditory manifestations in patients with TMD and will allowing testing of other novel therapeutic strategies to inhibit both the pain and auditory changes associated with TMD.

Category: Electrophysiologic Responses

Poster #: 128 **Mentored Student Research Poster Award**

Single-Trial Analyses of Auditory Brainstem Response Waveforms

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Objectives: Auditory Brainstem Response (ABR) waveforms have been widely used as an objective measure of hearing ability because of the ease of recording and the reliability of the response. Wave V of the ABR has been extensively used to estimate hearing threshold, while Wave I has been suggested as a marker of cochlear synaptopathy. While the ABR is useful as both a clinical and research tool, its interpretation is generally marked by human judgment of the latency and amplitude of various waveforms. Moreover, these judgments are made on averaged waveforms obtained from thousands of trials. Recent developments in signal processing allow for analysis of the responses from individual trials. Such techniques have been utilized in cortical evoked potentials, but have not been applied to the ABR. Such applications are potentially important because they may enable objective identification of threshold with fewer trials, or a quantifiable measure of neural synchrony in the response. As a first step towards addressing these issues, here we compared 'single-trial' and 'averaged-waveform' analyses of the ABR across different recording montages and electrode placements.

Design: All 10 participants had audiometric thresholds no worse than 20 dB HL between 250 and 8000 Hz. Audiometric thresholds were also obtained from 10000 to 16000 Hz. After determining normal hearing sensitivity, we recorded the ABR with two recording montages and three placements of the active electrode. One was a horizonal montage designed to emphasize Wave I amplitude, and the other was the traditional vertical montage (Fz active electrode). For the horizontal montages, recordings were made from the earlobe, the ear canal using a tiptrode, and from the eardrum using a wick electrode. All wick electrodes were placed by a neurotologist or otolaryngology resident using a microscope. A click stimulus was used for all recording montages and electrode placements, and latency-intensity functions were obtained beginning at 70 dB nHL and concluding at 0 dB nHL. Data were analyzed in three stages. First, we compared the latency and amplitude of Waves I and V for single-trial analyses and averaged waveform analyses. Second, we examined the SP/AP ratio for the horizontal recording montages for single-trial and averaged-waveform analyses across the different electrode types. Finally, we compared the reliability of different responses obtained with single-trial analyses.

Results: While preliminary, our results suggest that single-trial analyses of ABR waveforms are feasible and yield similar results to waveforms averaged over thousands of trials. As expected, ABR waveforms observed with single-trial analyses were noisier than those seen with averaged-waveform analyses. However, Wave V latency-intensity functions and Wave I SP/AP ratios appeared to be similar for single-trial analyses and averaged waveform analyses.

Conclusions: Taken together, these results suggest that ABR waveforms can be reliably recorded and analyzed using single-trial methods. Such work provides an important step to increase the feasibility of new analysis techniques that could yield more accurate measures of threshold or supra-threshold abilities. The feasibility of this approach also raises the possibility for new measures of performance to be developed, such as more quantifiable measures of neural synchrony.

Category: Electrophysiologic Responses

Poster #: 129

Electrophysiological and Psychophysical Measures of Intensity Coding in Carboplatin Treated Chinchillas

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Objectives: Auditory temporal processing is essential for perceiving and coding complex acoustic stimuli, such as speech. These signals are considered complex in part due to rapid fluctuations along the intensity and temporal domains. Temporal processing and intensity coding abilities are thought to be negatively impacted by age-related or noise-induced hearing loss. It has been suggested that deficits in intensity coding or intensity detection ability may contribute to speech processing problems in damaged ears. Previous studies evaluating selective inner hair cell (IHC) loss in chinchillas have not shown deficits in threshold or temporal integration tasks, but has shown deficits in gap detection, a task that requires strong intensity detection ability. These results suggest that selective IHC loss may impact chinchilla intensity coding ability. The current study aimed to evaluate chinchilla sensitivity to intensity differences with an intensity increment detection (IID) psychophysical task, as well as amplitude modulated (AM) electrophysiological responses measured via envelope following response (EFR). Assessments were made before and after carboplatin treatment, a drug known to produce selective IHC loss in this species.

Design: Free feeding, young adult chinchillas were used for this study. Distortion product otoacoustic emissions (DPOAEs) and pure tone thresholds in quiet were used to assess cochlear nonlinearity and overall hearing sensitivity. Chinchillas were conditioned to respond to intermittent changes in intensity to an otherwise continuous reference narrowband noise. IID performance was assessed at 1, 2, 4, 8, and 12 kHz center frequencies and at three continuous reference noise levels: low (20 dB SPL), moderate (50 dB SPL) and high (70 dB SPL). The low-level noise was initially increased by 20 dB SPL, the moderate-level noise initially increased by 15 dB SPL and the high-level noise initially increased by 10 dB SPL. An automated method of limits procedure was used to determine IID threshold as intensity decreased by 0.5 dB SPL for correct responses and increased by 1 dB SPL for incorrect responses until the lowest intesity at which the animal achieved 66% correct was obtained. EFR was assessed using AM steady-state stimuli which were modulated using AM depths of 100%, 80% and 20%. Following baseline testing, chinchillas received a single dose of 75 mg/kg of carboplatin (i.p.). DPOAEs, pure tone thresholds, IID thresholds, and EFR were re-assessed after a four-week recovery period.

Results: Following carboplatin treatment there were no significant elevations of pure tone thresholds and no significant changes to DPOAE; results suggesting that hearing sensitivity had not changed. Chinchilla IID thresholds were slightly elevated at each intensity level following carboplatin treatment. Significant differences were observed as a function of AM depths.

Conclusions: These results suggest that carboplatin may impact sensitivity to intensity changes and that this model could be used to study the effects of cochlear pathologies involving IHC.

Category: Electrophysiologic Responses

Poster #: 130

Investigating Auditory Maturation in Down Syndrome

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Objectives: Hearing loss is known to be associated with long-term deleterious consequences for speech understanding, delayed auditory processing, cognitive abilities, and language acquisition. Individuals with Down syndrome (DS) show a significantly higher prevalence of hearing loss compared to typically developing

(TD) individuals. In addition, in DS, there is evidence for altered auditory processing, including altered cortical-evoked responses to simple auditory stimuli as compared to TD individuals. Notably, the relationships between the degree and type of hearing loss, auditory processing delays, and speech intelligibility skills have not been systematically evaluated in individuals with DS. The present study focused on young adults with DS. We used cortical auditory evoked potentials (CAEPs) to assess auditory processing and behavioral measures to assess speech intelligibility. To characterize the maturational status of these measures in our DS participants and facilitate comparisons with the normative maturational trajectory, we carried out identical assessments in TD children and adults. We also examined the impact of the type and severity of hearing loss on these measures among individuals with DS. We hypothesize that DS participants will show maturational delays in auditory processing and speech intelligibility skills. Importantly, this study focuses on the extent to which hearing loss and immature auditory processing will each predict speech intelligibility skills. We expect that the interaction of hearing loss and immature auditory processing will amplify the adverse impact on speech intelligibility.

Design: This study includes young adults with DS (age 18-24 years), TD children (ages 5-7, 9-11, and 14-16 years), and age-matched TD adults. The type and degree of hearing loss are assessed using audiometry. Speech intelligibility is measured in quiet and in the presence of background maskers. Target stimuli comprise a closed set of 25 male-spoken spondees, and masker stimuli are two-talker male-spoken speech interferers from the IEEE corpus. CAEPs are elicited by /m/ and /s/ speech stimuli in quiet to assess low and high-frequency-specific auditory processing, respectively, while participants watch a silent video.

Results: Data collection is ongoing, and preliminary results will be presented. Based on pilot data, we predict that speech reception thresholds among individuals with DS will be higher (worse) than age-matched TD adults and more akin to TD children. Similarly, we expect that the waveform morphology of CAEPs of DS individuals will be a biphasic P1-N2 complex as found in TD children instead of the TD adult-like triphasic P1-N1-P2 complex, indicating immature auditory processing in young adults with DS. Importantly, data will be analyzed to reveal how each individual with DS compares to each of the TD age groups. We expect that greater immaturity in auditory processing will be significantly associated with greater impairment in speech intelligibility. The type and configuration of hearing loss will be analyzed to reveal if there is correspondence to frequency-specific auditory processing.

Conclusions: Our work aims to provide a comprehensive characterization of the auditory maturational profile of young individuals with DS and its association with hearing loss. [Work supported by NIH-NIDCD R01 DC019511 to R.Y. Litovsky].

Category: Electrophysiologic Responses

Poster #: 131

Toward Individual and Combined Elicitation of Olivocochlear and Acoustic Reflexes

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Objectives: The medial olivocochlear reflex (MOCR) and middle-ear muscle reflex (MEMR) alter peripheral auditory function which may benefit hearing in background noise. Typical experimental measurements attempt to isolate the two reflexes. However, in noisy situations, both reflexes may work in tandem to improve speech-in-noise perception. Therefore, it could be beneficial to develop methods to elicit both reflexes. The purpose of

this study was to determine if manipulations of the reflex elicitor in terms of level and temporal properties could elicit the MOCR alone or a combined elicitation of the MOCR and MEMR.

Design: Participants were healthy adults ages 18-30 with normal hearing who were recruited from a university campus. A total of 50 participants will be targeted. MOCRs and MEMRs were measured using four contralateral elicitor conditions: two levels (50 and 65 dB SPL) and two temporal properties (steady-state broadband noise and broadband noise pulsed at a rate of 10 Hz). Control measurements without a contralateral elicitor were also obtained. MOCR effects were quantified as the decibel change in transient-evoked otoacoustic emission amplitude with versus without the contralateral elicitors. MOCR effects were analyzed in half-octave bands with center frequencies from 0.7-5.7 kHz. MEMR effects were quantified as the change in wideband absorbance with versus without the contralateral elicitors. MEMR effects were analyzed in half-octave bands with center frequencies from 0.3-5.7 kHz.

Results: Data have been collected from 11 participants. Preliminary results revealed several trends. For the MOCR, the noises presented at 65 dB SPL elicited larger median effects across most frequencies compared to the noises presented at 50 dB SPL. Additionally, the steady-state noises tended to elicit somewhat larger median effects compared to the pulsed noises. For the MEMR, the pulsed noises elicited larger median effects across most frequencies compared to the steady-state noises. Additionally, the noises at 65 dB SPL elicited larger median effects compared to the noises at 50 dB SPL. In comparing MOCR and MEMR elicitation, steady-state noise at 50 dB SPL elicited median MOCR effects that were appreciably larger than the control condition. In contrast, steady-state noise at 50 dB SPL elicited median MEMR effects that were similar to the control condition.

Conclusions: The preliminary results suggest that the MOCR and MEMR are sensitive to elicitor level and temporal properties. Steady-state noise at 50 dB SPL may be more likely to elicit the MOCR than the MEMR. Elicitors presented at 65 dB SPL may be more likely to elicit the MOCR and MEMR, with pulsed noises eliciting more MEMR activity than steady-state noises. The results will inform the development of measurement paradigms that seek to elicit the MOCR and the MEMR.

Category: Electrophysiologic Responses

Poster #: 132

Hemodynamic Responses in Auditory Cortex During Spatial Release from Masking

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Objectives: In spatial release from masking (SRM), it is generally thought that interaural time differences (ITDs) provide the most robust cue, whereas interaural level differences (ILDs) are limited in their usefulness to an improved signal-to-noise ratio for a target in the near ear relative to a spatially separated masker. Cochlear implants do not provide a robust representation of ITD cues, and thus cochlear implant users do not show spatial release from masking. Recent work has established that increased hemodynamic response in superior temporal gyrus (STG) during vocoded listening, as measured by functional Near-Infrared Spectroscopy (fNIRS), may be a proxy for spatial masking release. Here, we hypothesize that while ILD cues at naturally

occurring magnitudes do not elicit a spatial release from masking, magnified ILDs may, as indicated by this neural correlate.

Design: Twenty-one native English speakers with no reported hearing deficits participated (14 females, 7 males, between 16 and 78 years of age). Subjects were seated in a sound-treated booth and heard target (spatialized left) and masker (spatialized right) sequences of object and color words. They pressed a button when they detected a color word. Target and masker were vocoded into 16 log-spaced frequency bands, nine of which were randomly selected to represent the target and the remaining seven, the masker. Seven spatial conditions were tested. Two replicated a previous study, using whole-waveform ITDs with either speech or noise maskers (ITDSpeech and ITDNoise, respectively). The remaining five used speech maskers and whole-waveform ILDs of different magnitudes (ILD0, ILD10, ILD20, ILD30, ILDinf). fNIRS recorded hemodynamic activation over STG and lateral frontal cortex.

Results: The ITD conditions replicate a previous finding that a speech masker elicits a greater hemodynamic activation in STG than does a noise masker. By manipulating the magnitude of whole-waveform ILDs, we found that activation was low in the cases where spatial cues were unavailable (ILD0) and for dichotic presentations (ILDinf). Increasing the magnitude of ILD in the ILD10, ILD20, and ILD30 conditions, however, led to increased activation in STG. Behavioral sensitivity did not vary across conditions.

Conclusions: The replication of the results from previous work suggests that hemodynamic activation in STG may be a proxy for release from masking from a competing talker, confusable with the target. Results from magnified ILD conditions allow us to assess whether these cues facilitate spatial release from masking. The pattern of results observed suggests that broadband ILDs elicit a hemodynamic response as large as that of ITD conditions. We show that enhanced ILDs increase activation of auditory-related areas associated with spatial release from masking.

Category: Electrophysiologic Responses

Poster #: 133

Withdrawn

Category: Electrophysiologic Responses

Poster #: 134

Middle Ear Muscle Reflex Measures in Carboplatin-Treated Chinchillas

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Objectives: In mammals, moderately loud acoustic stimuli produce an involuntary contraction of the stapedius muscle. This reflexive response, known as the middle ear muscle reflex (MEMR), briefly reduces middle ear admittance and attenuates sound input to the inner ear across varying frequencies. The MEMR is routinely assessed as part of standard audiological test protocols to provide information regarding the status of the auditory system, including the middle ear, inner ear, and central auditory pathway. Recently it has been

suggested that the MEMR may be an effective measure of noise- or age-induced degeneration of inner hair cell (IHC) synapses, or cochlear synaptopathy. IHC damage is believed to underlie associated deficits such as tinnitus, hyperacusis, and difficulty understanding speech in noise that are independent of auditory thresholds. Previously, we found that MEMR thresholds measured using the 226 Hz clinical probe tone were unaffected by severe and selective loss of IHC in chinchillas treated with carboplatin, an anticancer drug that destroys IHC in this species. In contrast, studies have shown that MEMR sensitivity to synaptopathy appears to increase when measured with a wideband probe stimulus. In order to explore potential differences among MEMR measurement parameters as an assay of IHC pathology, the MEMR was measured using both a wideband probe and a single-frequency probe in chinchillas with carboplatin-induced IHC loss.

Design: Adult chinchillas with free access to food and water were used for this study. MEMR measurements were conducted in awake, gently restrained animals, as anesthesia abolishes the reflex response. Single-frequency probe tone (226 Hz) MEMR were measured using a Tympstar clinical analyzer. 226 Hz MEMR thresholds and growth functions were obtained using multiple elicitor stimuli, including pure tone bursts and broadband noise (BBN). A dual probe system (ER10X) was used to measure wideband MEMR thresholds and growth functions using click stimuli in the measurement ear and BBN elicitors in the contralateral ear. Auditory brainstem response thresholds (ABRT) were evaluated from 1-12 kHz as a measure of hearing sensitivity. Distortion product otoacoustic emissions (DPOAE) were collected (1-10 kHz) to assess the presence and overall function of OHC. Following baseline data collection, chinchillas were treated with 75 mg/kg carboplatin (i.p.). This dose has repeatedly produced 50-80% IHC loss and 0-5% OHC loss in chinchillas. ABR thresholds, DPOAE, and MEMR measures were re-assessed following a four-week recovery period.

Results: Consistent with previous studies, 75 mg/kg carboplatin dose induced 50-80% IHC loss, but did not affect OHC, DPOAE or ABRT. Preliminary data suggest that MEMR threshold, as measured by either 226 Hz probe tone or wideband probe, were not significantly affected by selective IHC loss; however, at high elicitor presentation levels, IHC loss may weaken the magnitude of the MEMR response.

Conclusions: Suprathreshold MEMR measures appear to be more sensitive than threshold MEMR measures in detecting selective IHC loss in carboplatin-treated chinchillas.

HEARING LOSS / REHABILITATION

Category: Hearing Loss / Rehabilitation

Poster #: 135

Social Anxiety and Negative Affect in Subjective Hearing Health

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Objectives: Subjective ratings of communication function, such as hearing handicap, reflect both hearing sensitivity and the situational, social, and emotional consequences of communication difficulties. Spoken communication, however, is an inherently social situation that also requires peer to peer exchanges. Listeners interact with people and their environment differently, have various ways of handling stressful situations, and have vastly different communication needs. Therefore, understanding the relationship between auditory and mental health factors, such as social anxiety and negative affect (depression, anxiety), is critically important for holistic diagnosis and treatment of communication difficulty. The goal of this study was to evaluate the degree to which social anxiety and negative affect contributed to hearing handicap in adult listeners with and without self-reported hearing loss.

Design: Cross-sectional online survey administered via REDCap. Participants were 628 adults (408 women), ages 19 to 87 (mean = 43 years) living in the United States. Our primary measures were composite scores of social anxiety (Social Interaction Anxiety Scale, Social Phobia Scale, Revised Green et al. Paranoid Thoughts Scale), negative affect (PROMIS measures for Anxiety, Depression, Anger) and hearing handicap (Hearing Handicap for the Elderly-Screening, 15 Item Speech, Spatial, and Qualities of Hearing Scale).

Results: Individuals reporting more hearing handicap also had higher anxiety and higher negative affect scores. Multiple linear regression analysis revealed that age (partial $R2 = 0.09$), negative affect (partial $R2 = 0.04$), and social anxiety (partial $R2 = 0.21$), were each unique predictors of hearing handicap. Further analysis based on hearing status is discussed.

Conclusions: Social anxiety and negative affect both significantly contribute to how much someone feels a hearing loss impacts their daily function. Further examination of social anxiety and negative affect in adults with hearing loss may help researchers and clinicians understand the complex interactions between psychological and sensory function during everyday communication.

Category: Hearing Loss / Rehabilitation

Poster #: 136

Hearing and Vision Impairment and Wellbeing in Older Adults

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Objectives: Sensory (hearing and vision) impairment in older adults is associated with cognitive decline, elevated symptoms of depression, and low levels of life satisfaction. However, these relationships are usually investigated separately and in pairs. This study examined these relationships comprehensively, for the first time.

Design: The analysis included 5,659 community-dwelling older adults from the China Health and Retirement Longitudinal Study (aged 50 to 108 years, 52.1% male) who completed the Jorm Informant Questionnaire Cognitive Decline in the Elderly and the Center for Epidemiological Studies-Depression-short form. A questionnaire was used to collect information on hearing, visual status, and life satisfaction. Structural equation modelling was used to examine the direct and indirect relationships between these variables.

Results: Self-reported hearing and vision problems are directly associated with cognitive decline and depression. In addition, hearing and vision problems are indirectly related to cognitive decline through

depression. Although hearing and vision problems had no direct effect on life satisfaction, they were indirectly associated with life satisfaction through cognitive decline and depression.

Conclusions: This study provides the first epidemiological evidence of the comprehensive relationships between hearing and vision problems, cognitive decline, depression, and life satisfaction. When older adults report hearing and/or vision problems, clinicians and caregivers should be aware of the concurrence of declined cognition, elevated depressive symptoms, and compensated life satisfaction. Future studies should examine the causal relationships and potential mechanisms of these relationships.

Category: Hearing Loss / Rehabilitation

Poster #: 137

Does Socioeconomic Status Predict State EHDI Follow-up Rates?

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Objectives: Early hearing detection and intervention (EHDI) benchmarks are screening by 1 month of age (MOA), diagnosis by 3 MOA, and early intervention by 6 MOA. States vary in their compliance for these goals, particularly in the enrollment in early intervention by 6 months of age (EI6MOA) and failure to do so may result in speech and language delay. Our aim was to determine if five explanatory variables (state percent of the population with a bachelor's degree or higher, who are employed, without health insurance, and making under $25,000/year in addition to median household income) predict EI6MOA. We hypothesize that some of these explanatory variables will predict EI6MOA.

Design: Data from the Centers for Disease Control 2019 EHDI statistics and the US Census Bureau American Community Survey were aggregated by state in this ecological study design. Five separate regression models were created to assess univariate associations with EI6MOA. A multivariate model was created with all five explanatory variables, backwards selection was used to identify the most parsimonious model. An alpha to remain in the model of 0.15 was used, and any remaining variables were tested for significant interactions at the 0.05 level. The final model residuals were examined for violations of linear model assumptions. All statistical tests were conducted assuming a 5% chance of a type one error, using SAS 9.4.

Results: Four states (Alabama, Colorado, Florida, and Mississippi) were missing EHDI outcomes and were discarded from the analysis. In the univariate analysis, there was evidence state EI6MOA increased 1.0 (95% CI: 0.2, 1.8) unit for each percentage increase of state percentage with bachelor's degree or higher. (R^2=0.12, p=0.0182) However, there was no evidence in the univariate analysis that percent employed (p=0.1926), uninsured (p=0.2043), making less than $25,000 per year (p=0.1740), or median household income (p=0.1246) were associated with a significant change in EI6MOA. The backwards selection process in the multivariable model removed in order the state percent of making less than $25,000 per year (p=0.9681), uninsured (p=0.7479), employed (p=0.3744), and state median household income (p=0.4021) leaving only the univariate association with state percentage of population with a bachelor's degree or higher. The lone variable was assessed for a curvilinear structure, but that also was not significant. (p=0.4113). The final multivariable model

selected was the same model as the univariate model with only state percent of the population earning a bachelor's degree or higher.

Conclusions: State percentage of those earning a bachelor's degree or higher was the only variable that predicted EI6MOA. State EHDI programs should increase educational outreach efforts to regions with low educational attainment to improve EI6MOA rates.

Category: Hearing Loss / Rehabilitation

Poster #: 138

Is Sensorineural Hearing Loss an Adverse Reaction to COVID-19 Vaccination?

Logan Churchman, BS; Allison Curry, BS; Ty Fullingim; Hailey Hewett, BS; Emily Carter, BS; Carole Johnson, AuD, PhD, HERO Lab; University of Oklahoma Health Sciences Center, Oklahoma City, OK

Objectives: The COVID-19 Pandemic was caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2). Four vaccines have been developed to provide acquired immunity against COVID-19: Comirnaty (Pfizer-BioNTech), Moderna (Spikevax), Johnson and Johnson (Janssen Pharmaceutica and BIDMC), and Novavax. Some people chose not to be vaccinated against COVID-19 due to fears of adverse reactions including sudden sensorineural hearing loss (SSNHL). Our aim was to weigh the evidence for SSNHL as a possible adverse reaction from COVID-19 vaccination. We hypothesize that the results may be inconclusive at this point.

Design: A systematic review was conducted to weigh the evidence for SSNHL as an adverse reaction to COVID-19 vaccination. A reference librarian created a strategy to search Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review and Other Non-Indexed Citations and Daily in addition to other databases on September 2, 2022. A team (LC, AC, TF, HH, & CJ) independently went through the search and retrieval process, quality assessment of, and data extraction from the articles. Disagreements were settled using a consensus approach.

Results: The search and retrieval process yielded 111 articles after removal of duplicates. Blinded review of titles and abstracts resulted in 11 articles for full article review (six case studies, two commentaries, one cross-sectional/case series study, one retrospective chart review, and one retrospective population-based cohort study). Two studies had characteristics amenable to providing data to answer the experimental question. One cross-sectional/case series study used the Centers for Disease Control and Prevention Vaccine Adverse Events Reporting System (VAERS). Between 12-14-20 and 7-16-21, 185.4 million vaccinations occurred with 555 reports of SSNHL which represented an annual incidence rate of 0.6 to 28 cases per 100,000 people/year with similar results across vaccine types. Incidence rates for SSNHL did not exceed those expected in the general population (11 to 77 per 100,000 people/year). The second study (retrospective cohort) conducted between 12-20-20 to 5-31-21 in Israel involved the Pfizer BioNTech (BNT162b2) COVID-19 vaccine. They found standardized infection ratios (SIRs) that were 1.35 (95% CI, 1.09-1.65) after the first vaccine and 1.23 (95% CI, 0.98-1.53) after the second dose. The SIRs were greater for women 16 to 44 years (1.92; 95% CI, 0.98-3.43) and 65+ years (1.68; 95% CI, 1.15-2.37) after the first vaccine and for men 16 to 44 years (2.45; 95% CI, 1.36-4.07) after the second dose indicating that COVD-19 vaccines may pose a slight risk for SSNHL.

Conclusions: The results of the systematic review were inconclusive regarding SSNHL being an adverse reaction to COVID-19 vaccination. Any possible slight risk for SSNHL from vaccinations is outweighed by the benefits of acquired immunity from COVID-19. Additional research on this topic is warranted particularly about increased rates of SSNHL for women and men of certain ages after administration of the first vaccine and second dose of COVID-19 vaccines.

Category: Hearing Loss / Rehabilitation

Poster #: 139

Does COVID-19 in Expectant Mothers Result in Neonatal Hearing Loss?

David Petto, BS; Jocelyn Johnson, BS; Carole Johnson, AuD, PhD, HERO Lab; University of Oklahoma Health Sciences Center, Oklahoma City, OK

Objectives: The COVID-19 Pandemic was caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2). It is possible that expectant mothers with COVID-19 may vertically transmit the virus to their unborn children and congenital infections can cause hearing loss. The purpose of this study was to examine the evidence for the possibility that expectant mothers diagnosed with COVID-19 vertically transmit the virus to their unborn children causing hearing loss. We hypothesize that this may be possible.

Design: A systematic review was conducted to weigh the evidence for whether COVID-19 in expectant mothers results in neonatal sensorineural hearing loss. A reference librarian created a strategy to search Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review and Other Non-Indexed Citations and Daily in addition to other databases on September 27, 2022. A team (DP, JJ, & CJ) independently went through the search and retrieval process, quality assessment of, and data extraction from the articles. Disagreements were settled using a consensus approach.

Results: The search and retrieval process yielded 278 articles after removal of duplicates. Blinded review of titles and abstracts resulted in 12 articles for full article inclusion (one systematic review, one cross-sectional study, two prospective observational studies, one respective case-control study, seven retrospective cohort studies). No study found that expectant mothers vertically transmitted the COVID-19 infection to their neonates causing hearing loss.

Conclusions: The results of the systematic review confirmed that expectant mothers with COVID-19 do not vertically transmit COVID-19 infection to their babies causing hearing loss. However, it may be prudent for a child whose mother had COVID-19 during her pregnancy to have ongoing developmentally appropriate hearing screening and a diagnostic audiology assessment by 24 to 30 months of age.

Category: Hearing Loss / Rehabilitation

Poster #: 140

Evaluating Gamified Auditory Training in Veterans with Hearing Complaints

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Aaron Seitz, PhD, Brain Game Center, University of California Riverside, Riverside, CA

Objectives: Evaluating feasibility of a gamified auditory training task for Veterans with reported hearing impairment (known or hidden). Therapy will be accomplished using the Listen: An Auditory Training Experience app, developed by the University of California Riverside Brain Game Center. We hypothesize that the Veteran population will complete the gamified auditory training therapy and show within-task improvement. Additionally, a transfer to untrained auditory tasks, such as performance on a test of speech in noise, will be evaluated.

Design: Ten veterans will be recruited from the local community and Western Washington University's Veteran Service Office, with preference given to those with difficulty hearing speech in noise. Therapy will be conducted twice a day for two weeks. Speech in noise and other tests of auditory processing ability will be conducted during pre-, mid-, and post-assessments. Participants will also complete questionnaires regarding feasibility of the therapy.

Results: Preliminary results on the ability to complete the gamified auditory training therapy as well as pre- and post-test performance on tests of auditory processing ability will be shown.

Conclusions: We expect improvements on the trained auditory tasks, and we are optimistic for a transfer to other untrained auditory tasks such as improvements in speech in noise performance. This an important first step in providing auditory therapy to clinical populations such as Veterans. We are excited about the possibility of introducing the gamified auditory training task to additional clinical populations in the future.

Category: Hearing Loss / Rehabilitation

Poster #: 141 **Mentored Student Research Poster Award**

Virtual Partnership-Centered Aural Rehabilitation for Older Adults with Hearing Loss

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Objectives: Audiology appointments are typically focused on the client to meet their individual hearing healthcare needs. However, a client's spouse often notices the hearing loss first and is also affected when communicating (third-party disability). Because hearing loss affects more than just the client, we focus on the relationship between the client and their closest communication partner. This work represents a shift in typical audiologic practice by welcoming the partner's views to better meet the needs of the overall partnership. Family-centered approaches are standard for pediatric services, but adults could also benefit from this approach, as hearing loss and aging tend to inhibit communication and social engagement. The goal of this work is to reduce the mismatch between both parties' expectations and perception of the hearing loss, and to enable them to create mutual tangible goals to improve daily communication and quality of life. We hypothesize that agreement will improve between the client and partner after experiencing hearing loss simulations, interviews, and setting communication goals together.

Design: Older adult clients with hearing loss (ages 60-80 years) and their most-frequent communication partner completed remote interviews and questionnaires related to the impact of the client's hearing loss via virtual video communication. Participants (clients and partner) separately completed the SPARQ, HHIE, and SOS-HEAR questionnaires and interview. Together participants joined a remote session in which they listened to conversational speech in realistic "restaurant" background noise at various SNRs. Both listened to hearing loss simulations and discussed empathy and third-party disability. Afterwards participants separately completed the same questionnaires. Questionnaire results were analyzed using an ordinal agreement analysis to determine mismatch between partners on the various scales before and after the shared listening experience. Finally, the client and partner participated in a structured exit interview, discussed their mismatches, and developed mutual goals toward improving general communication.

Results: Preliminary results show stark differences in agreement between clients and their communication partners. Results were highly variable as clients tended to reveal greater impact of their hearing loss than acknowledged by the partner, and vice-versa. Structured interviews shed light on common themes of issues with hearing loss and third-party disability such as decreases in social engagement, additional communication responsibilities, and apprehension.

Conclusions: Preliminary results indicate that each partnership faces unique challenges to successful communication, requiring tailored partnership-centered hearing health care. Each partnership can develop mutual goals for communication when working with an audiologist. Partnership-centered aural rehabilitation can be successful via virtual appointments and can help promote positive and successful communication skills between clients and their most frequent communication partners. Moreover, providing rehabilitation virtually enables audiology to be more inclusive by providing better healthcare access to diverse populations with various socioeconomic status. Importantly, the agreement and lack thereof within each partnership would not likely be apparent during standard individualized audiologic appointments. This approach shows promise for evaluating hearing aid satisfaction, retention, and outcomes. Work supported by NIDLRR award to Gallaudet University, C. Voger, PI

Category: Hearing Loss / Rehabilitation

Poster #: 142 **Mentored Student Research Poster Award**

Estimating the Contribution of Objectively Measured Hearing Loss on Dementia

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Jason Smith, Johns Hopkins University, Baltimore, MD
Pamela Lutsey, PhD, University of Minnesota, Minneapolis, MN
Pablo Martinez Amezcua, MD, PhD; Kening Jiang; Danielle Powell, AuD, PhD; Alison Huang, PhD; Jonathan Suen, AuD; Richey Sharrett, MD, Johns Hopkins University, Baltimore, MD
James Russell, University of North Carolina, Chapel Hill, NC
Josef Coresh, MD, PhD; Nicholas Reed, AuD; Jennifer Deal, PhD, Johns Hopkins University, Baltimore, MD

Objectives: Hearing loss (HL) is a leading late-life modifiable risk factor for dementia. Prior work estimates the population attributable fraction (PAF) of HL on incident dementia to range from 2-8%, however these studies likely underestimate the preventative potential because of methods used to identify HL (i.e., inclusion of self-

report measures). We estimated the PAF of dementia from audiometrically-assessed HL (the clinical standard) among a large community-based cohort of older adults, hypothesizing that the PAF for incident dementia from audiometric HL is higher than previous estimates.

Design: Data were drawn from the Atherosclerosis Risk in Communities Neurocognitive Study (ARIC-NCS) study, a prospective, multicenter community-based cohort. We excluded participants with incomplete audiometry (visit 6, 2016-17), dementia diagnosis at or before visit 5 (2011-13; baseline for this analysis), missing covariates (age, sex, race, center, education, hearing aid use), and, given small numbers, those who did not identify as White or Black race, resulting in an analytic sample of 3,488. Incident dementia diagnosis, defined using a standardized algorithm incorporating longitudinal neuropsychological test data and hospitalization and death certificate records, was ascertained through 2019. HLwas measured by pure-tone audiometry and defined as a pure-tone average (PTA) >25 dB HL (mild HL, PTA 26-40 dB; moderate/severe HL, PTA >40 dB). For the primary analysis, we quantified PAFs of incident dementia from HL, adjusted for demographic and clinical covariates. We explored potential effect modification by age and sex. In secondary analyses, we quantified PAFs of audiometric HL among non-hearing aid users and from self-reported HL (reporting at least some difficulty hearing without using a hearing aid).

Results: Overall, the mean age was 75±4.6 years, 60% were female, 23% self-identified as Black race, 66% had audiometric HL, and 302 (9%) developed dementia during follow-up. Among participants with HL, 29% used hearing aids. Overall, the PAF of dementia from any HL was 25.9% (95% CI: 6.7, 40.0%). PAFs from mild and moderate/severe HL were 13.9% (95% CI: 2.8, 21.2%) and 13.2% (95% CI: 2.2, 20.9%), respectively. Age and sex did not modify associations. However, PAF estimates were higher and statistically significant among those aged ≥75 years (32.3%; 95% CI: 3.4, 51.6%) but not<75 years. Restricting to non-hearing aid users, the PAF was similar to the overall PAF (25.8%; 95% CI: 8.0, 39.1). PAFs from self-reported HL were non-significant.

Conclusions: We found that up to 26% of dementia cases in a population may be attributable to HL, which is substantially higher than previous estimates, perhaps because prior estimates have largely depended on self-reported HL, which do not suggest increased risk in our study. Methodologic limitations resulting in wide confidence intervals support future work with longer follow-up times or combined samples (meta-analyses). Additionally, HL in our study was measured 5 years after baseline; however, we believe this approach is valid given slow HL progression over time (1-2 dB/year). Interventions targeting HL in late-life might reduce a large proportion of dementia cases; however, future work is needed to determine the effect of HL interventions, such as hearing aids, on incident dementia.

Category: Hearing Loss / Rehabilitation

Poster #: 143 **T35 Research Trainee Poster**

Surveying Oncology Providers About Ototoxicity and its Management in VA

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Objectives: Research indicates the importance of collaboration between oncology and audiology services for successful implementation of ototoxicity management. The goal of this study is to understand the value, service delivery gaps, and barriers associated with ototoxicity management from the oncology providers' perspective so a contextually-relevant approach can be used to implement a standard set of ototoxicity management goals across the Department of Veterans Affairs (VA) healthcare system. Our group reported audiologists' perspectives using the same survey instrument last year and a goal of the current project is to evaluate the alignment between audiologists and oncology providers in this important area of cancer care.

Design: This study utilized the Ototoxicity Management Interdisciplinary Communication (OtoMIC) survey and was administered to oncology nurses, physicians, and pharmacists working at the VA. This survey included 26 questions mapped to three constructs of the Consolidated Framework for Implementation Research (CFIR) framework (Outer Setting, Inner Setting, and Characteristics of Individuals). Participants were recruited using the Veterans Administration Extension for Community Healthcare Outcomes educational seminar series and Association of the Veteran Affairs Hematology/Oncology. Questions related to the Outer Setting construct included those asking about Veterans' OtoM needs and resources and organizational prioritization for addressing those needs. The Inner Setting construct included questions about the healthcare system/facility, structural characteristics and culture surrounding OtoM. The Characteristics of Individuals construct included questions regarding oncology providers experience, knowledge, and beliefs regarding ototoxicity and its management. Results were analyzed using both descriptive statistics and thematic analysis of open-text responses.

Results: Key findings include that oncologists are willing to consider a dose or medication change to preserve hearing and see themselves as being more responsible for discussing ototoxicity risk and options for mitigating this risk than the audiologist. Preliminary results indicate that barriers to effective OtoM include a lack of interprofessional communication, collaboration, and referrals for OtoM, an incomplete understanding of the prevalence of ototoxicity for various chemotherapeutic regimens; a lack of knowledge of OtoM best practices; and a lack of alignment about which provider is responsible for various aspects of the OtoM program.

Conclusions: The results from audiologists and oncology providers to the OtoMIC survey should help guide recommendations on OtoM across the VA enterprise, including the creation of recommendations for eliminating specific barriers to care and high-impact practices to influence patient outcomes and promote these important

areas for interprofessional collaboration. The implementation of these practices would reduce service gaps in OtoM delivery and reduce the long-term impacts of cancer care for Veterans.

Category: Hearing Loss / Rehabilitation

Poster #: 144

Factors Influencing Help-Seeking and Hearing Aid Uptake: A Systematic Review

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Objectives: This systematic review examined the audiological and non-audiological factors that influence hearing help-seeking and hearing aid uptake in adults with hearing difficulties based on the literature published during the last decade.

Design: Peer-reviewed articles published between January 2011 and February 2022 were identified through systematic searches in electronic databases CINAHL, PsycINFO and MEDLINE. The review was conducted and reported according to the PRISMA protocol.

Results: Forty-two articles met the inclusion criteria. 71 (44 audiological and 27 non-audiological) hearing help-seeking factors and 159 (93 audiological and 66 non-audiological) hearing aid uptake factors were investigated with many reported only once (10/71 and 62/159, respectively). Hearing aid uptake had some strong predictors e.g., hearing sensitivity with others showing conflicting results (e.g., self-reported health). Hearing help-seeking had clear non-predictive factors e.g., education and conflicting factors e.g., self-reported health. New factors included cognitive anxiety associated with increased help-seeking and hearing aid uptake and urban residency and access to financial support with hearing aid uptake. Most studies were classified as level 4 evidence (67%) and rated as fair quality (86%).

Conclusions: Effective promotion of hearing help-seeking requires more research evidence. Investigating factors with conflicting results and limited evidence is important to clarify what supports help-seeking and hearing aid uptake in specific groups. These findings can inform future research and hearing health promotion and rehabilitation practices.

Category: Hearing Loss / Rehabilitation

Poster #: 145

Factors Influencing Hearing Aid Use, Benefit and Satisfaction in Adults: A Systematic Review of the Past Decade

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Objectives: This systematic review aims to examine the audiological and non-audiological factors that influence hearing aid use, benefit and satisfaction in adults based on studies published during the last decade (2011 and 2022).

Design: Following the PRISMA 2020 guidelines, articles were identified through systematic searches on five platforms which included Web of Science, Scopus, PubMed, EBSCO host including CINAHL and Academic Search Complete. The National Institute of Health (NIH) Quality assessment tool and the Oxford Centre for Evidence Based Medicine (CEBM) tool were used for quality assessment and grading of level of evidence.

Results: Thirty-four articles met the inclusion criteria and were included in the review. A total of 95 significant factors influencing hearing aid use (n=45), benefit (n=13) and satisfaction (n=33) were identified. Clear determinants of hearing aid use, benefit and satisfaction were hearing sensitivity, self-reported hearing difficulty, speech perception, cognition, attitude and beliefs. Non-significant determinants were slope of audiogram, occupation, and marital status. Conflicted determinants were type of hearing aid fitting, age, gender and income. 30 cross-sectional studies included in this review were graded level 4, 1 cohort studied rated graded level 3 and 2 randomized control trials rated level 2.

Conclusions: The review identified some new factors of hearing aid outcomes such as speech perception ability, bothersome tinnitus, neurological disorders that contributes to mental health, prevalence of hearing aid problems, narratives on hearing aid fitting procedures, service delivery model and social networks that were not evident in the previous reviews. These factors need further investigation through high quality studies to further strengthen the existing evidence.

Category: Hearing Loss / Rehabilitation

Poster #: 146

Care Partner's Role in Medical Visits of Older Adults with Hearing Loss and Dementia

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Objectives: Dementia and hearing loss are conditions which restrict one's ability to communicate, amplifying the need for effective care coordination and communication with medical providers. The role of care partners in facilitating communication between clinicians and older adults with dementia and hearing loss remains unknown. We examine how the presence of hearing loss and dementia influence communication with medical providers and the role of involved care partners during medical appointments

Design: Drawing on responses from 7,070 community-dwelling older adults who participated in the 2015 National Health and Aging Trends Study, we use logistic regression to quantify care partner accompaniment to medical visits and the role care partners assume during visits by older adult hearing and dementia status.

Results: Nearly 4 in 10 older adults with dementia also report hearing loss. Eighty-two percent of older adults with both hearing loss and dementia are accompanied to medical visits by a care partner. Those with hearing loss and dementia are six times more likely to be accompanied by a care partner to medical visits than those with neither condition (OR:6.04; 95%CI:4.06,8.99). Care partners of older adults with both (versus neither) hearing loss and dementia are more actively engaged in facilitating understanding between the older adult and physician (OR:4.55, 95%CI:2.68,7.71), asking or telling the doctor information (OR:6.13, 95%CI:3.44,10.9), and reminding the older adult of their questions (OR:2.52, 95%CI: 1.66,3.83).

Conclusions: Care partners have an active role during medical visits among older adults with hearing loss and dementia. Efforts to support care partner engagement and teach advocacy skills may close gaps in care quality for the subgroup of older adults who are living with hearing loss and dementia. Further research on more detailed contribution by care partners and support tools used during medical visits is needed to optimize care.

Category: Hearing Loss / Rehabilitation

Poster #: 147

AIMER: An Intervention to Improve Provision of Mental Wellbeing Support

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Objectives: Due to the combination of hearing and communication challenges imposed by hearing loss and the use of maladaptive coping strategies acquired over years of hearing decline, adults with hearing loss are at increased risk of experiencing poor mental wellbeing, including social isolation, loneliness, anxiety, and depression. However, the mental wellbeing impacts of hearing loss are not consistently addressed within routine audiological care. This study describes the development and evaluation of an intervention to increase the frequency with which audiologists provide mental wellbeing support to adults with hearing loss within routine audiology services.

Design: The Behaviour Change Wheel, an eight-step systematic process, was followed to develop a multifaceted intervention targeting audiologists' behaviours relating to: (1) asking clients about their mental wellbeing; (2) providing general information on the mental wellbeing impacts of hearing loss; and (3) providing personalised information on managing the mental wellbeing impacts of hearing loss: the Ask, Inform, Manage, Encourage, Refer (AIMER) intervention. The AIMER intervention was then evaluated as part of an implementation study within the clinical context, informed by the RE-AIM implementation framework exploring Reach, Effectiveness, Adoption, Implementation, and Maintenance.

Results: The AIMER intervention incorporates a variety of intervention functions and behaviour change techniques, including instruction and demonstration, information about the approval of others, adding objects to the environment, use of prompts/cues, and endorsement from credible sources. Evaluation of the AIMER intervention demonstrated significant increases in audiologists' behaviours relating to (i) asking about, (ii) providing general information, and (iii) providing personalized information and support for the mental health impacts of hearing loss.

Conclusions: The Behaviour Change Wheel and RE-AIM frameworks provided systematic, comprehensive and transparent processes for the development and evaluation of the AIMER intervention. Behaviour change

techniques are effective in changing audiologists' behaviours relating to provision of mental wellbeing support within routine clinical care.

Category: Hearing Loss / Rehabilitation

Poster #: 148

Conceptualising Empowerment for Hearing Health Care

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Objectives: The primary objective of this qualitative study was to explore how empowerment manifests itself for individuals on the journey from first awareness of hearing challenges to becoming an active hearing-aid user. Research has demonstrated a positive relationship between patient empowerment and health outcomes in long-term conditions such as diabetes and heart disease. Empowerment may take different forms in different contexts, but its common feature is that it enables individuals to gain mastery over an issue of concern to them. Zimmerman's Theory of Empowerment suggests that intrapersonal, interactional, and behavioral components are all necessary ingredients for empowerment. Although the benefits from the patient empowerment process intuitively transfer to a chronic condition like hearing loss, only a handful of studies have previously explored hearing loss and empowerment.

Design: Semi-structured interviews were conducted with adult hearing aid users (N=18) from Sweden and Australia. The participants were asked open-ended questions to facilitate discussion of their experiences about the selected empowerment dimensions knowledge, participation, control, skills and self-efficacy during their hearing journey, defined at three points (pre-fitting, fitting, post-fitting). The interview guide was created in close collaboration between both research teams. Each conversation was audio-recorded and transcribed verbatim. The Swedish interviews were translated prior to analysis through the software nVivo 13. The analysis was done by deductive thematic template analysis.

Results: The participants shared insights from all five a priori dimensions. Five key dimensions and twenty sub-themes were created. For knowledge, both knowledge about hearing and hearing aids as well as knowing about myself was a central part of the hearing journey. The dimension skills was expanded to include both skills and strategies. Participants shared that during the pre-fitting stage they often relied on themselves to learn strategies. This happened both unconsciously and consciously, resulting in both adaptive and maladaptive strategies. For participation, participating socially was discussed and seemed to be as important as participating in hearing health care. For self-efficacy, participants gained more confidence in communicating from when they started to use hearing aids, but some also said that they had the same sense of confidence before and after. For control, hearing aids helped feelings of being in control, for communication and everyday life.

Conclusions: Empowerment in hearing health care was conceptualised as the process through which individuals with hearing-related challenges acquire and use knowledge, skills, and strategies, and increase self-efficacy, participation, and the feeling of control of their hearing health care, hearing solutions and everyday lives.All dimensions of empowerment were shown to be important parts throughout the patient journey with some temporal variations for the different dimensions. These findings may benefit people with hearing loss and

enable the finetuning of patient-centered care. The next stage of this research was to develop an outcome measure of empowerment.

Category: Hearing Loss / Rehabilitation

Poster #: 149

Perception of Patient-Centered Care Among Individuals with Hearing Loss

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Objectives: Previous work suggests hearing loss is associated with increased healthcare utilization and expenditures. Researchers propose this may be mediated by communication barriers in healthcare settings, yet fewer analyses have focused on the association of hearing loss with healthcare experiences. Moreover, there is a paucity of work at the intersection of hearing loss and race in healthcare experiences. The primary aim of this analysis was to characterize the association of perception of patient-centered healthcare experiences by hearing status with a secondary aim to explore whether race modified the association.

Design: We pooled data of participants who completed the hearing measure module from the 2016 (n=7,674) and 2018 (n=6,839) waves of the Health & Retirement Study, a representative longitudinal panel study of Americans over 50 years of age. Perception of patient-centered care was assessed by the question: "Thinking about your experiences with the health care system over the past year, how often were your wishes for care taken into account [Always, Sometimes, Never]?" We derived a binary variable of optimal (always) vs suboptimal (sometimes or never) perception of patient-centered care. Hearing was measured using the HearCheck Screener, which presents three tones of different intensity at 1000Hz and 3000 Hz in each ear (6 total tones). Consistent with previous work, possible hearing loss was defined as hearing anything less than all 6 tones in at least one ear.Logistic regression was used to characterize the association of suboptimal perception of patient-centered care by hearing status. Covariates included: age, gender, race/ethnicity, marital status, education, insurance status, usual source of care, and self-reported chronic comorbidities count. To explore the presence of effect modification by race, the logisitic regression was stratified by White and non-White groups.

Results: In the analytic sample, 58.2% of respondents had possible hearing loss and 28.5% reported suboptimal patient-centered care. In an adjusted model, individuals with hearing loss had 17% greater odds of having suboptimal perception of patient-centered care (OR=1.17;95%CI: 1.07,1.27) relative to those without hearing loss. Stratified models revealed a significant association between suboptimal patient-centered care and hearing loss among non-White participants (OR=1.21;95%CI:1.07-1.37). However, no association was found among White individuals.

Conclusions: In a representative sample of Americans over 50 years of age, hearing loss was associated with higher odds of perceiving suboptimal patient-centered care during healthcare encounters. This may be attributable to hearing loss as a barrier to effective patient-provider communication which limits patient preferences and participation in care decisions. Moreover, findings may reflect implicit bias from clinicians who avoid discussions to prevent communication breakdown or speak over adults with hearing loss to companions. Following stratification, the association remained present only among non-White participants. It is possible this may reflect racial disparities and implicit bias in the healthcare system such that White Americans with hearing loss receive accommodations while non-White Americans do not. Suboptimal patient-centered care may

mediate previous work on the association of hearing loss and increased health utilization/expenditures. Future work should focus on mediation analyses as well as whether interventions can modify the observed association.

Category: Hearing Loss / Rehabilitation

Poster #: 150

Hearing Loss and Cognition: A Protocol for Ensuring Speech Understanding in Neuropsychological Assessment

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Objectives: Neuropsychological evaluations are standardized tests used to assess cognitive function. These tests often involve presenting both instructions and test items verbally. Age-related hearing loss is thus an important consideration when performing these tests with older adults. Hearing loss is present in approximately two thirds of adults aged 70 years or older and may adversely affect performance if an individual is unable to hear and understand information during neuropsychological evaluation. Although protocols often recommend testing occur face-to-face in a quiet environment, there are currently no standard guidelines for neuropsychological evaluation for research with older adults who have hearing loss.A main purpose for this study is to introduce and describe the Ensuring Speech Understanding (ESU) test, which assesses speech understanding prior to neuropsychological assessment. The association between hearing loss severity, cognitive function, and ESU failure will be presented as well. It was hypothesized that greater hearing loss severity is associated with a higher probability of failure on the ESU test.

Design: Data was used from the Atherosclerosis Risk in Communities (ARIC) study, a large population-based cohort of older adults, with recruitment starting in 1987-1989. Audiometric data was collected during visit 6 (2016-2017), while the ESU and neuropsychological testing was performed during visit 7 (2018-2019). The analytic sample consisted of individuals with complete data on ESU performance, hearing, and a full set of covariates. Multiple logistic regression was used to assess the association between hearing loss and the

probability of failure on the first trial of the ESU. Four-frequency pure tone average of the better hearing ear was computed and used to categorize participants into five groups according to the 2021 World Health Organization guidelines. The association was also estimated modeling hearing loss as a continuous variable while stratifying by cognitive status (normal cognition vs. Mild Cognitive Impairment [MCI] or dementia). Cognitive diagnoses of dementia or mild cognitive impairment were made using neuropsychological test results and ARIC panel review.

Results: Information regarding the context under which the ESU test was developed and subsequent applications of the test are presented. Of 2,926 participants (mean age 81.2¬±4.5 years, 58.8% female, 23.3% Black), 61 individuals failed the ESU test. The main finding of the present investigation is an overall low rate of failure on the ESU test. In fully adjusted models, the estimated probability for ESU failure was 0.3% (CI: 0-0.007) for mild, 2.3% (CI: 0.01-0.03) for moderate, 8.1% (CI: 0.047-0.114) for moderately severe, and 16.9% (CI: 0.087-0.251) for severe to complete hearing loss. No statistically significant differences were found in the estimated probability of ESU test failure between those with and without a diagnosis of mild cognitive impairment or dementia.

Conclusions: Low overall rate of failure on the ESU test suggests this evaluation is appropriate for use with individuals who have various degrees of hearing loss and cognitive diagnoses. Based on these results of the study, it is recommended that the ESU be completed prior to neuropsychological testing in research settings, in order to confirm that patients have access to information presented verbally and to determine whether accommodations for hearing loss are necessary.

Category: Hearing Loss / Rehabilitation

Poster #: 151

Accompaniment, Perceptions of Healthcare Providers, and Hearing Difficulty

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Objectives: Hearing loss has been associated with increased healthcare utilization and spending. Moreover, adults with hearing loss may be vulnerable to poorer patient-provider communication and healthcare experiences. However, little is known about hearing loss and perceptions of interactions with healthcare providers and potential modifiers of such associations, such as companionship to healthcare visits. The aims of our study were to (1) characterize patient perceptions of provider interactions among Medicare beneficiaries with and without hearing difficulty and (2) explore if accompaniment modifies the association between hearing difficulty and perceptions of health provider interactions.

Design: This cross-sectional study used the 2016 Medicare Current Beneficiary Survey (MCBS), a nationally representative annual survey of the health status and healthcare utilization of Medicare beneficiaries. The analytic sample was limited to beneficiaries over 65 years of age who indicated a usual health provider (n=9520). The primary outcome was perceptions of usual health providers over the past year based on

participant responses of agreement ("strongly agree" "agree" "neither agree or disagree" "disagree" "strongly disagree") with a series of 10 statements such as "The doctor or other health professional is competent and well-trained." Hearing was assessed using a self-report question of trouble hearing ("no trouble", "little trouble", "a lot of trouble"). Accompaniment was identified as reporting a companion normally travels to the facility and specifically speaks with the doctor with the participant (yes/no). Ordinal logistic regression adjusted for age, sex, race, education, income, marital status, and comorbidity count was used to assess the association between hearing difficulty and perceptions of providers. Interaction terms and models stratified by accompaniment were used to assess whether accompaniment modifies the association.

Results: Adjusted ordinal models revealed a general trend such that hearing difficulty was associated with poorer perception of providers. Specific examples include, beneficiaries with hearing difficulty had lower odds of disagreeing with negative statements such as "the provider doesn't explain medical problems" (Odds Ratio[OR]=0.85;95%Confidence Interval[CI]=0.78-0.94) and "the provider seems to be in a hurry" (OR=0.81;95%CI=0.73-0.90) relative to those without hearing difficulty. Conversely, those with hearing difficulty had higher odds of disagreeing with positive statements such as "the provider checks everything when examining" (OR=1.21;95%CI=1.09-1.34) or "the provider answers all questions" (OR=1.18;95%CI=1.07-1.31) relative to those without hearing difficulty. No clear trend was identified when assessing whether accompaniment modified the observed associations. However, hearing difficulty was no longer significantly associated with a few statements among the accompanied group.

Conclusions: In a nationally representative sample of Medicare beneficiaries over 65 years of age, hearing difficulty was associated with higher odds of reporting negative perceptions of interactions with healthcare providers. Subsequent models stratified by accompanied revealed a slight mitigation of negative perceptions of provider but revealed no clear trend. The current work is limited by potential recall bias and self-report measures. Future work could use objective measures of hearing and assessments at the time of the interaction. Hearing loss may be a modifiable factor impacting patient-provider interactions with several relatively simple, low-cost mitigation strategies including accompaniment, accommodations, and handheld amplification.

Category: Hearing Loss / Rehabilitation

Poster #: 152

Learning from My Elders: A Paradigm Shift in Research with Indigenous Peoples

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Objectives: The sense of hearing is perceived as important by Indigenous peoples, there are however stark inequities in access to hearing healthcare (HHC) and hearing health and wellbeing. This was reflected within my doctoral study entitled 'Taringa Whakarongo' that aimed to bring forward kaum*ƒ*Åtua (M*ƒ*Åori elders) and wh*ƒ*Ånau (collective family/ies) realities of hearing loss and HHC.

Design: A majority of hearing science research has been done 'on' Indigenous peoples, which is likely to fall short in explaining Indigenous experiences/realities and maintain the status quo. As part of a decolonising project, research that involves Indigenous peoples should be embedded within Indigenous theoretical

frameworks and methodologies that centralize Indigenous experiences and intellectual thought, values, and principles. status quo. The Taringa Whakarongo project shifts away from Western paradigms of research and towards a kaupapa M*ƒ*Åori research approach that realises the need for Indigenous peoples governance, decision making, and self-determination within the research project.

Results: Findings from the Taringa Whakarongo project with guidance from hard-of-hearing M*ƒ*Åori elders will be shared in the presentation. I discuss the need to claim space for Indigenous research approaches using examples from research with kaum*ƒ*Åtua and through Indigenous hearing health research that I am currently navigating with my supervisors from University of Arizona and University of Arkansas for Medical Sciences through a Fulbright scholarship. Within this discussion, I contextualise my learnings from Indigenous elders and my positioning as an Indigenous hearing audiologist and scholar in audiology research in both the Aotearoa New Zealand and Turtle Island contexts.

Conclusions: Indigenous peoples have the right to good hearing health and family-centred HHC. Unless we address the current concerns of Indigenous peoples, the impacts of unassisted hearing loss are likely to remain or increase. In starting these conversations, we can shift towards creating culturally safe and responsive research that are self-determined by Indigenous peoples and within Indigenous paradigms to better understand and inform policies relating to HHC for Indigenous peoples.

Category: Hearing Loss / Rehabilitation

Poster #: 153

Co-Designing Culturally Safe Approaches to Ear and Hearing Care with Aboriginal Communities

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Objectives: Otitis media (OM) in Australian Aboriginal children, is highly prevalent (3 times that of non-Indigenous children), occurs earlier, and lasts longer than non-Indigenous children, disrupting critical periods of neurocognitive, literacy, and language development. Data linkage studies of Aboriginal children in the Northern Territory suggest that the cumulative disease burden arising from OM and associated hearing loss contribute to lower rates of school readiness at 5 years of age, decreased school attendance in Year 1, lower academic achievement in Year 3, and increased contact with the child protection system. Early detection and connection to timely care could mitigate the longer-term impacts and improve language and life outcomes for Aboriginal children. In a partnership with 3 Aboriginal communities, we identified the barriers and levers in the ear and hearing care system and pathway in these communities to understand the opportunities for change.

Design: Two approaches were taken to understand the ear and hearing care system. First, we used desktop research to map the system of care and supports that should exist in each community. Then, we used focus groups in each community to map the system of care. Participants included individuals representing organizations involved in care, as well as Aboriginal Medical Services' and community members. Qualitative

interviews were conducted with families who had experienced the care pathway and Aboriginal health workers involved in delivering care.

Results: The study highlighted the fragmentation of the existing pathway, the long-wait times to specialist services, the lack of cultural safety of systems and services, and an over-reliance on the family to advocate for their child's ear and hearing health as key barriers to care. In some cases, it demonstrated differences between the designed (or expected) pathway to the one which families took. Enablers included the facilitatory and advocacy support of Aboriginal Medical Service to connect families to care.

Conclusions: The results of this study highlights key opportunities in the ear and hearing care pathway to transform this into a culturally safe, and more easily navigable pathway Aboriginal communities to mitigate the significant impacts of otitis media and hearing loss.

Category: Hearing Loss / Rehabilitation

Poster #: 154

An Ototherapeutic Improves Cognitive Health

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Objectives: Previous research has shown that hearing aid or cochlear implant use may improve cognitive functions. This has helped to fuel the notion that there is an intimate connection between the health of the auditory system and cognitive health. Carboxy alkyl ester (CAE) have been developed to provide trophic support to the cells of the auditory system which leads to improved cell signaling and protein trafficking. In the current experiment we test the hypothesis that CAE would also improve cognitive functions.

Design: A randomized double-blind cross-over placebo controlled pilot experiment was pursued. Standardized unsupervised neuropsychological assessments served as the main methodology. These assessments included individual tests that measured attention, memory, executive function, and social cognition. A total of 18 individuals participated in the study.

Results: The results showed that CAE treatment resulted in statistically significant ($p < 0.05$) improvement in attention, memory, and executive function. Additionally, 64% of the participants evidenced improvement in social cognition.

Conclusions: In addition to auditory electronic devices (e.g., hearing aids and cochlear implants), it is possible that ototherapeutics (e.g., CAE) may indirectly improve and/or maintain cognitive health by providing trophic support to the auditory system.

Category: Hearing Loss / Rehabilitation

Poster #: 155

Hearing Loss in U.S. Children Aged 6-19: NHANES 2017-March 2020

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Objectives: To estimate prevalence and risk factors associated with hearing loss among U.S. children. Hearing threshold exams and related health questions for children aged 6-19 years were included in the National Health and Nutrition Examination Survey (NHANES), 2017-March 2020. NHANES last assessed hearing of youth aged 12-19 years in 2005-2010 and younger children aged 6-11 years in 1988-1994 (NHANES III).

Design: Cross-sectional, nationally representative NHANES 2017-March 2020 pre-COVID-19 data were analyzed (n= 3,986). Hearing trouble was ascertained by parental report of hearing status, characterized as "excellent", "good", "a little trouble", "moderate trouble", "a lot of trouble", or "deaf." Among children whose hearing was less than excellent, the Gallaudet Hearing Scale was used to ascertain functional status. Parents were asked sequentially whether the child could usually hear and understand what a person says without seeing his/her face if that person whispers from across a quiet room; …talks in a normal voice across a quiet room; …shouts from across a quiet room; …speaks loudly into their better ear. Pure tone air conduction audiometric thresholds in each ear were obtained at 0.5, 1, 2, 3, 4, 6, and 8 kHz. Hearing impairment (HI) was defined separately for better ear and worse ear based on pure-tone averages (PTA) ≥ 20 decibels (dB) hearing level (HL) for: (a) speech frequencies (0.5, 1, 2, and 4 kHz) and (b) high frequencies (3, 4, 6, and 8 kHz). Risk factors examined included parental reports of asthma, birth weight, ear infections, insertion of ear tubes to treat recurrent otitis media, cigarette smoking, body mass index, noise exposure from work or recreational activities, and weekly levels of physical activity. Multivariable regression models (adjusted for children's age, sex, race-ethnicity, and poverty index) were used to estimate risk ratios (RRs) and 95% confidence intervals (CIs).

Results: Parents reported any hearing trouble for 4.5% (CI: 3.5%, 5.7%] of children aged 6 to 19 years. Females had higher prevalence, 5.3% (CI: 3.8%, 7.3%), compared to males, 3.7% (CI: 2.7%, 5.0%). The Gallaudet scale also indicated more hearing difficulty for females: 7.1% could not hear a whisper, compared to males, 5.0%. The overall (unilateral and bilateral) speech-frequency HI prevalence was 4.1% (CI: 3.0%, 5.6%) for females and 3.3% (CI: 2.2%, 4.8%) for males. Prevalence of hearing trouble increased with age: younger children, 6 to 11 years, had a prevalence of 3.3% (CI: 2.2%, 5.0%); youth, 12 to 17 years, 4.2% (CI: 3.1%, 5.7%); older youth, 18 to 19 years, 9.1% (CI: 5.9%, 13.9%). The speech-frequency HI prevalence was also higher for older youth, 4.9% (CI: 2.3%, 9.8%), compared to all children, 3.7% (CI: 2.9%, 4.7%). Childhood asthma, ear infections, ear tube insertions, cigarette smoking, obesity, reduced physical activity, lower birth weight, and firearm use were associated with increased speech and/or high frequency HI.

Conclusions: Hearing loss in children may be reduced by interventions that decrease risk factors, such as otitis media, asthma, cigarette smoking, firearms use without hearing protection, and reduced physical activity.

Category: Hearing Loss / Rehabilitation

Poster #: 156

Importance of Hearing for Emotional Responses to Movies and Television

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Objectives: Watching recorded media (e.g., television) is an important component of modern life for most adults. However, rapid speech rate and background sounds can contribute to difficulty understanding the on-screen dialogues. Additionally, adults with hearing loss might have a disrupted emotional response while watching television. Prior research demonstrates listeners with hearing loss show reduced valence ratings in response to pleasant sounds relative to their peers with normal hearing, even when complementary visual cues are available. However, whether work with non-speech stimuli would generalize to realistic situations is unclear - specifically watching recorded media. When evaluating emotional responses to recorded media for adults with and without hearing loss, we hypothesized that listeners with hearing loss would rate recorded media clips as less pleasant than their peers with normal hearing. To explore a potential amelioration of these deficits, we also evaluated different loudspeaker configurations and expected those with broader bandwidth would result in the most pleasant emotional responses.

Design: 58 adult listeners aged 22 to 79 years, with and without hearing loss participated. Emotional responses to recorded media were evaluated in 6 conditions, involving two dialogue-to-background ratios (+7 dB and +12 dB) and three loudspeaker configurations (default, stereo, surround). Relative to default speakers, the stereo and surround conditions used loudspeakers with a much wider frequency bandwidth. Stimuli were 10-second clips obtained by editing existing television or movie scenes. Speaker configurations and dialogue-to-background ratios were randomized across participants. In Experiment 1, media clips were presented without video (auditory-only). In Experiment 2, media clips were presented with their accompanying video (auditory-visual). Both experiments had the same conditions. Listeners rated valence and arousal after each clip.

Results: Experiment 1: (auditory-only clips): 1) Young adult listeners with normal hearing gave the lowest ratings of valence (least pleasant) when listening through the default speakers. Older adults with hearing loss gave the lowest ratings of valence when listening through surround speakers. There were no differences in ratings across speakers for older adults with normal hearing. 2) Under the favorable dialogue-to-background ratio (+12 dB), valence ratings were not different between listener groups. However, under less favorable dialogue-to-background ratio (+7 dB), adults with hearing loss rated study stimuli as less pleasant than did their normal hearing peers. Within groups, better dialogue-to-background ratios led to higher valence ratings. Experiment 2 (auditory-visual clips):1) Valence ratings among young adults were lowest when listening through default speakers, while for older adults with hearing loss the ratings were lowest for surround speakers. 2) There were no listener group differences of valence ratings under the same dialogue-to-background ratio. However, within groups, the better DBR consistently led to higher valence ratings.

Conclusions: Under a challenging dialogue-to-background ratio, listeners with hearing loss rated audio media clips as less pleasant than their peers. This has important implications for quality-of-life for adults with hearing loss, because watching recorded media is a common daily activity for many. Improvements in dialogue-to-background ratio and changes in loudspeaker configuration might improve emotional responses of recorded media. Additional work is necessary to evaluate alternative interventions.

Category: Hearing Loss / Rehabilitation

Poster #: 157

Insights on Speech Perception Testing Directly from Patients

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Objectives: Standard audiological speech testing, while informative, does not fully represent the full range of the demands of everyday communication. The goal of this exploratory project was to learn how adults with cochlear implants navigate conversations in challenging listening environments, toward the longer-term goal of tailoring experiments and clinical evaluations to better address these concerns.

Design: Semi-structured interview data from seven adults wearing cochlear implants were collected and analyzed using qualitative content analysis. We asked some targeted questions about listening effort, mental repair strategies, and audiological testing, as well as open-ended questions about everyday listening situations that were challenging.

Results: Several key themes emerged from analysis of the transcripts: (1) People often mentally repair words and miss the next words that are spoken, (2) It is very common to miss the beginning of an utterance, which can make the entire conversation difficult as the listener catches up, (3) The behavior (e.g. fast talking, facing away, patience or impatience) of a conversation partner can influence the listener's emotional state, (4) Adults with cochlear implants use a variety of strategies to cope with difficulty, including intentionally tuning out to recharge for later moments, and (5) Participants reported that diagnostic testing could be improved in a variety of ways, with particular attention to more naturalistic, noisy simulations and presence/absence of expectations for upcoming speech.

Conclusions: There are numerous communication difficulties that are common but not represented in clinical testing. Mental repair and coping strategies can go unnoticed in testing and in conversation. The timing of words and the continuity of listening are reported to be very important, but they have been largely neglected in the literature, motivating a new approach to evaluating auditory abilities.

HEARING SCIENCE / PSYCHOACOUSTICS

Category: Hearing Science / Psychoacoustics

Poster #: 158

Does Presentation Level Influence Working Memory?

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Objectives: This study examines how presentation level affects word recall as an indirect measure of listening effort (in a dual task paradigm) when listening to speech in noise. Additionally, the study explores the interaction between hearing loss and presentation level.

Design: A repeated measures design was used. Thirty native speakers of American English ranging in age from 34-74 years (M=58.5; SD=12.03) with normal to moderately severe hearing loss participated in the study. Listening effort was measured in dual-task paradigm (primary task: sentence recognition; secondary task: last word recall). Subjects were also asked to rate listening effort, frustration level, and disengagement using a ten-point rating scale. A total of thirty R-SPIN sentences were used for the sentence recognition and word recall task. Sentences were presented at three different SNRs (+8, +4 and 0 dB SNR) and two linguistic contexts (high and low probability sentences). The testing was conducted with speech stimuli at two presentation levels, 65 dB SPL and 80 dB SPL. The order of SNR and linguistic context were randomized within each test trial.

Results: A three-way mixed ANOVA test was conducted to examine the effect of presentation level, SNR and hearing loss (between-subject factor) on word recall. There was no significant three-way interaction ($p>.5$). However, there was a significant two-way interaction between SNR and presentation level ($F(2,58)=9.94$, $p=<.001$). At 0 dB SNR, less effort was exerted when sentences were presented at 65 dB SPL compared to sentences presented at 80 dB SPL ($p=.002$; Hedge's $g=0.56$, 95% CI: -.82 to -.21). When sentences in noise were presented at +8 dB SNR, we observed a reversal, with less effort reported while listening at the 80 dB SPL presentation level compared to the 65 dB SPL presentation level ($p=.003$; Hedge's $g=0.56$, 95% CI: .22 to .95). The frustration and disengagement scores were not significantly correlated to recall scores ($p>0.05$). There was no significant effect of presentation level on listening effort (or perceived listening effort), frustration and disengagement rating ($p>.05$).

Conclusions: The results of the current study expand our understanding of the effect of presentation level on word recall. The results show an average of 10% poorer word recall (medium effect) at 80 dB SPL when SNR is poor (0 dB SNR) due to increased listening effort; and an average 10% better word recall (medium effect) at 80 dB SPL when SNR is favorable (8 dB SNR) due to reduced listening effort. This observation is because, increased presentation level in poor SNR conditions reduces attentional resources available for word recall. There was no effect of hearing loss on the interaction between presentation level and SNR. The results agree with previous research that indicated reduction in working memory with increase in loudness of distractor sounds. The present study showed that the negative effect of loudness is significant at poor SNR conditions only. The effect of presentation level on listening effort is only evident with word recall test and is not experienced by patients as indicated by perceived listening effort scores.

Category: Hearing Science / Psychoacoustics

Poster #: 159

Children's Visual Attention to Talkers Varies by Hearing Ability

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Objectives: During face-to-face interactions, individuals have the option to look at the talker or not. When the acoustics of speech are degraded, for example in the presence of background noise or when the listener has hearing loss, access to a talker's face (i.e., lipreading) can support speech perception. Given these potential benefits, we hypothesize that individuals allocate more of their visual attention toward a talker when the acoustics of the speech are degraded. Extant evidence suggests that infants flexibly alter their visual attention to a talker's face to disambiguate unfamiliar speech. The purpose of this study is to test the prediction that

preschool-aged children allocate their visual attention to a talker when the acoustics of the speech signal are degraded.

Design: Thirty-one children aged 30-48 months participated in a looking-while-listening task in quiet or in the presence of two-talker background speech presented at +10 dB SNR. Nineteen children had normal hearing, and 12 children had permanent, bilateral, sensorineural hearing loss and used hearing devices. Children's eye gaze was video recorded while they viewed a screen, which included two familiar images (e.g., dog, ball) in the right and left lower corners and a video of a female talker, placed in the upper center of the screen. The female talker verbally labeled one of the objects on each trial. Following the experiment, children's eye gaze position for each trial was documented by trained coders every 33 ms. Data were summarized as the proportion of the looking at the center talker to estimate children's visual attention to the talker in the quiet and background speech conditions. We tested for differences between the conditions in terms of proportion of looking-to-center over the timecourse of a trial using the Bootstrapped Differences in Timeseries (BDOTS) package for R Statistical Software. Individual participant and group average of the proportion of looking to the talker, target image, and distractor images were summarized in triangle graphs.

Results: Children with normal hearing, looked significantly longer at the talker in the background speech condition than in the quiet condition. In contrast, children with hearing loss did not alter their visual attention to the talker across the quiet and background speech conditions. Notably, the performance of children with hearing loss looked more like performance of children with normal hearing in the background speech condition. Visual inspection of the triangle graphs showed that children with hearing loss prioritized visual fixation to the talker and target image. Visual fixations of children with normal hearing were more distributed across the talker, target image, and distractor image.

Conclusions: Preschool-aged children flexibly alter their visual attention to a talker when speech is degraded by background noise or by hearing loss. The way in which children allocate their visual attention to a talker may provide insight into how they perceptually weight audiovisual speech cues in real time.

Category: Hearing Science / Psychoacoustics

Poster #: 160

Presentation Level Does Not Affect Listeners' Emotional Responses to Sounds

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Objectives: The International Affective Digitized Sounds (IADS-2) is a corpus of auditory materials used to assess emotional reactions. It comprises naturally occurring non-speech sounds that vary along the dimensions of valence (pleasant to unpleasant) and arousal (calm to excited). The peak intensity of the original recorded corpus varies approximately 20 dB when presented at a set level. Researchers frequently adjust the relative intensity of stimuli so that the peak levels are relatively equivalent regardless of their typical occurrence in real-world (e.g., bee buzzing vs a rollercoaster). For research purposes, we desired to present sounds for different categories of valence/arousal at different loudness levels, while representing these sounds at ecologically valid intensities. However, systematically modifying loudness of these stimuli might change participants perceived valence/arousal ratings. This study aimed to identify the loudness at which participants would expect these sounds to occur in daily listening and compare participants' valence/arousal ratings for these sounds to those of the original recordings and available norms.

Design: Young adults with typical hearing participated in this two-phase study. For the first phase, descriptors of 155 IADS-2 sounds were presented to 25 participants and they indicated how loud each descriptor would be if they heard them in daily listening. Response options were soft, average, and loud. The loudness category for each sound was determined by identifying the category that received the maximum votes. For phase 2, 75 sounds were selected that best represented each of 5 valence-arousal categories (high pleasant-high arousal, high pleasant-low arousal, low pleasant-low arousal, low pleasant-high arousal, neutral) for each loudness level. Sounds in each loudness category were presented in their unprocessed condition (with variable loudness) with a calibration signal set to 65 dB SPL and after digitally modifying them (processed condition) to represent their expected loudness in daily listening (soft, average, and loud sounds at 55-, 65-, and 75-dB SPL respectively). Twelve participants reported their valence/arousal levels in response to each stimulus. Participants' ratings for the 5 sounds in each category were averaged and were compared between the two conditions, and with previously collected norms.

Results: Repeated measures ANOVA comparing the two conditions demonstrated a significant main effect of loudness but not condition, for both valence and arousal ratings. Pairwise comparisons demonstrated that loud sounds were significantly more unpleasant and arousing than soft and average sounds. However, valence/arousal ratings were not significantly different when presented at original-recorded versus modified-loudness levels. When compared with the norms, we observed a difference in ratings between the two samples, with our participants rating all sounds as significantly less pleasant and arousing.

Conclusions: Systematically modifying loudness presentation levels of these sounds to present them at their expected levels had no impact on participants' perceived emotional reactions. The lack of interaction between loudness and condition suggests that attributes other than actual loudness (e.g., auditory memory) might contribute to participants' emotional impressions of recorded sound stimuli. The final list of modified 75 sounds can be used to represent the 5 targeted valence/arousal categories for each of three loudness levels.

Category: Hearing Science / Psychoacoustics

Poster #: 161

Musician Advantage for Segregation of Competing Speech

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Objectives: While previous studies have shown musician advantages for melodic pitch perception, advantages for speech perception in steady noise are inconsistent. Musician advantages have been observed for speech perception tasks where voice pitch cues are important (e.g., vocal emotion perception, voice gender recognition, etc.). Voice pitch cues can also benefit segregation of competing speech. The aim of the study was to evaluate whether musician advantages for melodic pitch perception extend to segregation of competing speech. Given

advantages in pitch perception, we expected that musicians would make better use of target-masker talker differences than would non-musicians.

Design: Sixteen adult, normal-hearing, native Chinese, Mandarin-speaking musicians and 16 non-musicians participated in the study. Musician status was defined as having more than five years of continued formal instrument or voice instruction beginning at or before age 12, and currently active in music. Melodic contour identification was tested as a measure of melodic pitch perception. The spectrally-temporally modulated ripple test (SMRT) was used to estimate perception of specto-temporal cues. Speech recognition thresholds for a target male talker were measured in the presence of six-talker speech babble or two-talker maskers. For competing speech, the target sentence was always presented directly in front of the listener, and the maskers (two different male or female talkers) were either co-located with or spatially separated from the target (symmetrically placed at ¬±90¬∞. Masking release was defined as the difference in speech recognition thresholds with talker sex and/or spatial cues, relative to co-located targets and maskers of the same talker sex.

Results: Melodic contour identification, SMRT thresholds, speech recognition thresholds were all significantly better in musicians than in non-musicians. Musicians exhibited significantly larger masking release when talker sex and/or spatial cues were available. Across all participants, SMRT thresholds were significantly correlated with speech reception thresholds. Within the musician group, a significant association was observed between the onset/extent of music training and speech reception thresholds when the target and masker talker sex was different.

Conclusions: The data show significant musician advantages for melodic pitch perception, spectro-temporal pattern perception, masked speech reception thresholds, and masking release due to talker sex and/or spatial cues. The variability in masked speech recognition across all participants may be partly explained by perception of spectro-temporal information in a psychophysical task (SMRT thresholds). The data also suggest that early and extensive music training may benefit utilization of talker sex cues when segregating competing speech.

Category: Hearing Science / Psychoacoustics

Poster #: 162 **Mentored Student Research Poster Award**

Task Learning in a Gamified Spatial Release from Masking Test

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William Bologna, AuD, PhD, Towson University, Towson, MD

Objectives: Difficulty understanding speech in noise is a common complaint among many individuals with and without hearing loss. Speech-in-noise tests used in clinical environments do not accurately represent real-world listening conditions, and offer patients limited intrinsic motivation to perform to their best ability. In a recent study done in our lab, game elements were added to a traditional test of spatial release from masking to create a "gamified" test in effort to better reflect the motivation provided by real-world communication. Participants had the option to continue the gamified test until they solved a visual puzzle, which resulted in longer adaptive tracks than the traditional test. In the current study, these trial-level data were reanalyzed to estimate psychometric functions from different points in the adaptive track. Changes in the slope and estimated

thresholds from the psychometric function were evaluated to determine if learning effects contributed to observed changes in performance.

Design: Fifty-four younger adults with normal hearing completed a traditional laboratory and a gamified test of spatial release from masking. The traditional test ended after 10 reversals of the adaptive track, and the gamified test ended when the participant completed the visual puzzle (30.2 reversals on average). Trial-level data will be reanalyzed using a generalized linear model to estimate psychometric functions of performance over the course of the run. Estimated thresholds and slopes will be compared within and between subjects for the first and second halves of runs for the traditional and gamified tests.

Results: We found no significant difference between thresholds estimated after 10 reversals in the traditional and gamified test. However, thresholds improved from the first to second test, regardless of test order. Furthermore, thresholds were lower when calculated from the last six reversals of the gamified test, compared to thresholds calculated at the point of the 10th reversal. Thresholds estimated from the average of reversals will be compared to threshold estimates from psychometric functions generated from the first and second halves of the run. Results will be discussed in terms of the changes in threshold and slope over the course of the run, and how these changes suggest an effect of task learning; within and between subjects.

Conclusions: In general, adaptive tracking is an efficient means of estimating threshold, but it cannot clearly indicate changes in the underlying psychometric function. By generating psychometric functions, we will examine the extent to which the learning effect contributed to changes in inter- and intra-subject performance on the gamified test. Quantifying the learning effect will allow us to explore the utility of conducting tests of longer duration, and whether these tests provide a more accurate assessment of spatial release. Implications for future development and application of gamified tests and task engagement will also be discussed.

Category: Hearing Science / Psychoacoustics

Poster #: 163

Speech-in-Noise Assessment Depends on the "Noise"

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Objectives: Past studies report disparate effects of spatial separation on speech understanding in noise, especially when assessing adults with clinically normal hearing thresholds. We posited that variation in masker characteristics may help explain these differences. In particular, many speech-in-noise assessments use a multitalker speech babble masker to mimic real-world listening conditions. Yet, while speech babble is composed of intelligible speech sources, the composite babble is typically acoustically dense such that individual sentences and words are not intelligible. We hypothesized that individual talker maskers may better simulate the cognitive and acoustic competition experienced in everyday listening scenarios. If so, such maskers may be more appropriate for assessing real-world listening difficulties, particularly for adults with normal hearing thresholds who struggle to understand speech in social settings. Here, we compared the masking effects of broadband noise (a purely energetic masker), speech babble, and individual competing talkers on sentence recognition in young and older adults. Participants heard target sentences played concurrently with maskers that were either spatially separated or spatially coincident with the target, allowing us to determine the spatial release from masking (SRM) for each masker. We expected SRM to be greater for the individual-talker maker

than for other maskers, reflecting the importance of spatial features in combatting central interference of competing, intelligible maskers.

Design: Fifty-eight young (aged 18-30) and 51 older (aged 55+) adults with self-reported normal hearing performed an online matrix sentence identification task. Sentences were presented in either speech babble, broadband noise, or two other sentences from the matrix test spoken by talkers with different fundamental frequencies. Target sentences were always presented diotically. The two maskers in a trial were either presented diotically or symmetrically left and right of midline by applying interaural time differences of -300 and +300 microseconds, respectively. At the end of each trial, participants clicked boxes on a computer screen to indicate which words from the matrix they thought the target sentence contained. Scores were calculated as the percent of words correctly identified. SRM was defined as the difference in performance between the spatially separated and diotic conditions for each masker.

Results: As predicted, the competing talker masker produced both the lowest performance and the greatest SRM relative to the other maskers. Importantly, there were no significant differences in either overall performance or SRM between speech babble and broadband noise, suggesting that a speech babble masker produces the same kinds of perceptual interference as a purely energetic, noise masker and thus does not capture real-world challenges of listening in situations with multiple intelligible speech streams. In addition, despite previous studies showing reduced performance and SRM in older relative to young adults on speech-in-noise perception tasks, older adults achieved statistically similar scores and SRM as young adults on our task.

Conclusions: Compared to speech babble, individual competing talker maskers may better simulate the acoustic, linguistic, and semantic interference experienced in many real-world listening scenarios. Speech-in-noise recognition assessments in which the "noise" is one or more competing talkers may be most appropriate for evaluating listening difficulties in adults with normal hearing thresholds.

Category: Hearing Science / Psychoacoustics

Poster #: 164

Why Do Binaural Manipulations Reduce Spatial Release from Masking?

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Objectives: Spatial release from masking (SRM) refers to an advantage in detection or intelligibility of a target (typically speech) presented at a spatial location that differs from a competing sound (masker). The specific features that support SRM are not well understood, but include spatial acoustic cues (e.g. interaural time [ITD] and level [ILD] differences) and spatial selective attention. ITD and ILD make specific and different contributions to SRM in binaural detection tasks, but it is not known whether the same holds for speech-on-speech masking. Some recent studies attempted to investigate the role of ITD and ILD during SRM by comparing ITD and ILD alone and in combination. Results have been mixed, failing to identify individual contributions of ITD and ILD. Instead, some authors have hypothesized that SRM primarily reflects differences in perceived spatial location. In this study, we address that hypothesis directly, by measuring the perceived spatial location of speech stimuli presented with combinations of ITD and ILD as used in prior studies.

Design: Participants were young adult listeners with bilaterally symmetric normal hearing (< 20 dB HL, 250-8000 Hz). Stimuli were sentences from the coordinate-response-measure (CRM) corpus, which were processed by filtering with head-related transfer functions (HRTF) obtained from a binaural mannikin (KEMAR; MIT database). HRTFs for 0, ¬±45, ¬±90 degrees azimuth were used, and further processed in four conditions: ITD only, ILD only, consistent ITD+ILD, and opposing ITD/ILD. Processed stimuli were presented over earphones in a sound-attenuating booth. On each trial, the listener heard a single sentence processed by one of the HRTF conditions and indicated the perceived lateral position using a touch display. Responses were normalized relative to each listener's overall response range and used to calculate mean perceived location in each of the conditions. Mean locations were compared to SRM reported in previous studies using comparable stimuli.

Results: Across conditions, perceived location was most eccentric (farthest from midline) for sounds presented in the consistent ITD+ILD condition. Other conditions produced spatial percepts that were closer to the midline. The overall pattern of perceived location roughly matches the ordering of conditions by SRM magnitude reported previously.

Conclusions: Preliminary results appear consistent with the hypothesis under test: inconsistent mixtures of ITD and ILD produce spatial percepts that are not strongly lateralized. SRM studies typically presents targets at the midline, and maskers to the side. Manipulating the ITD and/or ILD of the masker thus results in reduced spatial separation between the target and masker, possibly impacting listeners' ability to direct attention to the target and successfully perform the task. [Supported by NIH R01-DC016643, T32-DC000013]

Category: Hearing Science / Psychoacoustics

Poster #: 165

Optimizing Both Speech Intelligibility and Environmental Sound Recognition

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Objectives: Environmental sounds can mask speech (when the signal-to-noise ratio is low), and vice versa (when the signal-to-noise ratio is high). There thus exists a tradeoff between speech intelligibility and environmental sound recognition. The objective of this study was to determine the optimal signal-to-noise ratio for jointly maximizing both speech intelligibility and environmental sound recognition for listeners with normal hearing and sensorineural hearing loss.

Design: Eleven adults with normal hearing (defined as pure-tone thresholds at 20 dB HL or lower at octave frequencies from 250 to 8000 Hz) and 10 adult hearing aid users with sensorineural hearing loss listened to sentences from the Hearing in Noise Test mixed with environmental sounds at various signal-to-noise ratios. In a dual-task paradigm, subjects were instructed to attend to both the speech and the environmental sound in each stimulus and then repeat the sentence and identify the background sound using a computer mouse. Percent-correct scores for each of these two tasks were calculated and used to generate a pair of overlapping, opposite-facing psychometric functions for each listener group. For each listener group, the optimal signal-to-noise ratio for jointly maximizing intelligibility and environmental sound recognition was calculated by finding the point of intersection between the two functions.

Results: For listeners with normal hearing, it was found that performance for both tasks exceeded 95% correct for any signal-to-noise ratio between 2.8 and 22.4 dB, with and optimal value of 12.2 dB. For listeners with hearing loss, any signal-to-noise ratio between 4.7 and 5.8 dB yielded performance of 95% correct or greater on both tasks. The optimal value of 5.1 dB, which is the point where the two psychometric functions for hearing-impaired listeners intersect, yielded a score of 95.6% correct performance on both tasks.

Conclusions: Many environmental sounds may be of interest to listeners or even relevant to their personal safety, such as approaching vehicles, alarms and alerts, horns and sirens, a knock on the door, etc. These data show that recognition of both speech and environmental sounds are possible at certain signal-to-noise ratios. Instead of aiming to strip all non-speech information from the acoustic signal, future speech-enhancement (noise-reduction) systems should target signal-to-noise ratios that allow for both high speech intelligibility and high environmental sound recognition.

HEARING TECHNOLOGY / AMPLIFICATION

Category: Hearing Technology / Amplification

Poster #: 166

Better, Worse, or Both Ears? What's the Best Hearing-Aid Fitting?

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Objectives: Evaluate associations of hearing-aid (HA) fitting laterality with i) long-term HA use persistence, and ii) short term HA use and HA satisfaction, accounting for hearing loss (HL) asymmetry and severity.

Design: We used longitudinal electronic health records data from the US Veterans Affairs healthcare system. The determinant of interest was HA fitting laterality, defined as bilateral fitting or unilateral fitting in the worse or better ear. Pure tone average (PTA; thresholds 0.5-4.0 kHz) was used to define HL asymmetry (≥10 dB between ears) and severity (normal: ≤25 dB; mild: 25-40 dB; moderate: >40-60 dB; severe: >60-80 dB; profound: >80 dB). We defined four regions of binaural HL configurations based on HL asymmetry and severity: 1) profound HL in the worse ear with normal hearing to severe HL in the better ear, 2) mild to severe HL in the worse ear with normal hearing in the better ear, 3) moderately asymmetric HL (better ear PTA>25 dB, worse ear PTA ≤80 dB), and 4) symmetric HL. Based on HL symmetry, region, and HA fitting laterality, five categories of HA fitting were defined, 1) bilateral, 2) unilateral better ear, 3) unilateral better ear in presence of a 'dead ear' (region 1 only), 4) unilateral worse ear, and 5) unilateral in presence of symmetrical hearing (region 4 only). Long-term HA use persistence was defined by a metric constructed from longitudinal battery reorder data. Short term HA use and HA satisfaction were determined by self-reported use >4 hours/day (question 1) and the total score on the International Outcome Inventory for Hearing Aids (IOI-HA), respectively. Multivariable-adjusted logistic (long-term HA persistence, n=249,719; short-term HA use,

n=65,028) or linear (HA satisfaction, n=65,028) regression models were fitted for each region, separately. Results are presented as odds ratios (OR) or regression coefficients (B).

Results: Most patients were categorized in region 4 (79.1%) and fewer were in regions 1 (3.1%), 2 (4.2%) and 3 (13.3%). Most patients were fit bilaterally (92.8%), while 2.0% were fit unilaterally in the presence of symmetrical hearing, 3.2% unilaterally in the worse ear, 1.6% unilaterally in the better ear, and 0.5% unilaterally in the presence of a dead ear. Unilateral fittings in the better (region 1: OR 0.89, $0.10>p>0.05$; region 2: OR 0.99, $p>0.05$; region 3: 0.89, $p<0.01$; region 4/symmetric HL: 0.59; $p<0.01$) and worse (region 2: OR 0.72; $p<0.01$; region 3; OR 0.64 $p<0.01$) ears were associated with reduced odds of long-term HA use persistence as compared to bilateral fittings. There was no evidence that laterality was associated with short-term HA use across different regions. Unilateral fittings in the better (region 1: B -0.72, $p<0.01$; region 2: B -0.65, $p>0.05$; region 3: B -0.70, $p<0.01$; region 4/symmetric HL: B -0.61; $p<0.01$) and worse (region 2: B -0.01; $p>0.05$; region 3: B -0.31 $0.10>p>0.05$) ears were associated with reduced HA satisfaction as compared to bilateral fittings.

Conclusions: Bilateral HA fittings yielded the best long- and short-term HA outcomes. If a unilateral fitting is preferred, it is likely preferable to fit the better ear.

Category: Hearing Technology / Amplification

Poster #: 167

On Quantifying Time-Frequency Variations in Minimal Contrast Word Sets for Hearing Aid Applications

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Bhaskar D. Rao, PhD, Distinguished Professor, Electrical and Computer Engineering, UC San Diego, CA
Harinath Garudadri, PhD, Systems engineering and real-time master hearing aids

Objectives: An important aspect of Over-the-Counter (OTC) Hearing Aid (HA) devices is enabling self-fitting of hearing aid devices without requiring experts' interventions. In the current best practices, audiologists use diagnostic tools such as Pure Tone Audiometry (PTA) and then generate HA programs prescriptive approaches such as NAL-NL2. Typically, the audiologist then optimizes the fitting for multiple environments. For the OTC HAs, the hearing-impaired person is expected to fit the HAs without the experts' support. This necessitates the need for the effective tuning of hearing aid parameters with minimum cognitive load using simple controls with user in loop feedback. In this work, we investigate the effect of hearing loss on the perception of "minimum contrast word sets," with the objective of enabling effective self-fitting of hearing aids. Understanding the variations in the time, frequency, and amplitude of such word sets is an important step that can provide a wealth of information regarding the nature of perception among normal and hearing-impaired subjects and inform potential strategies for OTC HAs.

Design: A database of 60 words spoken by a native English speaker is created. A pair of words selected from this database differ in their acoustical properties at a single position and are thus called minimal contrast word pairs. We propose a strategy to compute the "contrast vectors" for such word pairs which encodes the difference in these acoustical properties between the minimal contrast word pair. This difference dictates the

discernibility of the words when perceived by an individual. The contrast vectors are computed for each word pair by time aligning each word pair, computing the energy envelopes from sub-band signals extracted using an audio-metric filter bank, and then passing it through a contrast function. The contrast function outputs contrast vectors in each sub-band which is indicative of the time-frequency variations between a word pair.

Results: The computed contrast vectors indicate the frequency bands of maximal contrast given a pair of minimal contrast word pairs. The contrast vectors provide insight into aspects pertaining to the effect of temporal variations in frequency and amplitude on the discernibility of minimal contrast word sets. A database consisting of a contrast vector for every word pair combination from the dataset is generated.

Conclusions: The contrast vectors capture and encode the time-frequency variations of minimal contrast word sets. These contrast vectors represent areas of high contrast between minimal contrast word pairs and helps identify regions in a word where the contrast or difference between the two words must be maximized to increase the discernibility of the words when perceived by individuals with hearing loss. Thus the contrast function provides actionable information regarding the nature of hearing loss and serves as input to identify appropriate parameters of the hearing aid system to achieve better hearing aid fitting in OTC HAs.

Category: Hearing Technology / Amplification

Poster #: 168

Hearing Aid Use in Adolescents Who Are Hard of Hearing

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Objectives: The Outcomes of Children with Hearing Loss Consortium (OCHLCON) is a longitudinal, NIH-funded, multi-center study designed to explore service provision and developmental outcomes of children who are hard of hearing. The primary research question in the current study was to evaluate predictors of average hearing aid (HA) use time for adolescents with hearing loss between 12-18 years of age. Additional goals included examining correlations between parent report of HA use, adolescent self-report of HA use, and data logging.

Design: Sixty-nine parents and adolescents estimated the average amount of time HAs were worn during the week and weekend. We conducted a linear regression analysis to investigate the relationships among the independent predictor variables (chronological age, age at HA fitting, maternal education level, proximity of hearing aid fitting to prescriptive targets, and better-ear pure-tone average) and the dependent variable (average daily HA use).

Results: Greater HA use was associated with poorer hearing thresholds and higher maternal education level. To determine the correlations between different measures of hearing aid use, audiologists collected data logging information from the HAs and compared that to parents' and adolescents' estimates of daily usage. Parents' estimates and adolescents' self-report of HA use were highly correlated ($r = .83$, $p < .001$), as was data logging and parent report ($r = .66$, $p < .001$) and data logging and adolescent self-report ($r = 69$, $p < .001$).

Conclusions: Severity of hearing loss and socio-economic status account for variation in hearing aid use among adolescents who are hard of hearing, whereas chronological age, age at hearing aid fitting, and proximity of fitting to prescriptive targets do not. Parent report, adolescent self-report, and data logging are in high agreement, although both parents and teenagers tend to overestimate amount of daily hearing aid use.

Category: Hearing Technology / Amplification

Poster #: 169

Using Data Logging, EMA and Questionnaires to Predict Hearing-Aid Preference

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Objectives: The combination of data logging, Ecological Momentary Assessment (EMA) and retrospective hearing questionnaires like the Speech Spatial Qualities of Hearing Scale (SSQ) allow insights into real world hearing aid (HA) use and outcome that are unavailable from each alone. EMA responses provide information about real-life listening intent and immediate opinions about outcome. Data logging provides information about the acoustic environment at the time the EMA was completed and over the long term, and about patterns of user behaviours regarding use and HA adjustments. Retrospective questionnaires provide insights into perceptions about HA function over time. Each can play a role in understanding opinions about a HA. The aim of this work was to examine the role of all three (EMA, data logging and retrospective questionnaire responses) when selecting one of two HAs that differed in their implementation of noise reduction.

Design: Participants were 40 experienced HA users. Each wore two pairs of commercially-available HAs for 2-weeks each. HA1 used a traditional approach to noise reduction while HA2 used a deep neural network algorithm. Several times each day, participants completed an 8-item EMA survey that asked about their listening activity, perceived noise levels and listening satisfaction. In parallel, the HA logged data every 20 seconds that were stored on the participant's iPhone. Data collected included HA volume setting and on-time, and time-stamped ambient sound pressure levels and signal-to-noise ratios. Towards the end of each 2-week wear period, participants completed an SSQ. At the end of the study, participants completed the SSQ-Comparison and selected their preferred HA to keep.

Results: Of the 40 participants, 17 selected HA1, 23 selected HA2. When comparing mean scores for the two HAs averaged across all ratings, the EMA data correctly predicted the final preference of 25 participants, SSQ scores predicted the preference of 24. These populations were not fully overlapping. The preference of 6 participants was not predicted with either SSQ or EMA.We also investigated the strength of the discriminability of the SSQ and EMA data by assessing the marginal mean difference in ratings completed while wearing the preferred versus the non-preferred HA, computed from multi-level models. The SSQ model revealed a significant difference in ratings between HAs for individuals preferring HA1 only, while the EMA model revealed significant differences for both. The best discriminability was obtained when the EMA model also included the SPL and SNR associated to each EMA, and the active HA volume and trial day as random intercepts.

Conclusions: EMA data, SSQ scores and measures of the acoustic environment each contributed to predicting HA preference - albeit in a complex fashion. For some individuals, EMA data predicted choice, while for others it was SSQ scores. Further analyses using SSQ-C scores and metrics of the long-term acoustic environment (perhaps reflecting listening needs) will be conducted. Nonetheless, analyses so far highlight the complexity of predicting HA preferences, and that the repeated samples EMA approach is superior since the contribution of each rating to the overall preference is weighted by its context (SPL, SNR, time-of-day etc.).

Category: Hearing Technology / Amplification

Poster #: 170

How AI-Driven, Self-Guided Fitting Apps Improve the Hearing Aid Wearer Experience

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Objectives: Digital assistants that enable hearing aid wearers to make fine-tuning adjustments based on data aggregated from thousands of other anonymized wearers are becoming commercially available.Data presented in this poster, attempts to address this questions: Does an AI-driven, self-guided fitting app result in improved wearer hearing aid outcomes that are better than traditional "trial and error" adjustments conducted in the clinic?

Design: The study included real-world use-time data from more than 50,000 hearing aid wearers from around the world. The participants consented to share anonymous data on their use of the digital fine-tuning and adjustment assistant. The digital assistant used in this study was connected to the wearers' hearing aids using a smartphone-enabled application (app).Using a structured approach and a simple user interface, the digital assistant allowed wearers to report specific problems and then suggested an adjustment of the hearing aids that the wearer then could choose to keep (or reject) in their hearing aids. The data collected during use of the digital assistant provided the following results: 1.) which types of problems were reported by the wearer, 2.) which fine-tuning solutions were suggested by the AI-based system, and 3.) the wearers' reactions to the solutions provided by the digital assist.

Results: The overall acceptance rate of the solutions provided by the digital assistant was approximately 80%.There was some variation in the acceptance rate between the specific types of problems reported. There was a large variation in how frequently the different types of problems were reported, with some problems being commonly reported, and others being much more rarely reported. Data on the development of the acceptance rate over time showed that retraining of the AI-based system, using data gathered from all wearers of the system, resulted in an increase in the acceptance rate.

Conclusions: This study indicates an AI-driven digital assistant results in higher quality outcome, as the AI-based digital assistant, in most cases, was able to arrive at a hearing aid parameter adjustment that improved the performance for the individual wearer to such a degree that the wearer decided to keep the adjustment. Retraining the AI-based system further improved the acceptance of the solutions provided, showing the ability of the digital assistant performance to improve over time based on data gathered from all wearers in the system. The findings from the study show the potential of AI to assist the clinician in the hearing aid finetuning and adjustment process.

Category: Hearing Technology / Amplification

Poster #: 171

The Many Effects of Hearing Aid Delay in Open Fittings

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Objectives: Hearing aid delay refers to the fact that processing in the hearing aid takes time, causing the signal from the receiver to be delayed relative to the original signal. Such delays typically fall in the range between 0.5 and 8 msec, with most commercially available devices in the higher end of this range. For users with closed fittings, this is low enough to be unproblematic, not giving rise to a noticeable echo or mismatch. However, for users with open and vented fittings, both temporal and spectral artifacts arise when the direct sound coming through the vent mixes with the delayed sound from the hearing aid. The goal of this presentation is to describe the range of effects hearing aid delay has on the experience and performance of hearing aid users with open and vented fittings, synthesizing the results of several different avenues of research. These include sound quality judgments, discrimination tasks, tracking of neural response, and surveys of real-life hearing aid use.

Design: To understand which delay changes are audible, a discrimination experiment was conducted. This showed that, for normal-hearing listeners (n = 9), delays as low as 0.3 msec were audible; for listeners with hearing loss (n = 12), the discrimination threshold was around 0.6 msec for mild losses and around 1 msec for moderate losses.

Results: How delay affects sound quality preferences was investigated in two studies. One study (n = 21) conducted double-blind A-B comparisons in a range of real-life scenarios indoors and outdoors. This showed a significant preference for a delay of 0.5 ms compared to a longer delay. The second study (n = 33) used A-B comparisons in a lab and varied delay parametrically, showing a significant preference for the lowest delay of 0.5 ms for normal-hearing participants as well as for participants with hearing loss but good low-frequency thresholds. In addition to the directly audible effects, delay also has a range of other effects. EEG data (n = 16) showed better envelope following response (EFR) for a hearing aid with lower delay compared to two devices with longer delays, indicating a more robust neural representation of the speech signal. Additionally, a spatial discrimination task (n = 15) showed better discrimination of listening positions with lower delay. Finally, a real-life survey (n = 39) showed high satisfaction with lower-delay devices in noisy situations, in addition to high ratings of sound quality, own voice quality and spatial perception.

Conclusions: In sum, hearing aid delay affects a range of important aspects of the experience and performance of hearing aid users with open and vented fittings and should therefore be considered as a relevant parameter in deciding how to fit such users. An important aspect to explore further is which users are most affected by delay variations.

Category: Hearing Technology / Amplification

Poster #: 172

Influences of the Number of Background Talkers on Hearing-Aid Output-Signal-to-Noise-Ratios

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Objectives: Wide dynamic range compression (WDRC) and noise reduction (NR) algorithms are common hearing aid technologies for providing optimal listening conditions, and these technologies interact with a variety of factors that influence the output signal-to-noise ratio (SNR) for hearing aids. The current study aims to investigate the effects of temporal features of background noise (i.e., the number of background talkers) and amplification prescriptions, based on audiometric configurations, on SNR at the output of the hearing aid.

Design: Output SNRs were estimated by a phase-inversion technique for a commercially available hearing aid. The hearing aid was placed in the right ear of Knowles Electronics Manikin for Acoustic Research (KEMAR), facing a loudspeaker 1.6 m away in a sound-attenuating room. The test stimulus was a single set of sentences taken from the Connected Speech Test (CST) presented in two- or twenty-talker babble at input SNRs of -10, -5, 0, 5, and 10 dB. The hearing aid was programmed with four standard audiograms using the National Acoustic Laboratories for Nonlinear hearing aid fitting formula 2 (NAL-NL2), provided by the hearing-aid manufacturer's fitting software, and two compression speeds (Fast- and Slow-acting) for WDRC. Separate recordings of the hearing aid's output were made with the NR algorithm turned on and off. All other hearing aid technologies were turned off during recording.

Results: For the hearing aid with the NR algorithm off, the effect of temporal features of background noise on the output SNRs was clearly observed, with better output SNRs in temporally more fluctuating background noise (i.e., two-talker babble) than less fluctuating background noise (i.e., twenty-talker babble). The effect of amplification prescriptions, based on the four standard audiograms, on the output SNRs was only observed in twenty-talker babble at high input SNRs, with worse output SNRs for the standard audiogram with more severe hearing loss. When the NR algorithm was on, output SNRs were better for twenty-talker babble than two-talker babble at higher input SNRs and it was reversed at lower input SNRs. No effect of the amplification prescriptions was observed.

Conclusions: Temporal features of background noise impact the output SNRs and potential benefits from NR algorithms, which supports implementing signal-processing algorithms that can adapt to variations in the acoustic environment.

Category: Hearing Technology / Amplification

Poster #: 173

Exploring Factors Related to Loneliness in Hearing Aid Wearers

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Objectives: Previous research has shown that untreated hearing loss could lead to social isolation and potentially make the impacted individuals feel lonely, which increases the risk of issues like depression and dementia. Research is scarce on how hearing aid interventions influence sociability and loneliness of individuals with hearing loss. The purpose of this study was to explore how factors, such as personality, social isolation, physical and mental health, are related to loneliness in hearing aid wearers. We hypothesized that a lower degree of loneliness is associated with less social isolation, better mental health, and greater hearing aid satisfaction.

Design: This study was a survey study. Participants filled out five standard questionnaires, as well as some questions about demographics and hearing aid use. The questionnaires were the 36-Item Short Form Health Survey questionnaire (SF-36), Mini-Markers Big Five, the Friendship scale, the Social Network Index (SNI), and the UCLA Loneliness Scale. The participants were experienced hearing aid users recruited from Starkey's participant database. Survey invitations were sent to 129 emails via Qualtrics, and individuals who completed the surveys were paid $15.

Results: Sixty-five participants completed the survey. Their age range was from 25 to 90 years (Mean = 66.6, SD = 13.9). 83% of the participants reported wearing hearing aids > 9 hours per day. The UCLA Loneliness scale was used as the measure of loneliness. Higher scores indicate greater loneliness. The highest UCLA score from the participants is 24, which corresponds to a low degree of loneliness. Spearman correlations were used in this preliminary analysis. For both positive and negative correlation coefficients, a correlation of<0.4 is considered weak, 0.40-0.59 moderate, 0.60-0.79 strong, >0.80 very strong. The UCLA loneliness and Friendship scores were strongly correlated (rho = 0.66, $p<0.0001$), indicating that both measures were measuring similar constructs about loneliness. The UCLA loneliness scores and the Mental Component Summary (MCS) scores of SF-36 were also moderately correlated (rho = -0.48, $p<0.0001$), suggesting that wearers with better mental health feel less lonely. The UCLA Loneliness scores were weakly correlated to personality traits of neuroticism (rho = 0.38, $p=0.002$), conscientiousness (rho = -0.39, $p=0.001$), and agreeableness (rho = -0.31, $p=0.01$), suggesting that wearers who are less neurotic, more conscientious, and more agreeable, feel less lonely. UCLA loneliness scores were not significantly correlated to SNI, the Physical Component Summary (PCS) of SF-36, the personality traits of openness and extraversion, and hearing aid satisfaction.

Conclusions: Results from this study show that loneliness of hearing aid wearers is related to mental health and certain personality traits, but not social isolation and hearing aid satisfaction. These findings may be due to limitations of the present study that the participants were not lonely and mostly satisfied hearing aid users (62% of the participants were satisfied or very satisfied with their hearing aids). Future studies should include more participants with a wider range of degree of loneliness and hearing aid satisfaction. A comparison of the degree of loneliness before and after using hearing aids or certain hearing aid features also warrants investigation.

Category: Hearing Technology / Amplification

Poster #: 174

In-Lab and Real-World Perspectives on Advancements in Hearing Aid Technology

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Objectives: The primary aim of this project was to evaluate user benefit of a new hearing aid platform. In addition, a secondary aim was to gather qualitative data on listening effort and hearing aid satisfaction via daily retrospective surveys, as well as quantitative data on hearing handicap and aided speech intelligibility. Data from both aims will be presented in this poster.

Design: Fourteen subjects were recruited from the Aurora, IL area to participate in the study. The sample size was chosen based on an a priori power calculation for the primary aim. Subjects had moderate to moderately severe hearing loss, were current hearing aid users, and had a significant other (or other conversation partner) who was willing to complete a brief survey. Participants completed an in-lab speech intelligibility and listening effort task comparing a steered beamformer to a static beamformer when listening to speech from the side or the back. Participants received daily retrospective surveys via an ecological momentary assessment (EMA) app on their smartphone (or on a loaned phone, as necessary).

Results: In the lab, participants showed a significant improvement in overall listening effort with the steered beamformer, as well as a significant preference for the steered beamforming behavior over the static behavior. Additionally, a total of 163 daily in-field surveys were returned from the two-week home trial, giving a daily assessment of their listening effort in noisy environments and their satisfaction with their hearing instruments throughout the day. Surveys also captured open-ended feedback from participants (in written or voice-note format) to provide context for their categorical responses. A plurality of daily responses (31%) report not experiencing noisy environments at all during the day, with the remaining responses distributed mostly over the low end of the categorical scale. Participants were overwhelmingly satisfied with the instruments, with 90% of all daily surveys reporting satisfaction.

Conclusions: Results show that a steered beamformer offers benefits to listening effort and speech intelligibility in the lab environment, and EMA results overall show a high degree of satisfaction with hearing instruments using such a beamformer. A wide range of subjective listening effort experienced by participants during daily life were reported with a preponderance of participants indicating not experiencing noisy situations at all during the day. Results also show a high degree of satisfaction with hearing instruments, measured daily over a two week period.

Category: Hearing Technology / Amplification

Poster #: 175

Frequency Warping (Freping): A New Tool for Frequency Domain Manipulations

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Objectives: In this work, we present a novel use of an all-pass filter network to perform frequency warping, which we call "Freping", for frequency domain manipulations to improve hearing aids (HAs) outcomes. Freping is a nonlinear transformation which manipulates the frequency content of a signal. One application of Freping is feedback cancellation in hearing aids. Acoustic Feedback Control (AFC) continues to be a challenging problem

due to the emerging form factors in advanced hearing aids (HAs) and hearables. Applying Freping to the output of the hearing aid helps in breaking the Nyquist stability criterion and thus preventing the onset of feedback. In addition, Freping potentially allows for the expanding and compression of certain spectral components for psychophysical investigations beyond what is currently possible. The purpose of this study is to measure signal quality in the presence of feedback while using AFC and Freping, compare our work with commercial hearing aids, and determine the extent to which Freping is perceptible to a user. Freping is implemented on Open Speech Platform (OSP), which is an open source suite of hardware and software tools for hearing loss research.

Design: Real time Freping is a non-linear transformation which maps an input frequency to an output frequency according to an input-output curve. The effect of this transformation is that certain frequency intervals become wider, and certain intervals become narrower. The extent of warping is determined by a user controlled parameter. The non-linear nature of this transformation makes it possible to break the conditions of feedback onset, prevent howling, and improve the sound quality of hearing aids in the presence of feedback. This transformation also has the potential to expand or compress certain signal components for novel research into speech processing and psychoacoustics.

Results: Simulation results show that Freping integrated with Automatic Feedback Cancellation (AFC) offers quality improvement over basic and advanced AFC, as measured by the PESQ and HASQI quality indices: basic AFC (PESQ: 2.56 to 3.52 and HASQI: 0.65 to 0.78) at a gain setting of 20; and an advanced AFC (PESQ: 2.75 to 3.17 and HASQI: 0.66 to 0.73) for a gain of 30. We will build upon these results by performing feedback tests using the established verification tool Verifit by Audioscan. We will also compare the OSP hearing aid with Freping to commercial black-box hearing aids. Lastly, we will also conduct preliminary Just Noticeable Difference (JND) tests to determine the extent to which Freping is perceptible to a user.

Conclusions: Results thus far show that Freping, a method for transforming the spectral content of a signal, offers many novel benefits for hearing loss investigation and intervention. Freping can improve feedback cancellation and provide better audio quality in the presence of feedback, and potentially can expand or compress different signal spectral components. JND tests will determine the extent to which Freping is perceptible to a user.

Category: Hearing Technology / Amplification

Poster #: 176

Clinically-Relevant Acoustic Capabilities of Open-Source Platform for Hearing Aids Research

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Martin Hunt, BS, Nadi, LLC - Realtime master hearing aids and associated researcher apps
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Objectives: Hearing loss interventions research attempts to discover best practices for fitting hearing aids. This is sometimes stymied by the unknown nature of commercial hearing aids' proprietary signal processing. Open-source hearing aids validated in a rigorous and reproducible manner are necessary to advance hearing aid research. One such open-source hearing aid is the open-source speech processing platform (OSP). The OSP software enables researchers to adjust automatic feedback cancellation, multi-rate wide-dynamic range compression across eleven frequency bands, digital noise reduction, and spatial processing. While extensive

advances have been made with the OSP at the software level, validation with human subjects has been limited. To further clinical research using the OSP, it is necessary to ensure that the OSP is applicable to the clinical research population and can achieve current clinical best practice standards. The purpose of the present study is to validate the OSP device for providing adequate amplification across standard audiometric configurations using clinical measures of hearing aid fitting, including match-to validated prescriptive targets for audibility and Speech Intelligibility Index (SII) values.

Design: OSP fitting was completed on an acoustic manikin using a behind the ear, receiver in the canal coupled with ear domes. Audiometric configurations included the International Standards for Measuring Advanced Digital Hearing Aids standard audiograms (ISMADHA). Frequency-specific gains and compression ratios were adjusted according to real-ear measured output of the hearing aids to match validated prescriptive targets based on NAL-NL2. International Speech Test Signal, comprising brief segments from recordings of six female talkers across six international languages was used to assess the match-to targets at soft, average, and loud levels. Audibility was determined based on a comprehensive set of measures - a) Frequency-specific match to NAL-NL2 targets, b) Average root mean-squared error across frequencies, and c) Aided versus unaided SII. An additional measure included the real ear saturation response to a high-level tone sweep.

Results: Results to-date show that the OSP device can match NAL-NL2 targets within ¬±5 dB at frequencies of 0.25,0.5, 1, and 2 kHz and ¬±8 dB at 3 and 4 kHz, for relatively flat mild and moderate audiometric configurations. As expected, aided SII values increased by 21-25% across input levels, relative to unaided SII. Analyses will be provided for the full data set that will include audiometric configurations of greater severity and sloping losses.

Conclusions: Results thus far suggest that the OSP device can provide audibility according to clinical best practice standards for mild and moderate audiometric configurations. The research will establish the range of audiometric configurations that can be appropriately amplified by OSP. This work provides a baseline for future research that seeks to validate the OSP on adults with hearing loss. This research is supported by NIDCD R44DC020406.

Category: Hearing Technology / Amplification

Poster #: 177

Private Health Insurance Hearing Aid Coverage Mandates in the U.S.

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Objectives: (1) To describe the private health insurance hearing aid coverage policy landscape for pediatrics and adults in the U.S.; and (2) To quantify yearly averages of the share of youth (<18) and non-elderly adults (18-64) covered by a private insurance hearing aid mandate.

Design: Using guidelines based on policy surveillance methods, we conducted a longitudinal policy surveillance of state-level laws to compile a quantitative legal dataset of private insurance hearing aid coverage mandates.

Primary data sources were published statutes retrieved using the Westlaw Campus and Lexis Uni¬Æ legal search engines, and state legislature websites. Our hand-collected policy data was combined with individual-level age, insurance, state of residence, and year variables from 2008-2020 American Community Survey (ACS) data obtained from Integrated Public Use Microdata Series (IPUMS) USA. Privately insured individuals were considered covered by a mandate if they lived in a state with an effective mandate (including any statutory lags in effective coverage) and were within the eligibility age range of the mandate. For individuals surveyed the same year that a mandate came into effect in their state, a fraction was calculated based on the month that the policy went into effect to capture partial coverage for that year.

Results: Our policy surveillance resulted in identification of 27 states with effective private health insurance hearing aid mandates for youth, and 12 states with effective mandates for both youth and adults (total n = 39). Primary sources of coverage variability across states included maximum age eligibility (for non-elderly adults), total coverage reimbursement amount, and allowable frequency of benefit use. ACS/IPUMS national coverage trends revealed increases in hearing aid coverage from 5 to 22.5% for youth beneficiaries and .05 to 8% for non-elderly adult beneficiaries.

Conclusions: Variability exists across states with laws mandating private insurance hearing aid coverage. Despite evidence of increases following passage of state mandates, the overall proportion of privately covered individuals is low in both age groups. Future work will involve inclusion of state-specific public insurance (e.g., Medicaid) coverage for hearing aids, with the ultimate goal of preparing a longitudinal data set for public use to better understand the effects of policy on HHC access and use in the U.S.

Category: Hearing Technology / Amplification

Poster #: 178

Effect of Hearing Aid Orientation Discourse on Self-Efficacy and Comprehension

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Objectives: This study aimed to determine whether the manner in which a videoed clinician orients an individual to hearing aids (person-centered (PC) or clinician-centered (CC)) affects their self-efficacy and comprehension of the material. Furthermore, we were curious if such effects are moderated by the individual's health literacy.

Design: This study employed a between-subjects experimental design. The independent variable was video delivery method (PC, CC). The dependent variables were self-efficacy ratings (as measured by the Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids (MARS) and comprehension accuracy (as measured by a multiple-choice, comprehension questionnaire); health literacy (as measured by The New Vital Sign) served as moderator. One hundred adults with self-reported typical hearing, language, and cognitive skills were recruited via Prolific, an online recruiting tool, to participate.

Results: We are currently in the process of completing data collection. We predict that participants who view the video of an audiologist orienting the research participant in a PC manner will have comparatively higher self-efficacy ratings and comprehension accuracy scores than participants viewing a similar video of an audiologist orienting their patient to hearing aids in a CC manner. Furthermore, we predict that participants' health literacy levels will moderate this relationship.

Conclusions: Communication challenges between specialized clinicians and their patients can result in patients having low self-efficacy and weak understanding of health care and interventions. Ultimately such patient outcomes can have detrimental effects on individuals' overall health and wellbeing due to poor hearing aid compliance. We predict that our data will support the need for audiologists to communicate more effectively with their patients and in a patient-centered manner (e.g., use minimal jargon) that accommodates patients' health literacy levels as a means to improve patients' hearing aid self-efficacy and understanding.

Category: Hearing Technology / Amplification

Poster #: 179

Enhancing Audibility for Soft Speech in Pediatric Hearing Aid Users

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Andrea Dunn, AuD, PhD, Phonak, Aurora, IL

Objectives: The primary objective of this study was to evaluate whether soft speech recognition in quiet is significantly improved with a setting designed to boost gain for soft-level speech (low-level gain enhancer) in pediatric hearing aid users. The secondary objective was to evaluate comfort when presented with low-level transient noise in the different hearing aid conditions: low-level gain enhancer "off" versus "moderate" versus "strong".

Design: Twenty-one children, ages 9-12, and 13 children, ages 4-8, with moderate to severe sensorineural hearing loss were included in this single, cross-sectional group intervention study. All participants were consistent hearing aid users and native English speakers who were able to score greater than 30% on CNC words presented at 50 dB A in quiet. Participants were fit with research hearing aids matching their personal device form factor and fit to DSL v5.0 prescriptive targets. Output verified with real ear probe mic measurements for 55, 65, and 75 dB speech inputs and a high-level swept pure tone (i.e., maximum power output) as per standard clinical protocol. Participants repeated CNC words at 40 and 50 dB A presented in quiet from a single-speaker placed 1m away at 0 degrees azimuth. Participants were tested with and without the low-level gain enhancer. Study order was counter-balanced and randomized and participants were blinded to the test condition. Participants were also asked to provide subjective ratings of comfort by listening to a short story overlaid with looped, low-level transient noises (i.e. typing and HVAC) played without and with the low-level gain enhancer at two different settings, moderate and strong.

Results: Mean CNC scores were significantly better with the low-level gain enhancer on at the moderate level and the strong level compared to without the algorithm active. There were no significant differences in performance between the low-level gain enhancer "moderate" and "strong" settings. Comfort ratings were variable with no significant preferences for either setting (low-level gain enhancer off or on at moderate or strong levels).

Conclusions: The data collected in this study provide evidence that a low-level gain enhancer significantly improves speech perception performance in children for soft speech presented at 40 and 50 dBA presentation levels without significant decrements in comfort ratings. Use of a low-level gain enhancer may be considered for use in pediatric patients to improve audibility for soft speech.

Category: Hearing Technology / Amplification

Poster #: 180

Effects of Hearing Aid Use on Perceived Arousal and Valence in Emotional Speech

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Objectives: Older adults experience greater challenges with recognizing vocal emotions, and these challenges are exacerbated with hearing loss. Prior research has suggested that vocal emotion recognition does not improve with the use of hearing aids. However, it is likely that hearing aids influence perception of features of emotional speech, even if overall accuracy does not improve. The current study took a nuanced approach to vocal emotion perception with the use of a dimensional model of emotion. The study aimed to determine whether hearing aid use impacted perception of arousal and valence for unimodal and multimodal emotional stimuli.

Design: Nineteen older adults with mild-moderate hearing loss who regularly used hearing aids were presented with auditory-only, visual-only, and audiovisual dynamic emotional stimuli from the RAVDESS stimulus database. Participants were asked to rate the arousal and valence of each stimulus on a scale from 1 (low) to 9 (high). Each participant completed half of the study while wearing their hearing aids, and half of the study without their hearing aids.

Results: Participant ratings of arousal and valence were most distinct across emotions for the audiovisual and visual-only conditions, and rating patterns were similar overall for aided versus unaided conditions. However, for auditory-only presentations, arousal ratings obtained for low-arousal emotions (calm, neutral, sad) were lower when participants were aided compared to unaided. Similarly, valence ratings obtained for low-valence emotions (angry, sad) were lower when participants were aided compared to unaided.

Conclusions: When visual cues are available, hearing aid users experience similar perceptions of arousal and valence regardless of whether they are wearing their hearing aids or not. However, wearing hearing aids appears to enhance perception of low-arousal and low-valence emotions when visual cues are not available, suggesting that hearing aid use may improve some dimensional aspects of vocal emotion recognition.

PEDIATRIC AUDIOLOGY

Category: Pediatric Audiology

Poster #: 181

Masking Susceptibility in Children with Autism Spectrum Disorder

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Objectives: Individuals with autism spectrum disorder (ASD) often have difficulty communicating in complex auditory environments. However, the sources of these difficulties are not well understood. Research suggests that listeners with ASD have atypical auditory processing, often demonstrating difficulty processing spectrally and temporally complex sounds, as well as deficits in sound source segregation and selective attention, all potentially impacting speech recognition abilities. Behavioral studies examining speech recognition in children with ASD are limited, and those that exist almost exclusively focus on children over 10 years of age. The current study used a behavioral paradigm to examine how young children with ASD recognize words in the presence of competing sounds. We also examined whether children with ASD benefit from segregation cues intended to improve target speech recognition. We hypothesized that children with ASD would require a more favorable signal-to-noise ratio to recognize target words compared to their neurotypical peers. Children with ASD were also expected to differ in their ability to take advantage of the provided segregation cues.

Design: Participants were 8 children with ASD (ages 6.3-13.1 yrs; mean 9.0 yrs). Each child with ASD was age- and sex-matched with a neurotypical child. An adaptive four-alternative, forced-choice word identification task measured speech recognition thresholds (SRTs) in the presence of different competing maskers. Disyllabic target words were produced by an adult female. There were four masker conditions: (1) Speech-shaped noise, (2) Amplitude-modulated noise (3) Two-talker female, and (4) Two-talker male. Condition 1 evaluated speech recognition in the presence of a simple energetic masker, while Condition 2 examined the listener's ability to take advantage of temporal modulations. To assess informational masking, Condition 3 examined speech-in-speech recognition when the target/masker were the same sex (both female), while Condition 4 evaluated if recognition would improve when there was a target/masker sex mismatch (female target, male masker). To account for baseline differences between groups, vocabulary and nonverbal IQ were also assessed.

Results: Results suggest that children with ASD had similar susceptibility to masking as their neurotypical peers in the two conditions which produced the most energetic and informational masking. Differences were observed in conditions when segregation cues were provided. Unlike their neurotypical peers, children with ASD did not benefit from temporal modulations in the noise masker, regardless of age. In the speech masker, older children with ASD did benefit from the target/masker sex mismatch, but younger children did not.

Conclusions: These findings indicate that children with ASD struggle understanding speech in environments with competing sounds, similar to their neurotypical peers. When segregation cues were provided, performance did not always improve for children with ASD unlike their neurotypical peers. Our results suggest that communication difficulties experienced by children with ASD could be related to an inability to take advantage of temporal dips, consistent with previous research in older children and adults with ASD. This may be further complicated for younger children with ASD, who may be less likely to take advantage of talker voice differences in these contexts.

Category: Pediatric Audiology

Poster #: 182 **Mentored Student Research Poster Award**

Auditory Brainstem Responses are Symmetrical in Children with Autism

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Objectives: Asymmetric (left vs right hemisphere) processing of acoustic stimuli in the cortex is a quintessential process that is highly correlated to language measures in neurotypical individuals. Asymmetry is found throughout the entire auditory system, including the auditory brainstem and periphery. Reversed or reduced patterns of asymmetry are found in the cortex of individuals with autism spectrum disorder (ASD). However, it is uncertain whether auditory brainstem responses (ABR) in groups of autistic individuals are different than those from neurotypical control groups (CG). The purpose of the present study is to determine (1) if there is asymmetry in ABR latencies between right and left ear speech-evoked ABR (sABR) and click-evoked ABR (cABR) in school-aged children; (2) if asymmetries are significantly different in children with ASD from those in a CG and (3) if there is a relationship between the degree of asymmetry and verbal IQ.

Design: Sixteen autistic children and 26 non-autistic children aged 7-17 years underwent a routine audiological test battery and IQ assessment via the Wechsler Abbreviated Scale of Intelligence (Second Edition). Following the hearing evaluation, left and right ears were individually stimulated by a 63 dB nHL 100ÔÅ≠s click and a 40 ms synthetic /da/. The ABR was recorded ipsilaterally for right and left ear stimulation using a standard electrode montage. The peaks of the cABR waveforms (I, III, and V) and sABR waveforms (V, A, C, D, E, F, O) were visually chosen and interpeak latencies were calculated from absolute latencies. A series of paired t-tests were conducted for the absolute and interpeak latencies to determine if ABR latencies differed between ears within each group. Cross-correlations between ABRs recorded from the left and right ear electrode montages were performed for each participant's data. Mean lag times associated with the maximum correlation coefficient were compared between ASD and CG groups via t-test. A Spearman correlation was conducted to determine if there was a relationship between lag time and verbal IQ.

Results: Analysis included 13 ASD and 24 CG participants and 9 ASD and 22 CG participants for cABR and sABR, respectively. For the CG group, there was a significantly shorter wave O, interpeak A-O and longer wave III cABR latency in the right ear as compared to the left ear. There were no significant differences in cABR or sABR latencies between ears in the ASD group. Lag times were not different between the two groups. There was no relationship between cABR lag time and verbal IQ, but there was a significant, positive relationship between sABR lag time and verbal IQ.

Conclusions: Asymmetry is present at the level of the brainstem in neurotypical children but not those with ASD. Although there were no group differences in lag times between ASD and CG, greater asymmetry of sABR latency and verbal IQ was positively correlated, suggesting that the brainstem asymmetry of processing complex stimuli follows the trend noted in the cortex and supports the idea of a right-ear advantage in neurotypical children.

Category: Pediatric Audiology

Poster #: 183

Role of Natural Sleep MRI for Infants Identified with Congenital Single-Sided Deafness

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Objectives: The recent FDA approval of cochlear implantation (CI) for single-sided deafness (SSD) in children has catalyzed the need for earlier discussions about audiologic care options for infants diagnosed with SSD. With the high prevalence of cochlear nerve deficiency among children with congenital unilateral severe to

profound hearing loss, imaging offers critical information for counseling, audiologic management, and future treatment options, such as cochlear implant candidacy. Due to the medical risk of anesthesia in infants, otolaryngologists previously delayed magnetic resonance imaging (MRI) in the etiologic work-up of these patients. At the University of California San Francisco, our clinic implemented efforts for earlier MRI options, including natural sleep magnetic resonance imaging (NS-MRI). We present UCSF's care pathway of infants with congenital unilateral severe to profound sensorineural or neural hearing loss. The proposed protocol is described and supported by UCSF's own clinical dataset since 2019. At that time, UCSF clinicians hypothesized that obtaining imaging earlier in babies with SSD could differentiate CI candidates and non-candidates, thereby assisting with evaluation and treatment priorities.

Design: Our clinical pathway presents both audiologic and medical results, along with the respective decision-making pathways that led to diagnosis and intervention(s) at our center. Retrospective chart review was completed on all infants diagnosed with SSD via auditory brainstem response (ABR) testing at UCSF. Audiologic results and early MRI findings in conjunction with other factors were gathered to inform the proposed management options: potential CI candidate, poor CI candidate, and questionable CI candidate. Audiologic interventions were categorized by management group.

Results: Of 69 patients identified at UCSF with congenital unilateral sensorineural hearing loss/auditory neuropathy ICD-10 code after ABR, 36 of those patients were determined to have severe to profound hearing loss or abnormal ABR (cochlear microphonic without subsequent waves identified). 27 infants underwent MRI. NS-MRI was successful for diagnosis in 7 out of 14 individuals, and 6 out of 7 of those with a successful NS-ABR had cochlear nerve deficiency or cochlear nerve hypoplasia. 5 out of 7 who had an unsuccessful attempt with NS-ABR did not receive a sedated ABR, with some notes reporting hesitations with general anesthesia. 13 patients went directly to sedated MRI, and 2 patients had sedated MRI after NS-MRI. All 15 of those patients received a diagnosis of either cochlear nerve deficiency or cochlear nerve hypoplasia. Out of the 36 patients, 1 was categorized as a possible CI candidate, 21 were poor CI candidates, 14 were questionable CI candidates.

Conclusions: At present, audiologists and the medical team do not have standard guidelines for the etiology work-up for infants with congenital SSD. NS-ABRs offer a low-risk option to evaluate cochleae and cochlear nerve anatomy at an early age. Priorities for infants who are potential cochlear implant candidates vary from those who are considered poor candidates for cochlear implant. The majority of the infants in our study were considered poor CI candidates. Ultimately, clarifying the care pathway management of SSD infants helps mitigate medical risk and decreases family, medical team, and clinical burden.

Category: Pediatric Audiology

Poster #: 184

Increasing VRA Response Rates Using Filtered Environmental Sounds

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Objectives: In order to extend behavioral audiometry test time for young children or other difficult-to-test patients, we have developed a set of narrowband (i.e., one-half-octave wide) environmental sound stimuli that are potentially more engaging than tones. These stimuli have been shown to be valid and reliable in measuring

sound field auditory thresholds in listeners with normal hearing when tested with and without simulated hearing loss. The objective of this study was to determine the number of head turn responses that can be elicited by warble tones and narrowband environmental sounds at a single test frequency when visual response audiometry (VRA) is employed in toddlers. It was hypothesized that the availability of several narrowband environmental sounds per frequency would increase the number of head turn responses over that obtained with warble tones.

Design: Sixteen toddlers between the ages of 18 and 30 months were invited to participate in this study following a routine audiological exam that confirmed normal hearing. Participants were randomly assigned to a single test frequency (i.e., .5k, 1k, 2k, or 4kHz). They were conditioned to the visual response audiometry task with half being presented with a warble tone first and half with a narrowband environmental sound first. All stimuli were presented at 30 dB HL. Once the participant habituated to the first stimuli presented (i.e., either a warble tone or an environmental sound), a new environmental sound of the same frequency was introduced and additional head turn responses were counted. Individual environmental sound testing was terminated when no additional responses were obtained with the introduction of three consecutive new sounds. There were 8 narrowband environmental sounds available at each test frequency.

Results: To date, data is available for 15 participants, 7 who were tested with warble tones first and 8 who were tested with environmental sounds first. On average, when a single warble tone was the first stimulus, it produced 12 head turn responses prior to habituation. This compared to 15.5 responses when an environmental sound was presented first. The difference in maximum number of responses to the first stimulus presented was striking at 19 for warble tones and 41 for environmental sounds. When narrowband environmental sounds of the same frequency were introduced following habituation to the initial warble tone, participants on average produced an additional 15 head turn responses. Participants who were tested with environmental sounds first produced an average of 34 responses (averaged over the total number of environmental sounds they responded to), which is more than twice the number of head turns produced by a single warble tone alone. Two participants responded to all 8 available narrowband environmental sounds without meeting the criteria for cessation of testing. It is possible they would have responded more times had additional novel environmental sounds been available for trialing.

Conclusions: Use of narrowly filtered environmental sounds increases the number of VRA responses produced by toddlers at a single test frequency within a single test session.

Category: Pediatric Audiology

Poster #: 185 **Mentored Student Research Poster Award**

Transient-Evoked Otoacoustic Emissions in Children Born Preterm

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Objectives: Previous research from cross-sectional studies indicate that transient-evoked otoacoustic emissions (TEOAEs) change in amplitude from birth through early childhood. Data from our laboratory indicate TEOAEs in infants born preterm also change with development through 5 months of age. For this project, we have re-tested a sample of the same children who are now 5-6 years of age with the same auditory measures and equipment used when they were infants. The purpose of this poster is to (1) evaluate TEOAEs based on

tympanometric peak pressure (TPP) and wideband acoustic immittance (WAI) and (2) examine changes in TEOAE levels in children born preterm tested between 33 weeks gestational and 5-6 years of age.

Design: Thirty-one children who were tested four times from 33-64 weeks gestational age from the previous study participated in the current study. Behavioral thresholds were measured in both ears using standard audiometric procedures as well as TEOAEs, click-evoked ABR and tympanometry. The WAI and TEOAEs were measured at ambient pressure using the MIMOSA HearID system. The TEOAEs were evoked by tonebursts centered at 2000 Hz and 4000 Hz at a rate of 50/s with recordings including at least 200 averages. Stimuli were calibrated in the ear (spectral density = 65 dB SPL). 'Nonlinear' TEOAEs were filtered and analyzed in the ½-octave band centered at the toneburst frequencies and were considered present if SNR ≥ 6 dB. The TEOAEs were grouped based on whether the WAI for that ear had normal absorbance (A) and good impedance phase or abnormal A and/or poor impedance phase. An ear was considered normal if A was ≥ .69 at some frequency in the range of 1000-2500 Hz. Good phase was defined by average impedance phase between 500-1000 Hz< 0 cycles. Right/left ear differences in TEOAE and noise levels were analyzed as well as differences in TEOAE and noise levels based on normal and low A.

Results: All participants had behavioral thresholds ≤ 20 dB HL. Of the ten ears tested with TPP< -150 daPa, TEOAEs were present in six. For ears that had normal WAI, right-ear TEOAE levels evoked by 2000 Hz and 4000 Hz tonebursts were higher than left-ear TEOAE levels. Median noise levels for the right ear in the 2000 Hz band were higher than that from left ear. TEOAEs from ears having abnormal A and/or poor phase had lower TEOAE amplitudes than ears having normal A. TEOAE levels measured at 5-6 years of age for 4000 Hz were lower than those measured at 64 weeks gestational age, especially at 4000 Hz.

Conclusions: TEOAE levels were lower in ears with reduced A compared to those with normal A. Despite having lower levels, TEOAEs were present in the majority of children's ears despite negative TPP or reduced A. TEOAE levels in this group of infants measured from 33 to 64 weeks gestational age show similar developmental trends to the larger data set and indicate that TEOAE levels continue to decrease at older ages.

Category: Pediatric Audiology

Poster #: 186

Wideband Acoustic Immittance in Children Born Preterm

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Objectives: Wideband acoustic immittance (WAI) characteristics change with development in term neonates and children. Previous research in our laboratory indicates infants born preterm have similar development of WAI characteristics to published studies on term newborns. For this project, we have re-tested a sample of the same children who are now 5-6 years of age with the same auditory measures and equipment used when they were infants. This poster describes wideband absorbance, impedance magnitude and impedance phase in these children born preterm who are now 5-6 years. Specific goals include comparing (1) WAI in ears with and without normal tympanometric peak pressure, (2) WAI at 5-6 years of age to when the children were infants and (3) WAI to published literature.

Design: Thirty-one children who were tested four times from 33-64 weeks gestational age from the previous study participated in the current study. Behavioral thresholds were measured in both ears using standard audiometric procedures as well as transient-evoked otoacoustic emissions (TEOAEs), click-evoked auditory brainstem responses and tympanometry. The WAI was measured at ambient pressure using the MIMOSA HearID system. Chirps were presented at 70 dB SPL. A maximum of 235 stimuli were presented unless the stopping criteria of a SNR> 30 dB and a test time of at least 1 s was reached (maximum test time=10s). The audiologist was able to visualize absorbance, impedance magnitude and impedance phase when the test was complete. WAI was considered to have a good probe fit if impedance phase was close to -0.2 cycles for the lowest frequencies. Absorbance was averaged into various frequency bands. WAI was analyzed into one of two groups based on tympanometric peak pressure (TPP):<-150 daPa and ≥-150 daPa. T-tests were conducted to determine significant differences. Children's speech and language, as well as IQ and behavioral testing was measured in different laboratories.

Results: All children had hearing thresholds ≤20 dB HL. Children with negative TPP had lower levels of absorbance in mid-frequencies (1 kHz-3 kHz) compared to children with normal TPP. Impedance phase from 210-250 Hz was similar in children regardless of TPP, but children with negative TPP had steeper phase slopes around 0 cycles than children with normal TPP. Although averaged absorbance from 300 Hz-500 Hz decreased and 3000 Hz-6000 Hz increased in first three test sessions (33-52 weeks GA), there were no significant differences in these frequency bands between tests at 64 weeks gestational age and at 5-6 years of age. Data from the current study are similar to published studies, which do not state whether the participants were born preterm.

Conclusions: Although all children had 'normal' hearing thresholds by clinical norms, ears with negative TPP had decreased absorbance in mid-frequency bands as compared to ears with normal TPP. Negative TPP did not affect impedance phase for low-frequencies, however it did affect phase slope. Although published literature suggests developmental changes in absorbance throughout childhood, it did not change significantly in our participants, perhaps because of a small sample size.

Category: Pediatric Audiology

Poster #: 187

Hyperacusis in Toddlers and Young Children at Risk for ADHD

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Objectives: Sensory overload occurs when one or more senses becomes overstimulated and is more common in children with attention-deficit/hyperactivity disorder (ADHD) than typically developing (TD) children. Accordingly, there is an increased prevalence of hyperacusis in individuals with ADHD. Additionally, differences in auditory brainstem response (ABR) and acoustic reflex threshold testing between children with autism, which is similar in phenotype to ADHD, and TD children have long been established, but only recently has work begun to investigate hearing profiles in children with ADHD in isolation. Acoustic reflex threshold (ART) testing can provide insight on the central auditory dysfunction in the caudal brainstem. While there is little research connecting ARTs and ADHD, abnormal ARTs have been found in children with peripheral or low brainstem pathologies. The current study uses surveys, ARTs, and fNIRS data to identify sensitivity profiles of children with familial risks of ADHD compared to TD children. We hypothesize children at risk for

ADHD will show a higher prevalence of hyperacusis and significantly different ARTs compared to a control group.

Design: A total of 37 four- and five-year-olds participated in the study. Per parent report, 26 identified as familial risk children and 11 identified as TD. Parents filled out the SPM-2, parent-child hyperacusis survey, and an auditory sensitivity survey. Participants completed an audiological battery including otoscopy, tympanometry, and otoacoustic emissions to rule out hearing loss. ARTs were measured ipsilaterally and contralaterally at 500, 1000, and 2000 Hz. Functional near-infrared spectroscopy (fNIRS) was used to gather resting state data. We used a passive watching paradigm because it has been suggested that passively viewing a video is roughly analogous to rest in young children.

Results: Parents of 37 children completed the parent-child hyperacusis survey. 14 of the 26 children at risk reported hyperacusis or sensitivity to sound, while 4 of the TD children did. Parent-child hyperacusis survey results within our study had no significance (p= .064) between at-risk and TD participants. Additionally, differences in ipsilateral and contralateral ARTs were non-significant bilaterally. FNIRS neural data showed stronger connectivity within the right parietal cortex for children who classified as having hyperacusis. However, there was weaker connectivity between the right parietal cortex and the right frontal, temporal, and dorsal lateral frontal cortex. Additionally, there was weaker connectivity between the right temporal cortex and right frontal cortex.

Conclusions: There was no significant difference between groups for the parent-child hyperacusis survey. However, more children at risk for ADHD reported hyperacusis or sensitivity to sound. As of now, results indicate no differences in ARTs between at risk children and TD children. Additionally, the presence of hyperacusis correlates with stronger right parietal connectivity but weaker connectivity globally. Weaker global connectivity between attentional regions and the auditory cortex suggests disorganized and an inefficient attention system that is more broadly associated with auditory differences within this population. Further studies should include a larger sample size to look for significance.

SPEECH PERCEPTION

Category: Speech Perception

Poster #: 188

Comparison Between Perceived and Measured Speech Intelligibility

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Objectives: Measures that explain hearing aid wearers' satisfaction for their hearing aids would be useful in adjusting counseling or selecting appropriate technology to further enhance satisfaction. One such measure is a comparison between a person's subjective and objective speech intelligibility scores. While it has been demonstrated that there is a high correlation between subjective ratings of intelligibility and objective speech intelligibility on a group basis, some individual listeners under- or overestimate their speech understanding problems. The extent to which the listener misjudges his/her hearing ability would likely impact how satisfied they may be with interventions such as hearing aids. We developed materials that can be used to measure both the subjective and objective intelligibility performance. Normative data will be collected in elderly normal

hearing listeners. In addition, unaided and aided performance on elderly hearing-impaired listeners will be measured for comparison.

Design: 22 normal hearing and 15 hearing impaired older adult listeners were recruited. A set of sentences from Tracking of Noise Tolerance (TNT) test were selected for subjective and objective speech intelligibility measurements. The equivalency of the sentence intelligibility in noise was first tested in a group of 10 normal hearing participants. Based on the intelligibility data the sentences were rearranged into equivalent sets of similar difficulty. The PI functions for the objective and subjective speech intelligibility was assessed unaided and aided at 75 and 82 dB SPL speech levels. Normal hearing listeners were tested at -9 ,Ä¶ +3 dB SNR. Hearing impaired listeners were tested at individualized SNRs that ranged the objective speech intelligibility performance from 0 to 100%.

Results: For the normal hearing group there was a high degree of agreement between subjective and objective intelligibility scores across SNRs. The hearing-impaired group on the other hand had a larger proportion of listeners with elevated unaided subjective performance ratings compared to the objective performance. The use of amplification improved both subjective and objective performance and minimized the discrepancy between the subjective and objective speech understanding. However, the objective improvement was greater than subjective improvement.

Conclusions: Normal hearing listeners were accurate in estimating their speech performance. Compared to the normal-hearing group, the hearing-impaired listeners had more individuals who had higher subjective than objective intelligibility across SNRs. Such listeners may overestimate their speech performance and underestimate their need for amplification. Furthermore, the perceived performance improvement from amplification was on average smaller than the actual benefit. Identifying such listeners may help clinicians adjust counseling or selection of appropriate technology to enhance hearing aid satisfaction. The test materials developed in the current study may help identify such listeners.

Category: Speech Perception

Poster #: 189 **Mentored Student Research Poster Award**

Central Auditory Processing Testing in Native and Non-native English Speakers

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Objectives: The overall goal of this investigation was to determine if performance on speech and non-speech measures of central auditory processing (CAP) differs between native English (NE) and non-native English (NNE) speakers. A secondary goal was to develop a novel measure of perceptual English language proficiency and identify the extent to which this measure predicts performance on the CAP tests. Nearly 22 percent of the US population speaks a foreign language at home (Zeigler & Camarota, 2019). These NNE speakers are increasingly accessing audiology services and therefore it needs to be determined if the established CAP norms for NE speakers are appropriate for NNE speakers as well. It was predicted that NE listeners will perform better than NNE listeners on the speech-based CAP tests, but that performance will not differ significantly between the two groups on the non-speech tests. Additionally, it was hypothesized that NNE listeners with higher

English proficiency as assessed on the novel test would perform better than those with lower English proficiency.

Design: Participants were selected on the basis of age, hearing sensitivity, education level, and native language background. All participants were University of Maryland students, ages 18 to 35 years, with normal hearing. Thus far, we have tested 48 native speakers of English and 9 native speakers of Spanish whose second language is English. Participants completed a battery of CAP tests, including speech tests [i.e. time-compressed Quick Speech-in-Noise (QSIN), QSIN, Words in Noise (WIN), Dichotic Digits Test (DDT)] and non-speech tests [i.e., Gaps in Noise (GIN), Masking Level Difference (MLD), etc.]. In addition, English language proficiency was measured for the NNE listeners by quantifying the difference in their performance on the English and Spanish versions of the Oldenburg Sentence Test (OSLA) (Wagener & Kollmeier, 1999).

Results: Preliminary data analyses indicate that NE listeners performed significantly better than the NNE listeners on most, but not all, of the speech-based CAP tests. However, there were no significant differences between groups on non-speech CAP tests. Proficiency of the NNE listeners, as assessed on the OSLA English and Spanish tests, in relation to performance on the speech-based CAP tests will be discussed.

Conclusions: The results indicate that current English CAP test batteries, based on norms collected from native English listeners, need to be modified to adequately assess non-native English speakers for central auditory processing disorders. NNE listeners may appear to perform worse on speech-based CAP tests than their NE counterparts, in part because of less familiarity with the morphologic, lexical, semantic, and syntactic properties of the English language, and not because they have a CAP disorder. The results also support the use of a screening test for English language proficiency prior to administering the CAP battery, such as the OSLA measures described here, to account for reduced language proficiency that could influence test results.
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Category: Speech Perception

Poster #: 190 **Mentored Student Research Poster Award**

Cognitive Communication and Speech-in-Noise in Adults Following mTBI

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Objectives: The study aimed to examine the differences in perception of cognitive communication and speech-in-noise ability in young, middle-aged, and older adults with and without a history of mild traumatic brain injury (mTBI). A subset of individuals with mTBI report hearing-related difficulties, including difficulty hearing in background noise and in groups, understanding rapid speech, and remembering spoken information or instructions. It was hypothesized that individuals with a history of mTBI would 1) perceive greater difficulty with cognitive communication; and 2) perform more poorly during a speech-in-noise task than individuals without a history of mTBI.

Design: Two groups participated: 50 in a control group (42 female) ages 18-76 years (m=35.76) and 44 in a mTBI group (33 female) ages 19-70 years (m=36.64). Pure-tone hearing was normal for young adults (≤20 dB HL 250-8000 Hz), no more than a mild hearing loss for middle-aged adults (≤40 6000-8000 Hz), and no more

than a moderately-severe hearing loss for older adults (≤70 dB HL 6000-8000 Hz). Cognitive communication was measured using the Cognitive Difficulties Scale (CDS) and the LaTrobe Communication Questionnaire (LCQ). Hearing-related difficulty was measured using the Adult Auditory Processing Scale (AAPS) and the Hearing Handicap Inventory for Adult (HHIA). The Listening in Spatialized Noise- Sentences (LiSN-S) test was used to measure speech-in-noise ability and spatial release from masking.

Results: Preliminary analysis found that the main effect of mTBI and the interaction between age and mTBI status on the combined dependent variables (CDS, LCQ, and LiSN-S) were significant. The mTBI group exhibited significantly greater perceived difficulty in cognitive communication abilities than the control group. Significant differences in perceived cognitive communication and hearing difficulties were observed between the young and middle-aged groups, but not the older group, likely due to the current sample size of older adults. On average, the mTBI group demonstrated poorer speech-in-noise abilities than the control group, although this difference was not significant. The effect of age was significant for the LCQ and the LiSN-S, suggesting that perception of cognitive communication difficulties increases with age, whereas speech-in-noise ability and spatial release from masking decreases with age. There was a significant relationship ($r = .40$-$.71$) between hearing-related difficulty and cognitive communication, suggesting that participants with poorer speech-in-noise perceived greater cognitive communication difficulties.

Conclusions: Results from the present study suggest that individuals with a history of mTBI perceived diminished cognitive communication skills and performed more poorly on a speech-in-noise task when compared to controls. Further, when considering the effects of mTBI and age together, individuals with mTBI perceived poorer cognitive communication skills and performed more poorly on a speech-in-noise task than the effects accounted for by age alone. In addition, the results suggest a history of mTBI may negatively affect both perception of cognitive communication and hearing difficulty. Together, findings suggest mTBI status in combination with age could be an important contributor to how individuals seeking assessment perceive their hearing and cognitive status. Therefore, using subjective evaluations in this population may be a critical addition to the audiologic evaluation of individuals with mTBI.

Category: Speech Perception

Poster #: 191

Withdrawn

Category: Speech Perception

Poster #: 192 **Mentored Student Research Poster Award**

Would Closed Captions Help on Zoom When Videos are Active?

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Objectives: Recognizing speech during telecommunication, such as Zoom meetings or telehealth appointments, can be challenging in unfavorable listening conditions (e.g., presence of background noise, unstable internet connectivity). Text supplementation (e.g., subtitles or closed captions) or provision of facial cues can facilitate

speech recognition under some circumstances. However, our understanding of the combined benefit of text and facial cues in telecommunication is limited. The purpose of this study was to investigate the potential benefit of text supplementation for sentence recognition scores and subjective ratings of spoken speech with and without facial cues available.

Design: Twenty adult females (M= 24 years, range 21-29 years) with normal hearing performed a sentence recognition task and also completed a subjective rating questionnaire in 24 conditions. All participants were native English speakers who reported normal or corrected-to-normal vision. All passed a pure tone hearing screening at 25 dB HL from 250-8000 Hz in each ear. Participants were students completing graduate course work and had no history of speech, language, reading, or other cognitive difficulties. The testing conditions varied by integrity of the available facial cues (Clear facial cues, Slight distortion facial cues, Great distortion facial cues, No facial cues), signal-to-noise ratio (Quiet, +1 dB, -3 dB), and text availability (with text, without text). When present, the text was an 86-88% accurate transcription of the auditory signal presented at a 500 ms delay relative to the auditory signal. Analysis using linear mixed effects models was completed separately for speech recognition scores and each subjective rating. For each model, main effects were clarity of facial cues, signal-to-noise ratio, and text availability. Participant was a random intercept.

Results: The benefits of text supplementation were largest when facial cues were not available and when the signal-to-noise ratio was unfavorable. Although no recognition score benefit was present in quiet, recognition benefit was significant in all levels of background noise for all levels of facial cue integrity. Moreover, participant subjective ratings of text benefit were robust and present even in the absence of recognition benefit. Consistent with previous literature, facial cues were beneficial for sentence recognition scores in the most unfavorable signal-to-noise ratio, even when greatly distorted. Interestingly, although all levels of facial cues were beneficial for recognition scores, participants only rated significant benefit with clear facial cues.

Conclusions: The benefit of text for auditory-only and auditory-visual speech recognition is evident in recognition scores and subjective ratings; benefit is larger and more robust for subjective ratings than for recognition scores. Therefore, text supplementation might provide benefit that extends beyond behavioral speech recognition scores. Combined, these findings support the use of text supplementation in telecommunication, even when the talker's face is also available at the same time, such as during teleconferencing or watching television. Future work is warranted to evaluate if these benefits are observed for different populations (e.g., adults with hearing loss) and under different listening conditions (e.g., temporally misaligned audio, visual, and text cues).

Category: Speech Perception

Poster #: 193

Non-Native Speech-in-Noise Recognition by US Service Members

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Objectives: Approximately 20% of United States residents speak a language other than English in the home. In an increasingly multilingual society, individuals must be able to communicate with talkers who may not share their first language, and may speak with a non-native accent. Non-native accent is known to impact speech-in-noise intelligibility, and these effects may be exacerbated by listener factors such as age or hearing sensitivity. In this study, we examined speech recognition performance in a large cohort of listeners in order to describe these listener and stimulus-related effects on speech recognition performance.

Design: Over 1900 US Service Members volunteered to participate in the study, including over 100 self-identified non-native speakers of English. Each participant was tested with 16 closed-set Oldenburg Matrix Test sentences drawn from a corpus spoken by 60 different native and non-native English speakers from 13 different countries. The sentences were mixed in a 4-talker and speech-shaped noise. Each sentence was scored for number of keywords correctly identified, and response times were collected for each trial. Speech recognition outcomes were modeled to determine the influence of the following variables on performance: talker nativeness, listener nativeness, masker type, SNR, hearing sensitivity, and age.

Results: Preliminary analyses of this large dataset found significant effects of both talker and listener language: English speech produced by non-native English talkers was less intelligible than natively-produced English speech; listeners who speak English as a second language demonstrated poorer recognition of English speech than native English listeners. There was no compounding effect of listener and talker nativeness. Interestingly, the effects of talker and listener nativeness were dependent on masker type, with a multi-talker babble masker having a greater effect on speech recognition performance than a noise masker. Poorer pure-tone hearing sensitivity was associated with poorer performance, but there was no evidence of a super-additive degradation in performance when hearing impaired listeners listened to non-native speech. An examination of response times also revealed that non-native listeners required more time than native listeners to obtain the same number of correct keyword responses.

Conclusions: This large sample size in this study provided a unique opportunity to quantify the difficulties that might occur when individuals with different language backgrounds communicate in English in noisy environments. As expected, the data show that talker non-nativeness, listener non-nativeness, and listener hearing impairment all produce significant degradations in speech recognition in noise. However, the data do not suggest that there is a catastrophic drop-off in speech intelligibility in situations that combine two or more of these factors. Rather, non-native accent may involve an alteration of high-frequency cues that is redundant with the loss of high-frequency audibility caused by hearing loss. It is also notable that the effects of talker and listener nativeness were greater for babble maskers than noise maskers, suggesting informational masking may pose particular difficulties for tasks that involve non-native talkers and listeners. DISCLAIMER: The views expressed in this abstract are those of the author(s) and do not necessarily reflect the official policy of the Department of Defense or the U.S. Government

Category: Speech Perception

Poster #: 194

Temporal Fine Structure Encoding in Middle-Aged Adults: Preliminary Data

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Objectives: Difficulty understanding speech-in-noise (SIN) in the absence of overt hearing loss is a longstanding puzzle in auditory research and hearing health care. As standard clinical tests appear insensitive to identifying the issue, auditory processes not engaged in existing clinical batteries must be explored. It is known that the ability to separate speech from noise is dependent on the auditory system's coding of the signal's temporal fine structure (TFS). This study investigates the extent to which TFS encoding influences SIN understanding. We measure TFS encoding at the peripheral, central, and perceptual levels of the auditory system using auditory evoked potentials and psychoacoustic tasks. Data is collected in middle-aged adults to survey TFS encoding in the age group where SIN difficulties are first reported, and to limit confounds associated with aging, including reduced hearing sensitivity across standard audiometric frequencies and cognitive decline.

Design: Current data are from a subset of an ongoing study with a larger target sample size to achieve sufficient statistical power. The presented results represent preliminary findings and are reported as descriptive data. Once target sample size is met, comprehensive statistical analysis will occur. At the time of abstract deadline, 31 participants have been tested. Middle-aged adults (30-50 years of age) with thresholds ≤ 25dB across standard audiometric frequencies and a passed otoacoustic emissions screener participated in this study. Hearing thresholds at 10, 12.5, 14 and 16kHz were also collected. SIN perception was measured using the AzBio Sentence Lists in a co-located soundfield condition at multiple signal-to-noise ratios (SNRs). TFS encoding in the peripheral auditory system was evaluated using electrocochleography responses to slow (9.1/s) and fast (21.1/s) click rates. Percent change in the peak-to-trough amplitude of the compound action potential (cAP) - as a function of increasing click rates - was calculated, with larger percent reductions in the cAP amplitude suggesting poor TFS encoding. To measure central TFS encoding, the frequency following response to a 40-ms /da/ stimulus was collected and analyzed to compute the strength of response to the stimulus' fundamental frequency (F0), with smaller spectral magnitudes suggesting weaker phase-locking to the F0. Lastly, TFS encoding at the perceptual level was measured using a dichotic frequency modulation detection task, where higher FM thresholds suggest poor TFS encoding.

Results: Descriptive statistics on the data show a wide variation in extended high-frequency hearing thresholds across participants. AzBio performance systematically worsens with increased SNRs and shows higher variability in more difficult SNRs (0 and -3 dB). When comparing the top-half vs. bottom-half performers in the 0 dB SNR condition, we observe: slightly larger reduction of cAP amplitude, similar F0 spectral magnitudes, and poorer dichotic FM thresholds in the bottom-half performers.

Conclusions: The data provide a snapshot of an ongoing study investigating TFS encoding in middle-aged adults and its relation to SIN perception. By characterizing TFS at the peripheral, central, and perceptual levels of the auditory system, we can gather a more comprehensive picture of mechanisms and possible sites of dysfunction for individuals who report SIN difficulty despite having normal hearing thresholds.

Category: Speech Perception

Poster #: 195

Walking While Listening to Accented and Non-Accented Speech

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Objectives: Middle-aged adults (even those with clinically normal hearing sensitivity) often report that understanding accented speech is especially effortful. Dual-task studies have been used to quantify listening effort by determining the costs associated with listening while performing another task. The objective of the present project is to assess listening effort via quantifying costs involved in walking while listening to and remembering native-English and Spanish-accented speech.

Design: We will recruit 15 normally-hearing younger adults (18-25 years) and 15 middle-aged adults (40-60 years) via announcements in courses offering extra credit for research participation (younger adults) and via notices placed in online newsletters within the UMass community (middle-aged adults). They will complete a paradigm in which sentence recognition is measured while the participant is sitting, and while they are walking. Walking mechanics will be assessed using a motion capture camera. Participants will hear sentences presented via Bluetooth headphones and will be instructed to repeat back each sentence and then, at the end of a block of five sentences, recall the final word of each sentence. Stimuli will be IEEE sentences spoken by native English talkers (L1; the easy listening condition) or native-Spanish talkers (L2; the harder listening condition). All subjects will complete 3 sets of 5-sentence per condition. We will have four experimental conditions: Sitting L1, Sitting L2, Walking L1, and Walking L2.

Results: We predict that middle-aged adults will have increased costs in walking, speech understanding, and memory, compared to young adults. We also predict that dual-task costs will be larger in the difficult listening condition compared to the easy listening condition. Finally, we predict that the largest costs will be identified in the middle-aged adults in the more difficult listening condition.

Conclusions: Our results will contribute to what is known about how walking mechanics, speech understanding, and memory decline in the early stages of aging. Higher costs (in memory task performance and/or walking mechanics) associated with listening to accented (vs. non-accented) speech will be interpreted as an indication of increased listening effort. Moreover, results of this study will help determine the degree to which walking mechanics are compromised when individuals need to listen and remember what they hear as they walk. The importance of establishing these effects is highlighted by the high prevalence of falls in older age, and the potential dire consequences of falling. This work was supported by NIH grant #R01 DC 012057 .

Category: Speech Perception

Poster #: 196 **Mentored Student Research Poster Award**

Self-Reported Strategies Do Not Predict Degraded Speech Recognition

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Objectives: Individuals differ from one another in their ability to recognize speech, even in populations with normal hearing and cognitive ability. Individual differences in speech recognition accuracy are associated with individual differences in various facets of cognition, so it is possible that the mechanisms that explain variability in cognitive task performance would extend to speech recognition accuracy. One source of

variability in performance in specific cognitive tasks (e.g., working memory span and tests of nonverbal intelligence) is strategy use. To our knowledge, no study has examined strategy use in speech recognition. Thus, the first objective of the present study was to determine if individuals vary in their strategies used for degraded speech recognition. The second objective of the study was to examine the relationship between strategy use and speech recognition accuracy. It was predicted that individuals would vary in their use of self-reported strategies and that the use of strategies would be associated with higher degraded speech recognition accuracy and/or reduced self-reported listening effort.

Design: Forty-eight normal-hearing adults were recruited for the present study and completed experimental tasks through remote testing (n=24) or in-person testing (n=24). Using the PRESTO and PRESTO-FAE sentences, participants were asked to repeat sentences in five conditions: 1. Clear, unprocessed speech; 2. Time compression to 40% of original length; 3. 6 channel noise band vocoded; 4. Speech in two competing talkers at an average of 0 dB SNR; and 5. Foreign-accented speech in speech-shaped noise at +3 dB SNR. Following each listening condition, participants completed a strategy questionnaire and the NASA Task Load Index. The strategy questionnaire statements were created using knowledge of working memory strategies (e.g., repetition, imagery, and grouping), elements of speech understanding (e.g., indexical properties and context cues), and feedback from pilot participants and fellow researchers.

Results: Individuals varied from one another in their self-reported strategy use, with participants varying in their reported use of working memory strategies and of specific properties of speech. At a group level, strategy use was sensitive to the availability of speech cues across adverse conditions, with indexical properties being used less often in time compressed and vocoded speech than in the other conditions. Individuals also varied in speech recognition accuracy, with moderate to strong correlations across degraded conditions. Self-reported strategy use did not predict speech recognition accuracy or self-reported listening effort.

Conclusions: Our findings indicate that individuals vary in their use of strategies to understand degraded speech; however, use of strategy does not predict recognition accuracy or self-reported listening effort in this population. Differences in strategy use across adverse conditions indicate that listeners are aware of and attend to the acoustic cues that are informative in each condition, but this awareness does not seem to elicit the volitional use of strategies that are prevalent in cognitive tasks. However, it remains possible that such strategies would be employed and provide benefit in longer passages of speech or would have a greater impact on speech recognition in hearing impaired and older adult samples.

Category: Speech Perception

Poster #: 197

Recognition of Vowels Spoken by Korean Talkers: Two Speaking Styles

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Objectives: In adverse listening conditions, clear speech improves intelligibility by up to 20% but it is unknown whether the vowels in words contribute to this improvement. Vowels are the focus of this study because they differ across languages, opening up the question of whether the clear-speech advantage for non-native talkers is mediated by vowel clarity. Studies using native English talkers report better identification for vowels from b-vowel-t words spoken in a clear speaking style. Native Korean talkers speaking English show a clear-speech

advantage for words in sentences; the goal of the current study was to study the intelligibility of vowels extracted from words in sentences spoken by native Korean talkers speaking English to learn if they contribute to the clear-speech advantage. Numerous acoustic factors are associated with the clear-speech advantage, including a slower speaking rate, a high-frequency spectral emphasis, increased amplitude, changes in fundamental frequency, and an expansion of the formant frequencies in the vowel space.

Design: Three native Korean talkers spoke identical sentences in English in both clear and conversational styles. Vowels were extracted from target words in sentences using Praat. The 10 vowels extracted were: /æ/, /ɑ/, /ɔ/, /ɛ/, /ɪ/, /i/, /oʊ/, /ʊ/, /ʌ/, and /u/. Four tokens per vowel were selected in each speaking style per each talker. This yielded 240 vowels total for evaluation by participants.Twenty-five adult, native English speakers with self-identified normal hearing and familiarity with the International Phonetic Alphabet (IPA) participated in a vowel reidentification listening task. Listeners were presented with vowels extracted from sentences and played at conversational speech levels. After five practice trials, listeners judged the vowel by choosing one of ten vowel options in IPA on the screen. Listeners then rated their confidence on a 5-point scale.

Results: Recognition performance varied by vowel, and overall performance was better with vowels that existed in both English and Korean ($t = -10.9$, $p =<.00001$, two tailed). No clear speech benefit was found in vowels for English listeners in the overall mean data, suggesting the clear-speech benefit is vowel-specific. Mean performance of participants for clear speech ($M = .47$, $SD = .053$) and conversational speech ($M = .454$, $SD = .060$) only differed by 2% ($t = .099$, $p =.328$, two tailed).

Conclusions: The ability to create a clear speech benefit depends on the presence of the target vowels in a talker's native language. Talkers were able to produce a clear speech benefit in /i/ and /o/. Even in cases when a clear-speech advantage was not present, overall performance of listeners was better for vowels present in both English and Korean.

Category: Speech Perception

Poster #: 198

Positioning Strategies of Normal Hearing Adults in Simulated Listening Environments

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Objectives: Understanding speech in realistic backgrounds, such as a crowded restaurant, is a difficult perceptual task even for individuals with normal hearing. The physical position of the listener and target talker, relative to competing talkers, affects the signal-to-noise ratio and the availability of spatial cues to alleviate the effects of masking (i.e., spatial release). Listeners can optimize their speech understanding by using a variety of physical listening strategies, from subtle turns the head to moving the conversation to a quieter table. The objective of the current research is to begin investigating the use of these physical listening strategies among younger adults with normal hearing, and how these strategies influence speech recognition.

Design: Younger adults with normal hearing will be recruited from the student population at Towson University. Three simulated complex listening environments with different spatial configurations of competing talkers will be generated in virtual reality and rendered using the Oculus headset. Participants will choose their preferred listening position on a floorplan representation of the room and complete a sentence recognition task with competing talkers rendered spatially based on their chosen position. Listeners will be tested in their

preferred listening position, as well as other positions in each environment. Comparisons across listening positions (within participants) will evaluate the suitability of the Oculus headset for generating realistic simulated environments. Comparisons across participants in their preferred position will evaluate the extent to which these younger adults choose optimal listening positions in simulated complex listening environments.

Results: Percent correct keyword recognition will be reported across different positions within each environment. These data will be compared to expected patterns of results based on predicted differences in signal-to-noise ratio and access to spatial cues for each position. These results will determine the extent to which Oculus headset provides realistic acoustic input that approximates binaural cues available in the real-world. Analysis of individual performance in preferred listening positions compared to other positions will determine the extent to which listeners chose optimal positions in each environment and how their positioning strategy affects their speech recognition.

Conclusions: While the importance of signal-to-noise ratio and spatial cues for speech recognition has been demonstrated in the laboratory, a listener's ability to leverage these acoustic cues by manipulating their position in an environment has received less attention. From a clinical perspective, positioning strategies represent an important communication skill with the potential to improve speech-in-noise performance for a wide range of patients. This preliminary study will establish the suitability of the Oculus to generate realistic simulations of complex listening environments to study positioning strategies in a variety of populations. The extent to which younger listeners with normal hearing use optimal positioning strategies will inform future work evaluating how listening behaviors change with age and hearing loss. Future directions will be discussed, including analysis of more subtle positioning strategies (e.g., head turns, leaning forward), evaluation of visual cues and lipreading, addition of reverberation and other acoustic complexities, and the suitability of virtual reality for training clinical populations to use more effective physical listening behaviors in complex environments.

Category: Speech Perception

Poster #: 199

Auditory Difficulties in Normal-Hearing Young Adults with High Lifetime Noise Exposure

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Objectives: High noise levels that are typically encountered in occupational and recreational settings could induce cochlear synaptic dysfunction without causing a permanent elevation in hearing thresholds. Noise-induced synaptic dysfunction could cause suprathreshold speech perception difficulties in challenging listening conditions. The synaptic dysfunction could trigger abnormal hyperactivities in the auditory pathway associated with tinnitus and hyperacusis. This study evaluated the relationship between tinnitus, hyperacusis, suprathreshold speech perception difficulties, and lifetime noise exposure (LNE) in young adults with clinically normal audiograms.

Design: The study group comprised 150 normal-hearing young adults - 75 with chronic tinnitus and 75 without tinnitus. We used a structured LNE interview to categorize participants into low and high groups. Hearing thresholds (1-16 kHz) and questionnaire responses were evaluated. Suprathreshold perception was assessed with words-in-noise, QuickSIN, and dichotic digit tests.

Results: Individuals with high LNE reported speech perception difficulties and a higher incidence of chronic tinnitus and hyperacusis. Tinnitus and self-reported speech perception showed significant association. LNE and dichotic digit test scores showed a significant association.

Conclusions: Our results suggest that individuals with high LNE might exhibit a higher risk for suprathreshold speech perception difficulties, tinnitus, and hyperacusis, despite exhibiting normal audiograms.

TINNITUS

Category: Tinnitus

Poster #: 200

Tinnitus Severity and Work Functioning among U.S. Military Veterans

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Objectives: The objective of this study was to examine associations between tinnitus severity and self-reported work functioning in a generalizable, national sample of Veterans who use VA healthcare and were diagnosed with tinnitus, both with and without comorbid Traumatic Brain Injury.

Design: This study used a population-based survey to evaluate the relationship between tinnitus severity, measured using the Tinnitus Functional Index, and the impact of tinnitus on work, measured using questions from the Tinnitus History Questionnaire, among a stratified random sample of VA healthcare-using Veterans diagnosed with tinnitus, with and without comorbid Traumatic Brain Injury.

Results: Results indicated that for every 1-point increase in TFI score, there was an average 8% increase in the odds of reporting a high level of impact on work functioning (OR: 1.08; 95% CI: 1.06, 1.10) versus none or low impact on work functioning. Veterans with a comorbid Traumatic Brain Injury diagnosis, compared to those without, were more likely to have high tinnitus-related impact on work functioning (OR: 2.69, 95% CI: 1.85, 3.91), but the relationship between tinnitus severity and the impact of tinnitus on work functioning did not differ by Traumatic Brain Injury status.

Conclusions: These data can help researchers and clinicians understand complex symptoms experienced by Veterans with tinnitus, with and without Traumatic Brain Injury, supporting the improved provision of clinical services to these patients.

Category: Tinnitus

Poster #: 201 **T35 Research Trainee Poster**

Using Veteran Narratives to Improve Tinnitus Rehabilitation Services and Outcomes

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Objectives: Approximately 20% of individuals with chronic tinnitus find it impactful andbothersome enough to see a provider. However, there is considerable variation in the functionaland psychosocial impact, recommended treatments, and outcomes of those with chronictinnitus. Sleep difficulties, post-traumatic stress disorder, anxiety, depression, and hearing lossare common comorbidities associated with bothersome tinnitus. Furthermore, as of the fiscal year 2021, the Veterans' Health Administration has again reported tinnitus as the number one service-connected disability. By investigating Veteran experiences with bothersome tinnitus, weaim to increase patient and clinician knowledge about tinnitus symptoms and coping strategiesto improve tinnitus rehabilitation services and outcomes.

Design: Veterans with bothersome tinnitus were interviewed using a qualitative interview guide consistent with the Database of Individual Patients' Experiences (DIPEx) methodology. Administrative data were used to identify and recruit a diverse sample of 15 Veterans fromacross the country with bothersome tinnitus. The interview guide consisted of open-ended questions focused on Veterans' experiences with tinnitus in their daily lives and securing healthcare for it, as well as their levels of success using various coping strategies. A team ofresearchers, clinicians, and patients analyzed patient narratives using thematic analysis.

Results: Preliminary results describe the findings related to Veterans' lived experience withbothersome tinnitus, including topics such as impact on activities of daily living, self-management and coping strategies, and experiences with health care providers.

Conclusions: The utility of patient narratives extends across several domains, aiding inknowledge seeking and decision-making processes for individuals with tinnitus and their lovedones, building community, reducing stress, and providing support. Additionally, there isevidence that these stories can help bolster clinician education and empathy, which is crucialwhen navigating subjective disorders like bothersome tinnitus. By qualitatively investigatingVeteran experiences, it is our hope that we can gain knowledge of the functional andpsychosocial impacts of tinnitus and how those with bothersome tinnitus manage those impacts.

Category: Tinnitus

Poster #: 202

Hearing Loss, Race/Ethnicity, and Socioeconomic Factors for Tinnitus Prevalence, Frequency, and Related Healthcare Utilization

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Objectives: It is estimated that approximately 50 million United States adults have tinnitus. Previous literature indicates the prevalence of tinnitus may be impacted by factors such as hearing loss, hypertension, depression, anxiety, stress, and sleep; many of which are impacted by demographic factors. The present study evaluated how frequency and reported difficulty with tinnitus varied by degree of hearing loss, race and ethnicity, and socioeconomic status to identify potential tinnitus risk factors and to investigate whether these factors are associated with healthcare disparities.

Design: Cross sectional data from the 2017-20 National Health and Nutrition Examination Survey (NHANES)-a survey focusing on the prevalence and severity of a variety of health and nutrition measurements in a nationally representative sample of the American population-was pooled to assess the prevalence and factors associated with tinnitus. Data consisted of over 15,000 individuals who were asked to report on their tinnitus and other factors. About 15% (n=2,190) reported on their status of tinnitus, either having or not having experienced it. Four items from the hearing modules related to tinnitus were included in this analysis. The four items addressed whether they had experienced tinnitus in the past 12 months, how often they experience tinnitus, how much of a problem their tinnitus is in their daily life, and whether they have discussed their tinnitus with a healthcare professional. NHANES respondents also classify their race/ethnicity and annual family income in dollars during the last calendar years and their subjective hearing abilities. We examined the effects of race/ethnicity, income to poverty ratio, and subjective hearing ability on tinnitus variables. Weighted mean and frequencies of these tinnitus and demographic categories were computed.

Results: Only approximately 3% of the respondents in each hearing group between "excellent" and "a lot of trouble hearing" reported experiencing tinnitus over the past 12 months with no difference between hearing groups. Hearing group also did not impact the frequency of tinnitus nor how much of a problem tinnitus was for the respondents. Importantly, only about 50% of the respondents with tinnitus in each group reported ever talking to a healthcare professional about their tinnitus. There was no effect of race/ethnicity on the prevalence (~18% in each group) of reported tinnitus or the mean degree of problem respondents reported their tinnitus to have on their life. However, White respondents reported their tinnitus to be slightly more frequent on average than Hispanic respondents and more White respondents reported having talked to a healthcare professional about their tinnitus than Black and Hispanic respondents. Individuals with middle to high income to poverty ratio reported a higher average problem with their tinnitus and were more likely to talk to a healthcare professional about it than those with lower incomes.

Conclusions: Unlike in previous literature, the data showed no effect of hearing loss on any tinnitus variables. Importantly, only half of the individuals with tinnitus reported ever talking to a healthcare professional about it. The racial/ethnic and socioeconomic status results for tinnitus are consistent with previous literature on other hearing healthcare and general healthcare disparities.

VESTIBULAR

Category: Vestibular

Poster #: 203

Greater Hearing Impairment and Gait Parameter Stability in Older Adults

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Objectives: Hearing provides important spatial information for the neurocoordination of movement. Hearing loss predicts a greater risk of falls and slower gait speed, but associations with balance are conflicting, and emerging gait mat technology capable of capturing balance components within gait has not yet been applied to population-based samples of older adults with audiometry measures. We hypothesized that greater hearing loss among older adults is associated with gait parameters consistent with less stable gait, including poorer single-foot support balance and greater step-to-step inconsistency.

Design: We conducted a cross-temporal analysis of community-based older adults using data from the Atherosclerosis Risk in Communities Study. Participants with audiometry assessment at visit 6 (2016-17) and usual walking pace gait assessment at visit 8 (2020) were included. The primary exposure was better-ear 4-frequency pure tone average (BPTA), considered categorically (normal hearing,<25 decibels hearing level [dB HL] BPTA; mild hearing impairment, 25-40 dB HL BPTA; moderate/severe hearing impairment, 40+ dB HL BPTA) and continuously (per 10-dB HL increments). The primary outcomes were a measure of overall gait efficiency (walk ratio, with ratios below optimum 0.65 cm/step/min-1 indicating smaller, more frequent steps consistent with shuffling gait) and 3 gait stability parameters during single-support walking: single-support time (% of gait cycle on one foot), single-support Center of Pressure [COP] distance (body weight pressure movement in the direction of walking while on one foot), and single-support COP path efficiency (body weight pressure deviations perpendicular to direction of walking while on one foot) measured by Zeno Walkway,Ñ¢ Gait Mat. Secondary outcome was step-to-step variability in gait stability parameters. We tested associations with multivariable linear regressions adjusted for age, sex, race, education level, and BMI at visit 6.

Results: Of the 373 participants (mean (SD) age 78.4 (4.4) years; 19% Black, 55% female, 91% with > high school education), 27% had moderate/severe hearing impairment. Moderate/severe hearing impairment compared to normal hearing was associated with more frequent and smaller steps (-0.04 cm/step/min-1, 95% CI -0.06), less time in single-support (-1.06%, 95% CI -1.67 to -0.45), less COP movement in the direction of walking during single-support (-0.95 cm, 95% CI -1.56 to -0.35), and greater COP deviations perpendicular to direction of walking during single-support (-1.94% efficiency, 95% CI -3.29, -0.58), consistent with less forward body movement and greater lateral wobble during single-support walking. Each 10-dB increase in BPTA was associated with the same pattern of gait outcomes. All hearing categories (mild hearing impairment and moderate/severe hearing impairment) compared to normal hearing and BPTA (per 10-dB increase) were associated with greater step-to-step variability (coefficient of variability) in all gait stability parameters.

Conclusions: Moderate/severe hearing impairment was associated with gait parameters consistent with lower efficiency and greater gait instability. Greater step-to-step variability in stability gait parameters was broadly associated with poorer hearing across all exposure definitions. These results provide evidence connecting hearing with gait stability during movement, potentially suggesting a mechanism by which poor physical outcomes such as falls may arise from compromised single-support walking among older adults with hearing impairment.

Category: Vestibular

Poster #: 204

Enhanced Metrics for Identifying Aminoglycoside-Induced Vestibular Loss

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Objectives: There is no current gold standard for detection of aminoglycoside-induced vestibular loss. Existing traditional reflex-based vestibular tests, such as the video head impulse test (vHIT), can be difficult to perform and interpret. vHIT is often insensitive to subtle losses indicating normal findings, despite patient complaints of imbalance and quality of life deficits. Improved vestibular testing that identifies subtle aminoglycoside-induced vestibular loss would allow safer use of aminoglycosides, directly and immediately improving our ability to care for patients with difficult to treat infections. The aim of this pilot study is to compare evidence of vestibular loss using conventional and novel metrics in patients with cystic fibrosis (CF) and a history of balance complaints and aminoglycoside therapies.

Design: Preliminary data from five participants with CF (33-43 yr.; 4 females) exposed to intravenous aminoglycosides were enrolled. Conventional vestibular testing included video head impulse test (vHIT) assessment of horizontal canal function. Novel metrics included custom vestibular psychophysical (VPP) testing and balance assessment using central sensorimotor integration (CSMI) tests. VPP quantified a subject's ability to perceive and detect the direction of low-amplitude rotations about an earth-vertical yaw-axis. The rotation was a single-cycle 1-Hz raised-cosine stimulus velocity whose amplitude was adaptively adjusted on sequential trials following a Parameter Estimation by Sequential Test (PEST) paradigm of 100 trials performed in the dark. VPP test results were analyzed to estimate the vestibular threshold of motion detection. The CSMI test quantified sensory contributions, motor activation, and time delay properties of the balance control system based on body sway responses to 12 continuous 20-s duration, 2¬∞ (peak-to-peak) amplitude pseudorandom cycles of tilts of the stance surface and/or a visual surround. Two CSMI tests were performed: 1) surface-tilt with eyes closed (SS/EC) and 2) combined surface-tilt and visual-tilt with eyes open (SS+VS/EO). Both test conditions allow for the estimate of the vestibular contribution to standing balance.

Results: Four subjects had normal mean vHIT (Mean=0.95, SD=0.036) results except for the most symptomatic patient who showed reduced mean vHIT gain (0.66). In contrast to vHIT results, VPP findings showed elevated thresholds in four subjects (Mean=4.85 deg/s, SD=4.17; control subject mean=1.11 deg/s), and one within normal limits (0.92 deg/s). For CSMI, the vestibular contribution to balance for SS/EC and SS+VS/EO are 49% and 45% for controls, respectively. The mean values across the CF subjects were slightly less at 45% and 41%, respectively. However, the mean CF time delay of 174 ms was nearly 2 SD above the mean for controls (Mean+2SD=176 ms). The motor activation 'stiffness' factor tended to be lower than controls with the stiffness factor indicating the magnitude of corrective joint torque generated per unit of sensory-derived body sway. The combination of reduced vestibular contribution and reduced stiffness lead to subjects being particularly sensitive to balance disturbances.

Conclusions: Pilot data support the notion that VPP and CSMI methods can identify changes in motion detection and balance control that may be indicative of vestibular loss that is not identified using vHIT.

Category: Vestibular

Poster #: 205 **Mentored Student Research Poster Award**

Peripheral Vestibular Function in Patients with Chronic Moderate-Severe TBI

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Gary Jacobson, AuD, PhD; Richard Roberts, AuD, PhD; Daniel Romero, AuD, PhD, Vanderbilt University Medical Center, Nashville, TN

Objectives: Traumatic Brain Injury (TBI) is the leading cause of death and disability among young adults in the United States. Approximately 1.5 million people sustain a TBI each year, and 230,000 are hospitalized. A TBI diagnosis can range from mild to severe and may present with a wide variety of symptoms immediately after brain injury, with dizziness and imbalance among the most common. Although there is evidence to suggest the peripheral vestibular system is vulnerable to damage in patients with TBI, there are limited well-controlled prospective studies using audiology clinical methods to describe the type, frequency, and severity of vestibular impairment in TBI once patients enter the chronic phase (> 6 months). Vestibular evoked myogenic potentials (VEMPs) and video head impulse test (vHIT) are two objective methods to determine whether a peripheral vestibular impairment exists. Together, VEMPs and vHIT assess the function of the otolith organs and semicircular canals. We hypothesized that the TBI group would show decreased VEMP response rates and/or decreased peak-to-peak amplitudes relative to the group of neurotypical comparison participants. We also hypothesized that the TBI group would show reduced vHIT gain values and/or a greater number of corrective saccades relative to the neurotypical group.

Design: Adult participants (age 18-55) with moderate-severe TBI were matched pairwise to comparison participants on sex, age, and education. All participants with TBI were in the chronic stage of injury (time post injury > 6 months). Comparison participants had no history of hearing, vestibular, or neurological impairments. To measure otolith function, cervical and ocular VEMPs (cVEMPs and oVEMPs) were measured using an air-conducted 500 Hz tone burst presented at 125 dB pSPL. Response rates, latency, and peak-to-peak amplitudes were tabulated. VEMP responses were considered abnormal if no reproducible wave was present or if there was an amplitude asymmetry of 47% for cVEMPs or 33% for oVEMPs. vHIT was completed for the lateral semicircular canals. vHIT responses were considered abnormal if vestibulo-ocular reflex (VOR) gain was below 0.8 and/or corrective saccades were present.

Results: Preliminary results from 10 TBI participants suggest chronic moderate-severe TBI is associated with a greater degree of unilateral otolith impairment rather than semicircular canal impairment. Data collection is ongoing; however, based on available evidence, we expect this trend to continue and expect to observe statistically significant differences between the moderate-severe TBI and neurotypical comparison groups once our projected sample sizes of 30 TBI participants and 30 demographically-matched comparisons are reached.

Conclusions: We propose that peripheral vestibular impairment may represent a significant aspect of TBI, even after acute symptoms of dizziness and imbalance have subsided. This study will help to elucidate the frequency, location, and impact of vestibular impairment in patients with chronic moderate-severe TBI, which can lead to more appropriate triage, evidence-based decisions about test batteries, and comprehensive assessment and rehabilitation programs in TBI. Irrespective of final outcomes, this study fills important gaps in the vestibular literature concerning prospective studies focusing on moderate-severe TBI in the chronic phase, as most studies are retrospective and focus on mild TBI in the acute phase.

Category: Vestibular

Poster #: 206 **T35 Research Trainee Poster**

Traumatic Brain Injury and Dizziness: Associations and Mediating Factors

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Objectives: Associations between traumatic brain injury (TBI) and dizziness have been previously reported. It is well known that TBI is also associated with mental health (MH) conditions and sleep disturbances. However, the extent which MH conditions and sleep disturbances are associated with self-reported dizziness remains unknown. If present, these associations would suggest a mediated pathway between TBI and self-reported dizziness. Here, we examine these associations and evaluate potential mediators of the relationship between TBI and self-reported dizziness in post-9/11 Service members and Veterans.

Design: This study examined baseline data from the Noise Outcomes in Service members Epidemiology (NOISE) Study. Participants of the NOISE Study complete in-person audiometric evaluations and 14-18 surveys depending on their tinnitus and hearing status. The target population is post-9/11 Service members and Veterans recently separated from military service. Participants were recruited through the National Center of Rehabilitative Auditory Research in Portland, OR, and the Hearing Center of Excellence in San Antonio, TX. Our study sample included 424 Service members and 493 Veterans whose self-reported histories of TBI, post-traumatic stress disorder (PTSD), anxiety, depression, sleep disturbances, and dizziness were collected using survey instruments. Statistical analyses consisted of bi- and multivariable logistic regression models to estimate adjusted odds ratios and 95% confidence intervals for (1) TBI with PTSD, anxiety, depression, and sleep disturbances; and (2) PTSD, anxiety, depression, and sleep disturbances with self-reported dizziness. Results were stratified by Service member and Veteran status. Based on an a priori causal model, regression models were adjusted for probable confounders.

Results: The overall prevalence of dizziness was 23% in Service members and 30% in Veterans. Compared to Service members and Veterans without a history of TBI, those with a history of TBI had 2-3 times higher odds of self-reported MH conditions. Service members with a history of TBI had twice the odds of self-reported sleep disturbances compared to those without. Compared to Service members and Veterans without MH conditions, those with self-reported MH conditions had 3 times the odds of dizziness. Service members and Veterans with sleep disturbances had twice the odds of dizziness compared to those without.

Conclusions: This study corroborates previously observed associations between history of TBI and MH conditions (PTSD, anxiety, depression) and history of TBI and sleep disturbances. In addition, while controlling for important potential confounds, we found that a greater proportion of Service members and Veterans had self-reported dizziness among those who also had self-reported MH conditions and sleep disturbances (versus those without these conditions). These findings suggest that MH and/or sleep disturbances likely mediate some of the observed association between TBI and dizziness in Service members and Veterans. TBI-related dizziness may be related to peripheral (auditory and vestibular systems) and/or central (neurological) dysfunction. Additionally, possible mediators include psychological and physiological disruptions. Due to the complexities of TBI, our findings suggest an interprofessional approach may be warranted for assessment and treatment of self-reported dizziness in Service members and Veterans. Future research should examine if treatment of potential mediating factors (e.g., PTSD) can help mitigate self-reported dizziness in this population.