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PODIUM ABSTRACTS

PODIUM SESSION I: OTOTOXICITY/NOISE/INFECTION

Provider Perspectives on Ototoxicity Management Practices in Non-Tuberculosis Mycobacterium Centers

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Objectives: Non-tuberculosis mycobacteria (NTM) comprise a group of bacteria that can cause serious pulmonary infections. Medical management frequently includes treatment with intravenous (IV) or inhaled amikacin and oral macrolides which both carry the risk of ototoxicity. While there are general guidelines for ototoxicity monitoring of persons receiving aminoglycosides, there is no clear guidance specific to persons with NTM who are on chronic or repeated treatment regimens with these potentially ototoxic drugs. Discussions within a multidisciplinary International Ototoxicity Management Group (IOMG) Aminoglycoside Focus Group revealed a variety of practice patterns across NTM providers. This study was designed to assess ototoxicity management practices in NTM centers and clinics in order to evaluate current practice strategies and identify provider education needs.

Design: An information-seeking electronic Qualtrics survey was developed to assess current ototoxicity management practices as well as barriers to program adoption and sustainability in NTM clinical practice settings. The 35-question survey was distributed via flyer with QR code to attendees at the NTM Research Consortium Meeting (2024) and subsequently distributed via email to the NTM Care Network, the Cystic Fibrosis Foundation Care Center Network and members of the IOMG.

Results: Ninety-one respondents from at least 51 centers and 4 countries completed the survey. Respondents consisted of managing physicians including pulmonologists (n=50) and infectious disease specialists (n=20) and other healthcare providers involved in NTM care (nurses, physician assistants, pharmacists and audiologists). Sixty-three of the 91 respondents reported being in clinical practice for >10 years, and all indicated they were involved in clinical management of patients with NTM. Most respondents (51%) treated more than 50 NTM patients per year using antimicrobials; 20% managed 20 to 50 patients annually, while the remaining 29% saw fewer than 20 patients each year. The primary patient population reported was adults.Most (80%) indicated that ototoxicity management was typically initiated by the physician. Variation in referral patterns depends on route of drug administration, with 65% indicating that they always monitor for ototoxicity for patients treated with IV aminoglycosides, while only 39% routinely monitor for inhaled aminoglycosides. There was a significant variation in patterns of ototoxicity management for oral macrolides compared to aminoglycoside therapies. Monitoring frequency ranged from "as needed" to 6 months post-treatment. Fewer than 15% of the respondents felt very confident in their ability to manage ototoxicity in the NTM population. Respondents cited clinical guidelines (76%), greater access to (51%) or inclusion of audiologists on their care team (36%), and workshops and seminars (34%) as factors that could improve management.

Conclusions: In this cohort of NTM specialists, we identified substantial variability in ototoxicity monitoring, diagnosis, and management practices. Assessing these patterns and understanding barriers through the perspective of NTM care team members provides evidence to support development of guidelines and standardization of ototoxicity management practices in the context of NTM. This is crucial for the timely prevention, identification, and management of ototoxicity-related deficits. We plan to extend data collection to a larger pool of clinical care providers, including audiologists, and initiate development of NTM specific ototoxicity management guidelines.

Impact of Sepsis and Gentamicin Exposure on Auditory Function in Preterms

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Objectives: Preterm infants in neonatal intensive care units (NICUs) are at higher risk of sensorineural hearing loss than full-term infants, partly due to the use of ototoxic medications like gentamicin for treating sepsis. However, the combined impact of gentamicin exposure during sepsis on hearing remains unclear. Neonatal auditory screening restricted to 4kHz fails to identify high-frequency hearing loss (> 8 kHz) indicative of ototoxic damage. We tested whether cumulative intravenous gentamicin dosing during sepsis increases sensorineural hearing loss in preterm infants.

Design: This prospective, longitudinal cohort study enrolled 320 preterm infants from three sites. Audiologic testing occurred close to NICU discharge (screening visit) and again at ~3 months corrected age. Screening included wideband absorbance tympanometry (WBA), distortion product otoacoustic emissions (DPOAEs, 4-10 kHz), and follow-up included WBA, DPOAEs, and tone-burst auditory brainstem responses (tbABRs, 1-8 kHz). Clinical data were abstracted from electronic medical records. The primary exposure was a four-level categorical variable based on gentamicin dosing (< or ≥3 continuous days) with or without suspected sepsis. Secondary exposures included days of cumulative gentamicin exposure. Gestational and corrected age were compared between groups using Kruskal-Wallis with Dunn post-tests. Associations between exposures and auditory outcomes were evaluated using mixed-effects models adjusted for corrected age and frequency with nested random intercepts for site, subject, and in DPOAE models with repeated measures, ear.

Results: Of 320 enrolled participants, 230 had follow-up. Among the 309 who had usable data, 19 received ≥3 days of gentamicin-11 with suspected sepsis and 8 without. Gestational age at birth was significantly lower and corrected age at screening significantly higher in groups with sepsis compared to those with no sepsis and<3d gentamicin (reference group). In all adjusted models, corrected age was significantly associated with better hearing with higher DPOAE signal-to-noise ratio (SNR) estimates and levels, and lower tbABR thresholds and latencies with each increase of one week in corrected age. In adjusted DPOAE SNR and level models, only the no-sepsis, ≥3d gentamicin group had significantly poorer results than the reference group. For tbABRs, no groups significantly differed from the reference group. Secondary DPOAE models showed that after additionally adjusting for WBA, effects were attenuated but

still significant for the no sepsis, ≥3 days gentamicin group. Cumulative gentamicin exposure was associated with significantly lower DPOAE level.

Conclusions: Our findings suggest that even short courses of gentamicin in the NICU have detectable impacts on auditory function. Although these changes were modest and did not translate to clinical differences in tbABR measures, they highlight the vulnerability of the developing auditory system to gentamicin toxicity. Increased corrected age is associated with improved hearing measures and was higher in sepsis groups. Small exposure group sample sizes might have limited model accuracy in controlling for this confounder. Further longitudinal studies with larger sample sizes and genetic profiling are needed to determine whether early DPOAE differences persist, progress, or predict later auditory deficits. Clinicians should continue to exercise caution in prescribing aminoglycosides, balancing their lifesaving benefits with potential risks to sensory development.

ECHO: A Data Resource for Cancer, Hearing, and Outcomes Research

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Objectives: Cisplatin is a highly effective chemotherapy agent, but it causes permanent hearing loss in up to half of treated patients. However, ototoxicity monitoring is rarely implemented in practice. This lack of baseline and follow-up audiograms has hindered characterization of cisplatin-induced hearing loss in adults. To address this gap, we established the ECHO (Enhancing Cancer Hearing Outcomes) dataset, a multi-institutional resource designed to capture high-quality audiologic and oncologic data to study cisplatin ototoxicity and protective factors.

Design: We partnered with eight U.S. cancer centers to harmonize and aggregate de-identified audiograms and treatment records from cisplatin-treated adult patients. Pre- and post-cisplatin audiometric thresholds were collected alongside clinical variables including cumulative cisplatin dose, dosing schedule, cancer type, sex, age, and concurrent medications. The harmonized dataset currently includes 1,053 unique patients (74% male; median age 58 years, IQR 49–65) contributing 2,452 audiograms. Cumulative cisplatin exposure ranges 50–750 mg/m^2. Cancer types were predominantly head and neck (81%), with additional cases from lung, bladder, liver, kidney, and gynecologic cancers. To date we have received data contributions from two additional centers, which are currently undergoing data harmonization and integration. This approach enables standardized alignment of audiologic and oncologic variables across institutions, ensuring robust interoperability and expanding the utility of the ECHO dataset for future analyses. We used the ECHO resource to examine the relationship between cisplatin dosing regimen and ototoxicity in patients with head and neck cancer.

Results: This large real-world dataset enables detailed analysis of cisplatin ototoxicity. Dosing protocol significantly influenced hearing outcomes: patients on tri-weekly cisplatin had more severe high-frequency hearing loss than those on weekly dosing, confirming greater ototoxic risk with higher individual dose administration protocols. Additionally, patients taking statins during chemotherapy experienced markedly less hearing loss: concurrent atorvastatin use was associated with an approximately three-fold lower incidence of significant post-cisplatin hearing loss (~10% of patients

affected vs 29% without statin). This retrospective finding directly informed a Phase II clinical trial now underway to evaluate atorvastatin as an otoprotective intervention. The large sample size also permits stratified analyses by age, sex, cumulative dose, and statin type – analyses that were previously underpowered in single-center studies.

Conclusions: The ECHO dataset is a unique multi-center audiometric data resource that fills a critical gap in cisplatin ototoxicity research. This resource (encompassing data from over 1,000 patients) has already validated known risk factors and predicted new protective factors for cisplatin-induced hearing loss. It clearly demonstrates the power of data sharing in bridging laboratory findings with clinical practice. These insights have direct implications for oncology and otolaryngology – from guiding safer chemotherapy protocols to informing hearing conservation strategies and novel otoprotective trials. ECHO continues to expand via new partnerships and is available upon request as a community resource to drive discovery and improve quality of life for cancer survivors.

Disentangling Noise Exposure, TTS Symptoms, Hearing Thresholds and Hearing Difficulties

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Objectives: Temporary threshold shifts are known to produce permanent threshold shifts that cause increased hearing difficulties. However, recent results show that individuals who report frequent hearing changes after noise exposure can experience chronic hearing difficulties in the absence of permanent threshold shifts. This suggest that temporary threshold shifts have two pathways for producing hearing damage: the "traditional" pathway, where the temporary shifts result in permanent changes in hearing threshold that interfere with auditory perception, and a "direct" pathway, where the temporary shifts result in hearing damage that impairs auditory processing but does not result in a change in hearing thresholds. The goal of this study was to use path analysis to characterize the direct and indirect pathways between noise and blast exposure, hearing threshold shifts, and hearing difficulties in a large cadre of US Service Members (SMs).

Design: The analysis used hearing threshold pure tone average (PTA) and questionnaire data collected on 6,419 SMs as part of their annual hearing conservation tests. The questionnaire data included information on noise and blast exposure as well as a Temporary Threshold Shift (TTS) question that asked the frequency of temporary hearing symptoms (dull or muffled hearing) after noise exposure and an the 40-point hearing subscale of the Tinnitus and Hearing Survey (THS-H40). A path analysis was conducted on a model that assumed that TTS symptom frequency was influenced by age, noise exposure, and blast exposure, the pure tone average was influenced by age, noise exposure, blast exposure, and the TTS symptom frequency, and that hearing difficulties were influenced by all of these factors including pure tone average. The individual contribution of each factor to hearing difficulties on THS-H was also examined by calculating the change in R2 between the full model and the model without each factor via direct matrix calculations of the reduced model (Hayes, 2020). Bootstrapped confidence intervals were generated to determine whether the change in R2 for each factor was significantly different than 0.

Results: The results generally show that noise and blast exposure history influence TTS symptom history, and that TTS frequency plays a dominant role both in determining PTA and in determining overall hearing difficulties. The direct path from TTS symptom frequency to hearing difficulties (standardized b = 0.33, $p<<0.001$) was stronger than the pathway from PTA to hearing difficulties (standardized b = 0.23,

p< 0.001), even after accounting for the component of TTS that indirectly influenced hearing difficulties through increased hearing thresholds. Change in R2 analyses demonstrated the same pattern. TTS Frequency accounted for 9% (95% CI: 7%-10%) of the variance in THS-H scores, while PTA accounted for 5% (95% CI: 3% - 6%). Blast exposure had a limited direct effect on THS-H scores (standardized b = 0.06, p< 0.001), but contributed to the model primarily through its contribution to increased TTS symptom frequency (standardized b = 0.22, p< 0.001).

Conclusions: The results provide additional evidence of the important role that TTS symptoms play in determining the long-term risk of hearing damage in noise-exposed individuals. Disclaimer: The views expressed in this abstract are those of the authors and do not necessarily reflect the official policy of the Department of Defense or the U.S. Government.

Risk Factors for Cochlear Synaptopathy: Aging, Noise Exposure and Ototoxicity

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Objectives: Cochlear synaptopathy (CS), defined as the degeneration of synapses between inner hair cells and auditory nerve fibers, is considered a key mechanism contributing to hidden hearing loss. While CS has been described in various contexts, its primary risk factors in humans remain incompletely characterized. We investigated three major contributors to CS: aging, noise exposure, and ototoxicity, using the envelope following response (EFR) as an objective, non-invasive marker of neural integrity. The present abstract integrates findings from these studies to identify converging patterns of vulnerability and evaluate the sensitivity of EFR to subclinical auditory damage.

Design: Three complementary studies were conducted. (1) The aging study examined the relationship between age and EFR magnitude in 108 adults across a broad age range. (2) The noise exposure study longitudinally tracked 42 young adults before and after large-scale music events, combining personal noise dosimetry with standard audiometry, otoacoustic emissions, and auditory-evoked potentials, including the EFR. (3) The ototoxicity study followed 37 oncology patients undergoing cisplatin or carboplatin chemotherapy, with baseline and follow-up audiological assessments 2-10 months after treatment.

Results: In the aging cohort, a clear negative correlation was observed between age and EFR magnitude, reflecting a progressive decline in temporal envelope encoding efficiency with increasing age. This finding supports the hypothesis that age-related CS contributes to degraded suprathreshold auditory processing, even in individuals with clinically normal hearing thresholds. A regression analysis furthermore shows that the EFR magnitude makes a significant contribution to speech understanding in noise, in addition to hearing sensitivity. In the noise exposure study, average sound exposure reached 100 ± 4 dBA over approximately 10 hours. Although only one participant exhibited a clinically significant threshold shift, five demonstrated acute EFR magnitude reductions within 24 hours post-exposure, with

two of these changes persisting for 14 days. Importantly, no significant correlation was found between exposure level and EFR decline, suggesting that susceptibility to noise-induced CS varies considerably among individuals. These results emphasize the limitations of standard audiometric tests and underscore the need for physiological markers to detect “hidden” auditory damage at an early stage.In the ototoxicity study, a significant decline in EFR magnitude was observed from baseline to follow-up for the total patient group and for the cisplatin subgroup specifically, whereas no significant change was found in the carboplatin group. Regression analyses indicated that patients with the highest baseline EFR magnitudes showed the largest reductions post-treatment. Moreover, decreases in EFR magnitude were detected before the onset of subjective hearing complaints or measurable audiometric threshold shifts, confirming the EFR’s sensitivity to subclinical neural damage related to platinum-based chemotherapy.

Conclusions: Across the three studies, consistent reductions in EFR magnitude were found in association with aging, recreational noise exposure, and cisplatin-induced ototoxicity; three established risk factors for cochlear synaptopathy. These changes often occurred in the absence of audiometric threshold shifts, indicating that standard hearing tests may underestimate early neural injury. Together, the findings provide circumstantial evidence that the EFR is sensitive to cochlear synaptopathy, supporting its potential use as a noninvasive biomarker for early detection and monitoring of auditory neural dysfunction across diverse risk populations.Work supported by : ERC-PoC (899858), FWO Audimod (G068621N), EIC transition (101058278)

Exploration of HBEGF in Otitis Media with Gene Analysis

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Objectives: A hallmark of middle ear pathophysiology (ME) during infection, or clinically known as otitis media (OM), is the rapid proliferation of the mucosal lining of the ME space. Within just a few days following infection, this mucosa can expand from a thin layer made of simple, flat epithelial cells into a markedly thickened epithelium composed of secretory and ciliated cells. Upon infection resolution, the mucosa typically returns to its normal architecture unless chronic inflammation persists. The aim of this study is to better understand the role of heparin-binding epithelial growth factor (HB-EGF), a potent growth factor, in ME mucosal proliferation in response to nontypeable Haemophilus influenzae (NTHi) infection.

Design: OM was experimentally induced by inoculating the ME with NTHi, the most common bacterium causing OM. Conditional deletion of the Hbegf gene was achieved by tamoxifen administration to Hbegfflox/flox mice crossed with R26Cre/ERT2 transgenic mice. Mice were assessed with and without prior treatment with Tamoxifen. ME responses were characterized by histology. As well, Affymetrix mRNA microarray analysis and single-cell RNA-Seq were used to assess gene expression changes during OM in wildtype mice and in mice deficient in the growth-associated gene Ecrg4 (esophageal cancer regulated gene 4). Potential intergene relationships were evaluated by STRING network enrichment analyses.

Results: A significant genotype-dependent effect (HBEGF-CRE vs. Control) on mucosal thickness was identified. Infected untreated mice showed significantly increased mucosal thickness relative to HBEGF

deleted (tamoxifen-treated) mice at 24 and 72 hours post infection, whereas no significant difference was observed at the 48-hour time point. Immunofluorescent labeling of HBEGF using an anti-HBEGF antibody confirmed robust expression in the control MEs, while gene deletion (TAM+ condition) markedly reduced HBEGF signal indicating lower protein levels in ME cells. During OM, Hbegf mRNA expression was much higher in mice lacking Ecrg4 than in WT mice.

Conclusions: HBEGF was found to play a significant role in the pathophysiology of OM, specifically as a mediator of mucosal hyperplasia. The Hbegf is strongly regulated by ECRG4, an orphan candidate tumor suppressor. This study identifies HBEGF as a potential therapeutic target for OM. Pharmacologic inhibition of HBEGF signaling could reduce mucosal proliferation. Since mucosal hyperplasia drives mucus secretion, inflammatory mediators release, and leukocytes recruitment into the ME, such inhibition could attenuate the downstream inflammatory sequelae of OM.

PODIUM SESSION II: COCHLEAR IMPLANTS

The Apical Mechanics of the Implanted Guinea Pig Cochlea

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Objectives: Residual hearing loss following receipt of an electroacoustic cochlear implant (CI) affects up to 50% of patients. This loss reduces the benefit of the "hybrid" approach, which include improved speech-in-noise intelligibility and music perception. The immunological and audiological profile of the implanted ear has been explored, but outside of mathematical models there is little information on the influence of the implant array upon organ of Corti and middle ear mechanics. If and how the implant array or resulting foreign body response affect cochlear mechanics has not been directly measured. Here, we examine the mechanical impact of acute and chronic placement of the CI array in a guinea pig model, using optical coherence tomography (OCT) imaging and vibrometry. This model system allows the testing of our hypothesis that intracochlear fibrosis induces a global hydromechanical change in cochlear access impedance.

Design: We implanted young guinea pigs for at least eight weeks. We periodically collected auditory brainstem responses before and after implantation. Then, animals were anesthetized, and we measured the displacement and phase of three apical organ of Corti locations and the umbo, to various stimuli. Postmortem repeat recordings were also collected. Mechanical data was successfully collected from nine guinea pigs so far, with more experiments underway. Similar experiments were conducted in five guinea

pigs before and immediately after introduction of the array. Following vibrometry measurements, animals were sacrificed and their cochleae harvested, fixed and decalcified. OCT imaging was used to assess the amount of intracochlear fibrosis. The basal turn fibrosis, CI, and other intracochlear structures were segmented manually and also using a custom convolutional neural network. The raw displacement of the organ of Corti and umbo were analyzed in each animal. Umbo data were used as a reference point to estimate the amount of cochlear gain and compression in the organ of Corti response.

Results: Acute CI causes minor changes in apical responses that may result from temporary threshold shift. Chronic CI led to more pronounced, and more variable mechanical outcomes, but in cases where residual hearing loss was apparent, there was reduced umbo displacement in the presence of an intact apical cochlear amplifier. Imaging revealed extensive fibrosis in several implanted cochleae, but this was not always associated with residual hearing loss.

Conclusions: In conclusion, early residual hearing loss in chronic CI appears mechanical and conductive in origin. This finding may chime with tympanometry observations in the clinic. Further analysis of the OCT imaging is underway to better understand the basis of the variable chronic CI outcomes. These data represent the first attempt to appraise residual hearing after CI from a cochlear mechanics standpoint.

Bilateral Speech Interference with Single-Sided Deafness Cochlear Implants

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Objectives: For individuals with single-sided-deafness (SSD)-one ear with normal or near-normal hearing (NH) and one ear with severe-to-profound hearing loss-cochlear implants (CIs) provide clear spatial-hearing benefits but with large outcome variability. One possible factor contributing to this variability is bilateral speech interference, where speech presented to the NH ear can reduce a listener's ability to identify target speech in the CI ear. While previous work has established the prevalence and magnitude of bilateral speech interference, the underlying causes of across-ear interference and its consequences for speech recognition in everyday listening environments remain unknown. This presentation will provide an overview of a series of studies testing the hypotheses that: (1) interference reflects poor binaural fusion of the bilaterally presented interferer; (2) interference is correlated with a general selective-attention deficit unrelated to hearing status; and (3) interference manifests in reduced speech recognition in a variety of target-masker contexts and in sound-field listening.

Design: Study 1 examined how poor across-ear integration might limit binaural benefit. Target and masking coordinate-response measure (CRM) sentences were presented to the CI ear. Bilateral speech interference was compared in two conditions: when a copy of the masking speech was presented to the NH ear or when different masking speech was presented to the NH ear. Study 2 compared bilateral speech interference with one auditory (monaural speech-on-speech masking in the NH ear) and two visual measures of selective attention: Stroop (identify the font color of a word while ignoring the word text) and Flanker (identify the direction of a central arrow while ignoring surrounding arrows). Study 3 measured bilateral speech interference for a range of target and masker types and under simulated sound-field conditions. At least 15 SSD-CI users with wide range of ages participated in each study.

Results: SSD-CI listeners showed large variability in the magnitude of interference (0-28 percentage points). In Study 1, presenting a copy of the first masker to the NH ear produced the same magnitude of interference as different masking speech. In Study 2, listener age, auditory monaural speech-on-speech masking, and the non-auditory measures of selective attention each explained independent variance in interference magnitude. In Study 3, interference decreased as maskers became less similar to the target speech, but persisted even with more realistic target sentences and unrelated speech maskers. Interference was also observed under simulated sound-field conditions, reducing the magnitude of head-shadow benefit provided by the CI.

Conclusions: Bilateral speech interference appears to reflect a combination of (1) limited binaural fusion and (2) selective-attention deficits that hinder SSD-CI users from attending to the poorer ear while ignoring highly intelligible speech in the better ear. Bilateral speech interference effects carry over to more realistic listening conditions, reducing the benefit that the CI ear should otherwise provide. Targeted selective-attention training might mitigate these effects and improve SSD-CI outcomes.[Funding: NIH-NIDCD R01-DC-020506. The views expressed in this abstract are those of the authors and do not necessarily reflect the official policy of the Department of Defense or U.S. Government.]

Age-Related Adaptive Musical Sound Quality Responses to Electrode Deactivation

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Objectives: Cochlear implant (CI) users often comment on the substandard sound quality of their devices. This study aims to investigate musical sound quality with a targeted programming intervention, which contains the participant's clinical program with high stimulation threshold electrodes deactivated. Deactivating these electrodes decreases channel interaction, which is when adjacent electrodes' stimulation fields overlap, creating a distorted signal. Channel interaction may lead to decreased perceived sound quality. Thus, we hypothesize that participants will indicate higher musical sound quality ratings with the experimental program than the default clinical program.

Design: Eight adult CI users participated. Forward and reverse sweep-focused thresholds were obtained for electrodes 2 through 15 and stimulus levels were averaged across all trials. Two to five electrodes with the highest stimulation thresholds were deactivated. This program (experimental), along with each participant's default (clinical) program, was uploaded onto two research Naida M90 processors. The stimulus recordings were each 13 seconds long and consisted of a simple melody and harmony that ranged from approximately 1000-8000 Hz, or C6-G8. They consisted of "Happy Birthday," and an original composition. The intervals between each note in the harmonies and each emphasized/held note of the original tune were at least three semitones apart. Participants listened to both recordings through both programs twice in an A-B-A-B fashion and rated them on a scale of 0 to 100 in terms of sound quality, musicality, pleasantness, and naturalness.

Results: No significant differences emerged between programs overall (clinical: 75.9±21.4 vs experimental: 80.0±17.7; p=0.446) or when examined by individual rating dimensions (sound quality p=0.554; musicality p=0.698; naturalness p=0.342; pleasantness p=0.317). Similarly, no differences emerged between stimuli overall (familiar: 77.1±18.9 vs novel: 78.8±17.6; p=0.174) or for any rating dimension (p=0.140-0.571). However, age strongly predicted experimental program benefit (r=-0.846, p=0.008, R2=71.5%), with individual variability ranging from -10.5 to +31.9 points. This age effect remained consistent across all rating dimensions (pleasantness: r=-0.860, p=0.006; sound quality: r=-0.845, p=0.008; naturalness: r=-0.839, p=0.009; musicality: r=-0.754, p=0.031) and both musical stimuli (familiar: r=-0.819, p=0.013; novel: r=-0.829, p=0.011). Age-stratified analysis revealed younger adult participants (<65 years, n=2) gained substantial benefit (+21.9±14.1 points), particularly for naturalness (+30.5±7.8 points), while older participants (≥65 years, n=6) reported minimal change (-1.8±6.0 points; between-group p=0.011). Duration of deafness approached significance in predicting benefit (r=-0.645, p=0.084), while daily music listening (r=0.334, p=0.419) and number of basal deactivated electrodes (r=-0.155, p=0.715) did not predict outcomes.

Conclusions: Our study revealed that a high electrode deactivation protocol tended to be more successful for younger adult CI users in terms of sound quality. The improvement in musical sound quality ratings may be due to the decreased amount of channel interaction. Younger adult CI users may be more successful because their auditory systems have higher levels of neuroplasticity. .These neuroplasticity-dependent effects may also be demonstrated by the borderline significant association observed between duration of deafness and sound quality metrics; however, further data collection is needed to confirm this association.

How Prosodic Pitch is Perceived: Insights from Vocal Mimicry

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Objectives: The objective of this study is to quantify pitch perception through a cochlear implant (CI) as presented in a sentence spoken with emotion. The transmission of pitch cues with a CI is problematic, but the exact nature of pitch perception with electric hearing remains unknown. Behavioral measures of pitch perception (e.g., pitch scaling, discrimination, etc.) with a CI are challenging and subject to prescribed notions of meaningful pitch cues embedded in the listening tasks. Our alternative approach is to analyze vocal reproductions of pitch contours heard through the CI in terms of key acoustic features (e.g., fundamental frequency, or F0). Single-sided deaf (SSD) CI users are a unique population for this approach, as vocal reproductions for sounds heard with the acoustic-hearing (AH) ear can serve as a "ruler" with which to compare vocal reproductions of sounds heard with the CI.

Design: We recorded vocal mimicry of emotional speech (i.e., happy, sad, angry, scared, neutral) in 10 SSD CI users listening with the CI or AH ear; stimuli were provided by Dr. Monita Chatterjee. Stimuli were delivered to the AH ear via headphones or to the CI ear via direct audio input. During testing, a stimulus was played, and participants were asked to repeat the stimulus as accurately as possible. Listeners mimicked timing, pitch, intonation, and sound quality of the stimuli. The software interface allowed

listeners to read the sentences so that the focus was on imitation rather than word recognition. In both AH and CI conditions, the participants could hear their vocalizations through their AH ear. Vocal reproductions were recorded and F0 pitch contours were extracted using Praat software.

Results: Listeners accurately replicated pitch contours with their AH, though some deviations occurred due to vocal range differences (e.g., male listener mimicking female speech) and differences in ability to mimic pitch. F0 extracted from the CI and AH reproductions were correlated, but the range of F0 in the CI reproductions was smaller, suggesting that the F0 range within the CI ear was perceived as smaller. Frequency compression varied across listeners, with two response patterns observed: (1) compressed frequency contours across the entire range, or (2) well-represented contours at low frequencies (~<200 Hz) with compression at higher frequencies. Only one participant mimicked pitch contours above 300 Hz when listening with the CI. Often frequencies were perceived as lower pitched with the CI than with AH.

Conclusions: These results provide unique insights into how pitch and vocal emotion are conveyed through a CI. Most participants were able to reproduce low frequencies up to 200-300 Hz but not higher. CI signal processing primarily encodes low frequencies via temporal coding and higher frequencies by spectral representation. The data suggest that CI users interpret temporal information, but not spectral information, as pitch. The data suggest that CI users likely perceive pitch changes in prosodic speech as being smaller than the actual pitch changes represented by the acoustic signal. The vocal mimicry task is a promising method to investigate pitch and prosody perception in CI users.

Development and Validation of Patient-Specific Predictive Models for CIQOL Outcomes

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Objectives: Despite years of research, accurately predicting which patients will benefit most from cochlear implantation remains a challenge. Predictive modeling approaches have focused almost entirely on predicting speech recognition outcomes, however recent research has demonstrated that patient satisfaction with their implants is far more strongly associated with Cochlear Implant Quality of Life-35 Profile (CIQOL-35 Profile) domain score improvements than speech recognition score improvements. To build on these findings, this longitudinal study aims to (1) develop a model that uses pre-implantation factors to discriminate CI recipients who have clinically meaningful improvement in CIQOL domain scores from those who do not, and (2) validate this model in an independent sample.

Design: Multicenter cohort study of 389 adults receiving unilateral CIs for traditional bilateral hearing loss indications. Logistic regression models predicting 12-month post-implantation CIQOL domain improvement (beyond established conditional minimally detectable change values) were developed on a training cohort (n=273) and evaluated in an independent validation cohort (n=116). The model included demographic and hearing covariates along with either (Model A) pre-CI CIQOL Functional Stage or

(Model B) pre-CI CIQOL domain score. Separate models were developed for each CIQOL domain. Models were evaluated using area under the curve (AUC).

Results: Demographics, hearing factors, audiological sores, and pre-CI CIQOL Domain scores were similar in the training and validation cohorts. There were no significant differences in demographics, hearing factors, or pre-CI CIQOL Domain scores between the training and validation cohorts. For our regression models, pre-CI CIQOL Functional Stage (Model A) or pre-CI CIQOL domain score (Model B) were the only factors predictive of CI improvement at 12-months post-CI. While predictive strength varied by model, having either a higher pre-CI CIQOL Functional Stage or CIQOL domain score (greater abilities) predicted lower likelihood of improving after implantation for all CIQOL Domains. For example, CI users in Communication Stage >II prior to implantation had 46% lower odds of improving after implantation compared to those in pre-CI Stages I or II (OR 0.54[0.40-0.73]). For all other domains, pre-CI Functional Stage >I was associated with decreased odds of improving post-CI (OR 0.33-0.67; all significant). Based on AUCs, the models including pre-CI CIQOL domain score (Model B) had higher predictive ability than Model A, demonstrating moderate to excellent discrimination for all domains (AUC: 0.71-0.83) except Entertainment (AUC: 0.65). Importantly, the model performance was similar between the training and validation cohorts. Therefore, estimates from the regression models can provide patient-specific probabilities of pre to post-CI CIQOL improvement, which have never been previously available.

Conclusions: This study demonstrates that, after controlling for demographic and hearing variables, pre-implantation CIQOL scores/stages are significant predictors of post-implantation quality-of-life improvements across all domains. The logistic regression models developed and validated here offer a promising framework for identifying patients most likely to benefit from cochlear implantation in terms of real-world outcomes. These findings support a shift toward incorporating patient-reported outcome measures into preoperative counseling and clinical decision-making, ultimately enhancing personalized care for CI candidates.

DNN Hearing Aids Improve Speech but Don't Disqualify CI Candidacy

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Objectives: Hearing aids (HAs) with deep neural networks (DNN) can significantly improve speech recognition in noisy environments. Research has suggested that DNN noise reduction in HAs may disqualify patients from cochlear implant (CI) candidacy. Thus, we aimed to complete a prospective investigation of the effects of DNN-equipped HAs for adults scheduled for CI candidacy evaluation at a large audiology clinic. Our hypotheses were 1) conventional CI candidates fitted with DNN HAs will demonstrate benefit, but will still meet labeled CI indications for speech in quiet and/or noise, and 2) DNN HAs will offer significant benefit for borderline CI candidates and individuals with steeply sloping hearing losses meeting audiometric indications for electric and acoustic stimulation (EAS) and may disqualify some from CI candidacy.

Design: 12 adults (55-88 years) scheduled for CI candidacy evaluation were enrolled (33 planned per power analysis). All participants had audiograms meeting either conventional or EAS/Hybrid CI indications in both ears. Each participant was fitted with Phonak I90-Sphere HAs verified on-ear to NAL-NL2 targets. Three programs were used for aided speech perception testing: Calm situation, Speech in noise, and Spheric speech in loud noise. Test conditions included each HA alone as well as the bilateral HA condition for CNC words (60 dB SPL) and AzBio sentence recognition in noise at +5 dB SNR (speech at 65- and 75-dB SPL). Subjective reports of listening difficulty for AzBio +5 dB were obtained for the 65 dB SPL condition. To characterize subjective reports of communication and quality of life for adult CI candidates, validated subjective outcome measures were also administered: Speech Spatial and Qualities of Hearing (SSQ-12), CI Quality of Life (CIQOL-35), and Vanderbilt Fatigue Scale (VFS-10).

Results: There was no significant difference in aided CNC word recognition across the HA programs, as expected. We observed highly significant improvement in speech understanding in noise (AzBio +5 dB SNR) for the Spheric speech in loud noise program as compared to both Calm situation and Speech in Noise ranging from 16- to 20-percentage points for speech at 65 dB SPL ($p < 0.01$). For higher level speech and noise (AzBio +5, 75 dB SPL), Spheric speech in loud noise yielded even greater benefit ranging from 18- to 39-percentage points ($p < 0.01$). Participants reported lower listening difficulty with Spheric speech in loud noise as compared to both Calm and Speech in noise. Despite highly significant benefit for speech in noise with Spheric speech in loud noise, all study participants still met labeled CI indications.

Conclusions: Given poor CI utilization and reports suggesting HAs equipped with DNN noise reduction potentially influencing CI candidacy, rigorously executed studies are critical to ensure we are providing data-driven recommendations for patients meeting both traditional and EAS CI indications. Preliminary data analysis revealed that DNN HAs yielded highly significant benefit for speech understanding in noise for adult CI candidates; however, this technology did not disqualify listeners from CI candidacy and may be best combined with a CI for bimodal listening.

PODIUM SESSION III: COMMUNICATION CHALLENGES

Improving Communication Sciences and Disorders Diversity through Undergraduate Research Training

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Objectives: Undergraduate laboratory training opportunities are an invaluable and formative experience while students are considering graduate school and a PhD in Communication Sciences and Disorders. However, barriers limit the ability of all students to take advantage of these opportunities. At the University of Maryland in College Park, we addressed these barriers by developing a year-long undergraduate training program (UMD-REACH, Research Equity and Access in Communication and Hearing) with the goal to increase undergraduate research participation in Hearing and Speech Sciences and related departments (e.g., Biology, Engineering, Neuroscience, Education, Linguistics), while reflecting the diversity of the University of Maryland's student body. Our program sought to increase trainees' future academic success and likelihood of pursuing research careers by providing a wide

breadth of mentorship and professional development opportunities, improving the diversity of the pipeline for researchers entering Communication Sciences and Disorders.

Design: Students, typically under-represented in Communication Sciences and Disorders, were recruited through campus outreach, including posters, involvement fairs, and club presentations. Applications were submitted online and reviewed based on demographic, socioeconomic, and academic criteria. Each admitted trainee was paired with a faculty research mentor based on their interests. They received regular 1-1 mentorship, as well as additional support from graduate students (both dedicated to the training program and from their individual labs) and other lab members. During the summer, the training program is a full-time paid research experience and a residential summer program, including housing and meals. Students work full-time in their labs and attend a variety of professional development seminars. Summer concludes with the trainees presenting posters on campus. During the school year, students are paid to perform research 10 hours/week and continue attending weekly professional development seminars led by program faculty. These seminars serve as opportunities for students to discuss any unknowns about higher-level education or the college experience, as well as position them to succeed in graduate school.

Results: There have been a total of 34 trainees over 3 consecutive years. In year 1, 7 of 20 students were selected. In year 2, 15 of 47 were selected. In year 3, 12 of 116 were selected. At the beginning of the program, students and their mentors completed a brief survey on the student's ability to perform a variety of research-based tasks (Best Practices in Undergraduate Research Survey, BPUR). At the end of the program, students and their paired mentors take the same survey to document their progress over the given year. Trainee research skill scores improved from both the trainee's and mentor's perspectives. Most trainees remained in labs after the program. Several graduated with honors, by completing honors thesis projects, and are presently in graduate programs. The student feedback about the program has been primarily positive. The students report that they enjoy the opportunity to participate in research during their undergraduate careers and are learning valuable lessons about working in a lab and writing academic papers. Many students enjoy the weekly seminars that teach valuable lessons pertaining to how to write resumes/CVs, the process of getting a paper published, graduate student Q&A panels, etc. Students have voiced concerns about time demands and their time management skills while in the program; some of them need to work secondary jobs because they are not making a liveable income on the program stipend alone.

Conclusions: The REACH training program is considered a success by students, faculty, and university administration, with the number of applicants more than doubling each academic year. Trainees have positive experiences, improve their research skills, and join graduate programs in our field. Several continue to attend professional development seminars even after the end of the year-long appointment. REACH provides a space for students to learn, grow, and increase their overall research-based knowledge over the course of a year all while earning themselves an income. This, in turn, supports the goal of improving the diversity of communication sciences and disorders, by addressing this issue at the beginning of the research pipeline.

Characterizing Cochlear Health in Hypertension

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Objectives: Hearing loss and hypertension (HTN) are prevalent chronic conditions associated with substantial morbidity. Though animal studies suggest the stria vascularis is irreversibly compromised in HTN, research is mixed regarding the cochleopathy-HTN relationship and there are limited measures of cochlear health in hypertensive humans. The purpose of this study was to characterize cochlear health in persons with HTN. We hypothesized HTN would be associated with compromised outer hair cell function.

Design: This laboratory study enrolled 187 subjects aged 18-85 years (68% female; mean age=52.5 years [SD= 20.0]). Ninety-two subjects had normal blood pressure (BP; systolic [S]BP<120 mmHg and diastolic [D]BP<90 mmHg) and 95 presented with HTN (SBP ≥140 mmHg or DBP ≥90 mmHg or medication). Individuals with diabetes, otologic pathology, chemotherapy history, and current tobacco smokers were excluded. Puretone thresholds from 0.25-20 kHz were measured and hearing loss was defined as PTA0.5,1,2 >25 dB HL in either ear. Distortion product otoacoustic emissions (DPOAEs) were collected using a swept-tone approach (f2 1-20 kHz; f2/f1=1.22; L1/L2=65/55 dB SPL) and amplitudes were averaged in 1/3-octaves. Responses with SNRs ≥6 dB were considered present and those with SNR ≥6 dB and amplitude >0 dB SPL were deemed present and normal. Linear regression predicted thresholds accounting for HTN status, age, sex, race, education, and alcohol use. Logistic regression models were used to determine associations between HTN and reduced/absent (vs. present) DPOAE amplitudes adjusting for potential confounders. Analyses were conducted by ear (better/worse) and age-stratified (younger, 18-55 years and older, ≥56 years).

Results: HTN subjects were older than normotensives (62.1 [SD=15.1] vs. 42.8 years [SD= 19.8; p<.001) and more likely to be male (42% vs. 21%; p=.003).The prevalence of hearing loss was 26.7% and varied by HTN status: 37.9% for HTN vs. 15.2% for normotensives; p<.001. After adjustment, subjects with HTN had poorer worse-ear thresholds by ~10 dB at 9 and 10 kHz (both p<.05). HTN was otherwise not associated with thresholds and age was the most consistent predictor. The prevalence of present and normal DPOAEs (1) declined with increasing frequency and (2) was lower in HTN vs. normotensives. Amongst HTN subjects,<10% had present and normal DPOAEs at frequencies >2.5 kHz. Amongst younger hypertensives, the prevalence of present and normal DPOAEs was significantly lower than normotensives from 3.15-6.3 kHz (all p<.03). Present and normal DPOAEs were rare amongst older subjects and were primarily observed between 1-2.5 kHz. Older hypertensives had significantly lower prevalence of present better-ear DPOAE2-10 (38% vs. 65%; p=.03). In unadjusted models, compared to normotensives, subjects with HTN had lower odds of present DPOAEs from 1-12.5 kHz. Better ear age-stratified multivariable analysis demonstrated lower odds of present mid-frequency (2.5-5 kHz) DPOAEs, but only for older subjects.

Conclusions: Persons with HTN presented with poorer hearing sensitivity and cochlear health but age was the underlying driver behind most associations. The extent of cochlear involvement in HTN appears minimal and primarily amongst older adults in the mid frequencies. Data collection remains ongoing and future analysis will be conducted with a larger dataset.

Hearing Loss and Emotional Distress in U.S. Older Adults

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Objectives: Hearing loss is the most prevalent sensory disability in U.S. older adults and is associated with negative markers of emotional distress including depression, loneliness, and anxiety. However, there is little research focusing on emotions such as anger. Anger tends to be experienced by older adults when they face changes in health status (e.g., hearing loss). Understanding the extent to which hearing loss is linked to expressions of anger is important, as translational studies have shown anger to be a predictor of negative health outcomes such as cardiovascular disease events and stroke. The objectives of the current study were to estimate 1) the association between hearing loss and hearing aid use on expressions of internalized anger (anger-in) and externalized anger (anger-out) and 2) how this association varies by sex.

Design: The current study used nationally-representative, longitudinal data from 10,664 adults aged 50 and older in the Health and Retirement Study (2006-2012). Hearing status was ascertained at each wave by patient-reported hearing (excellent, very good, good, fair, poor) and hearing-aid use (no, yes). Outcomes were internalized anger (anger-in) and externalized anger (anger-out) scales based on participants' reported frequency of anger (range=1-4) using an adapted version of the State-Trait Anger Expression Inventory (STAXI). Linear mixed models were used to estimate anger scores while adjusting for sociodemographic and health-related characteristics.

Results: The mean (standard deviation [SD]) age of study participants was 66.77 (9.06) and more than half were female (61.52%). The mean hearing score was 1.54 (1.04) (range of 0-4) and males were more likely to report worse hearing compared to females (1.77 [1.08] versus 1.40 [0.99], P<.001). The mean (SD) anger-in score was slightly lower in females compared to males (2.16 [0.68] versus 2.19 [0.67], P=.001) and the mean anger-out score was slightly lower in females compared to males (1.47 [0.49] versus 1.55 [0.54], P<.001) at baseline. Multivariable mixed models showed that worse hearing was associated with significantly greater levels of anger-in (beta=0.04, 95% CI=0.03-0.05, P<.001) and anger-out (beta=0.03, 95% CI=0.03-0.04, P<.001). There was no significant sex difference in anger-in (interaction P=.362); however, males with worse hearing reported greater levels of anger-out than females (interaction P=.010). The associations remained largely unchanged after accounting for covariates.

Conclusions: Older adults with worse hearing had significantly greater levels of internalized anger (anger-in) and externalized anger (anger-out) than those with better hearing. Differences in anger-out were significantly greater in males than in females. Findings underscore the importance of effective hearing interventions, as poor hearing-especially when untreated-is associated with increased expressions of anger.

Effects of Hearing Intervention on Biomarkers of Neurodegeneration in ACHIEVE

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Objectives: Hearing intervention may reduce cognitive decline in older adults with hearing loss. Hypothesized mechanisms include attenuation of neurodegeneration associated with hearing loss. In a secondary analysis of the Aging and Cognitive Health Evaluation in Elders (ACHIEVE) randomized controlled trial, we examined the effects of hearing intervention on 3-year changes in glial fibrillary acidic protein [GFAP] and neurofilament light chain [NfL], blood-based biomarkers of neurodegeneration.

Design: ACHIEVE, a clinical trial in the United States, tested the effects of hearing intervention (audiological counseling, provision of hearing aids) versus health education control (counseling on chronic disease prevention) on 3-year cognitive decline among 977 community-dwelling adults ages 70-84 years with untreated hearing loss and without substantial cognitive impairment. Plasma was collected at baseline and at three years post-randomization from a subgroup of participants for whom hearing intervention had positive effects in the primary trial. Covariate-adjusted linear mixed effects models estimated intention-to-treat intervention effects on 3-year changes in inverse-normal transformed values of GFAP and NfL.

Results: Participants in the analytic sample (n=164) were mean (SD) age 78.1 (2.9) years, 64.0% female, and 73.2% White. Over three years, hearing intervention was associated with a slower rise in GFAP (intervention: -0.026; 95% CI: -0.144, 0.093, control: 0.149; 95% CI: 0.039, 0.260; difference: -0.175; 95% CI: -0.322, -0.028; p-difference: 0.019) and NfL (intervention: 0.171; 95% CI: 0.022, 0.319, control: 0.330; 95 %CI: 0.185, 0.475, difference: -0.159; 95 %CI: -0.348, 0.029; p-difference: 0.098), in parallel with observed effects on reduced cognitive decline.

Conclusions: Hearing intervention was associated with a slower 3-year rise in GFAP. Comparable estimates were observed for NfL, with wider confidence intervals. Effects are consistent with primary trial results showing effects of hearing intervention on reduced cognitive decline in this subgroup. The findings support reduction in neurodegeneration as a potential mechanism through which hearing intervention may slow cognitive decline.

Challenges to Perceiving the End of a Conversational Turn

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Objectives: Some individuals with hearing loss struggle to know when a conversational partner has finished their turn and is expecting a response. Utterance-final falling pitch cues typical hearing listeners to prepare to take their conversational turn as soon as the talker finishes. This study examines listeners' identification of prosodic cues to conversational turns, in light of the difficulties in pitch perception by cochlear implant users. We hypothesize that typical hearing listeners will respond more quickly to the end of a talker's turn when prosody explicitly signals turn completion. Pitch change is expected to be the strongest of these prosodic cues, so performance should be altered when pitch cues are compromised by a CI or vocoding.

Design: Stimuli included lists of varying length, where the final word's prosody indicated either list continuation or list conclusion. Lists were constructed from sentences produced by a female talker and contained 2-5 color/shape pairs in a carrier phrase (example: "I saw a blue circle and red triangle and a yellow square."). Eighteen participants with typical hearing indicated their recognition of list end by

repeating aloud the last item as soon as they could. Response time was the main outcome variable. Color-shape combinations, list lengths, and prosody (completion vs. continuation) were pseudo-randomized for each participant across four blocks of 30 trials each. A separate condition was tested in which stimuli were vocoded with parameters that severely degraded both harmonic and temporal pitch cues to approximate the challenges of listening with a CI. Results were analyzed in a mixed effects model where the log-transformed reaction times were predicted by vocoding condition (unmodified vs. vocoded), prosody condition, list length, trial number, and interactions between these terms. By-subject random intercepts and subject-specific random slopes for prosody condition and vocoding condition accounted for variability and repeated measures across participants.

Results: Verbal responses to prosodically complete lists occurred significantly faster than responses to prosodically incomplete lists. Without prosodic cues to list completion, reaction time was roughly 300ms longer-a consistent effect across nearly all participants. No significant effects of list length or trial number were observed. Contrary to expectations, listeners remained sensitive to prosodic cues to list completion when listening to vocoded signals, suggesting partial reliance on accompanying non-pitch cues like duration and intensity to recognize the end of a talker's utterance.

Conclusions: Typical-hearing listeners use talker prosody to determine when a talker's utterance is over. Without prosodic cues to list end, current data show listeners delay responses for around 600ms after the talker has finished, which was nearly double their response time to prosodically complete lists. Missing prosodic cues to conversational turn completion could carry social consequences, as these delays are comparable to those preceding negative statements in conversations. Continued work will examine CI listeners' performance on this task, revealing potential conversation challenges due to diminished pitch access that would not be probed in tests of word repetition accuracy, but which are vital to all listeners' conversational participation.

Documenting the Impact of Chronic Tinnitus with Pupillometry and Microsaccades

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Objectives: Approximately 10% of the general US population and as many as 44% of US Veterans experience chronic tinnitus. While most are not bothered by their tinnitus, those that are commonly report difficulties hearing, irrespective of objective hearing loss. However, most investigations have demonstrated few if any deficient auditory abilities in those with chronic tinnitus. Newer research suggests that autonomic nervous system function may be altered in those with tinnitus and sound tolerance disorders, which can be measured non-invasively using pupillometry. The objective of this study is to evaluate autonomic nervous system responses that have been linked to listening effort and arousal with pupillometry. The long-term goal of this line of research is to develop biomarkers that are associated with subjective hearing difficulties not captured by current audiological measures.

Design: Fifty-one adults participated in this study. Twenty-four participants indicated a mild or greater subjective tinnitus handicap and the remaining 27 reported a slight or no subjective tinnitus handicap. Participants with hearing loss had no greater than a moderately-severe sensorineural hearing loss and wore hearing aids that were verified using probe microphone measurements. Participants listened to AzBio sentences, viewed affective images, and listened to affective sounds while their pupil size and microsaccade rate were measured. Participants also completed subjective scales related to tinnitus,

hyperacusis, and depression. Linear mixed models, correlation, and principal component analysis were used to identify underlying relationships.

Results: Baseline pupil size exhibited a moderate negative correlation to subjective tinnitus handicap for participants with greater than a slight perceived tinnitus handicap. Peak pupil dilation to affective sounds and AzBio sentences was significantly different in participants with a slight or no tinnitus handicap, but undifferentiated in participants with greater than a mild tinnitus handicap. Average microsaccade rate was significantly higher for participants with greater than a slight tinnitus handicap during affective sound and image presentation. Degree of hearing loss was not significantly associated with any of the metrics. Generally, peak pupil dilation and the subjective scales loaded negatively onto the second principal component, while the others loaded positively.

Conclusions: The results from this study provide additional evidence that subjective tinnitus handicap is related to altered autonomic function. This altered function manifests as cascading effects on microsaccade rate and pupil dilation, primarily in response to affective auditory stimuli. Continued research is needed to determine how audiological and interdisciplinary interventions can be utilized to alleviate the burdens of chronic tinnitus.

PODIUM SESSION IV: DIAGNOSTICS AND SPEECH PERCEPTION

Conducting Evidence-based Community-engaged Research: Accessible Precision Audiology Research Center

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Objectives: Hearing loss affects over 40 million US adults and leads to 46% higher healthcare costs. Despite this, only 20% of those with hearing loss seek treatment. Rural communities are disproportionately affected with nearly 1 in 5 residents having hearing loss, compared to around 1 in 10 in metro and suburban areas. This group also waits 11 years on average to pursue care, 3 years longer than metro counterparts. This stems from a lack of access to care with only 1 audiologist per 24,500 Americans and the benefit of hearing aids remaining limited due to the lack of specificity in diagnostics for known subtypes of sensorineural hearing loss. The Accessible Precision Audiology Research Center (APARC) leverages collaborations between audiology, auditory neuroscience, and AI data analytics to collect large-N data from diverse populations while deploying an outreach model that provides quality audiological resources customized to the needs of communities in an evidence-based, community-engaged way.

Design: Originally located in West Lafayette, APARC expanded to Indianapolis' 16 Tech Innovation District to improve accessibility and participant diversity. APARC fosters community engagement and provides free comprehensive hearing evaluations to community members at both locations all while collecting research data. To reach rural populations lacking care we now have a completely mobile lab,

including a fully equipped van with a quiet room. We are using Community-engaged Approach for Scientific Collaborations and Decision (CASCADE) stakeholder panels (Kelleher 2025) to get input from rural health providers, Purdue Extension coordinators, and rural community members to guide engagement and make sure our methods are evidence-based. This method not only improves our data set, but also critically fosters community trust, supporting residents within typically underserved communities.

Results: Across both locations we have seen over 520 subjects with over half being at the Indianapolis location during its first year. Each participant receives a printed and signed copy of their results and personalized recommendations from a licensed audiologist. Our large-n dataset driven by community-based recruitment has been a catalyst for multiple student-led research projects, including projects on standard vs. wideband MEMR, the validity of the Audible Contrast Threshold (ACT) Test, and examining participants ability to accurately predict if they have hearing loss. Additionally, our database now mirrors the racial demographics of the US (unlike typical university campus recruiting). We have diagnosed 247 hearing losses, with nearly 50% of the group being unaware or unsure of their condition. We have further extended outreach by participating in a wide array of community events and health fairs. Finally, APARC has received two pilot grants to begin working with residents, educators, and health providers in rural Indiana via CASCADE panels and family health clinics. Our work demonstrates the efficacy and synergy of evidence-based, community-engaged research for not only science but for community buy-in.

Conclusions: APARC demonstrates the power of evidence-informed, community-engagement in advancing audiological research. Our unique design facilitates relationships within the community while building a more robust and rich data set for precision audiology.

Characterizing Hearing Across the Lifespan in Individuals with Down Syndrome

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Objectives: In the United States, Down syndrome occurs in ~1/700 births and the current average lifespan of individuals born with Down syndrome approaches 60 years of age. Down syndrome is the result of triplication of all or part of human chromosome 21, with effects that can vary in presentation across individuals. Previous research suggests that hearing loss is one of the most common associated conditions, occurring in 40-90% of individuals with Down syndrome across the lifespan. Although recent smaller-scale prospective studies reflect similar trends, many of the datasets currently available pertaining to hearing loss in individuals with Down syndrome are based on medical record reviews or participants recruited from clinical samples and therefore may overrepresent individuals seeking or undergoing medical treatment. Additionally, historical data often rely on participants recruited from institutional care facilities, and therefore results may not generalize to individuals currently living with Down syndrome, the majority of whom live in community-based settings.

Design: To date, participants have included 103 individuals with Down syndrome ages 5.1 to 55.8 years (avg = 23.1, stdev = 11.7) recruited through organizations supporting individuals with Down syndrome and their families, community events, social media, and word-of-mouth. Audiometric assessment was

completed using developmentally sensitive techniques for standard clinical (0.25-8 kHz) and extended high frequencies (11.2 and 16 kHz). Participants or caregivers completed surveys to characterize race and ethnicity, highest household education, hearing health history, and co-occurring conditions, and to screen for dementia (participants ≥25 yrs only); nonverbal intelligence and vocabulary size were assessed by research staff within six months of audiometric assessment.

Results: On average, data show largely normal hearing sensitivity for the youngest group of participants (i.e., 5- to 10-year-olds), with evidence of high frequency hearing loss for the 11- to 20-year-old group that worsens in severity with increasing age group. Either sloping or reverse cookie bite configurations were observed in approximately 70% of ears, with the proportion of sloping hearing losses tending to increase with increasing age. Described for each frequency within an ear, sensorineural hearing loss was overall the most common type, with the pattern of hearing loss type varying by frequency and age wherein conductive hearing loss was more prevalent at low frequencies than other types of loss and sensorineural hearing loss was more prevalent at higher frequencies, particularly for older participants. Whereas over 80% of participants had mild or greater hearing loss in one or both ears at standard clinical frequencies, approximately 50% of participants or caregivers reported being aware of the presence of hearing loss.

Conclusions: Results from this large community-based cohort confirm and extend previous findings suggesting that the hearing loss phenotype for individuals with Down syndrome varies by age and frequency. Evidence of high frequency hearing loss emerging in adolescence suggests that prioritizing high frequency hearing audiometric assessment is warranted for individuals with Down syndrome across the lifespan. Monitoring extended high frequency hearing may identify individuals with Down syndrome at risk for future loss in the standard clinical range.

Development and Evaluation of the Intelligibility-Based Repeat-Recall Test (i-RRT)

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Objectives: The Repeat-Recall Test (RRT) is an integrative assessment of speech-in-noise (SiN) ability, auditory working memory, and the subjective experience of effortful listening. The RRT's speech materials can also characterize a listener's dependence on semantic context. Recently, the RRT materials have been adapted for use in a Bayesian-guided adaptive test, known as the ezSRT, designed to efficiently estimate complete psychometric functions for SiN. The ezSRT now allows the RRT to be administered across individualized speech-reception thresholds (SRTs) rather than at pre-determined fixed signal-to-noise ratios (SNRs). Here, we describe the development and evaluation of this new intelligibility-based Repeat-Recall Test (i-RRT). We further explore how normative references generated at specific SRT levels might be used to better characterize the SiN difficulties of listeners with hearing loss.

Design: Single-blind, mixed design. Listeners with normal hearing (NH; n = 20) first completed the ezSRT test using high and low context RRT sentences (presented from directly in front at 68 dBA SPL) in two different noise configurations. The i-RRT was then administered at individualized SNRs corresponding to SRTs of 25, 50, 75, and 90%. At each SRT level, the i-RRT required listeners to repeat each of six RRT sentences before then recalling the content of those six sentences verbatim and providing ratings of listening effort and "tolerable time" (a proxy for motivation). Data from listeners with NH were used to

validate the sensitivity and reliability of i-RRT outcome measures and to establish norms for each outcome at the four SRT levels. Listeners with hearing-impairment (HI; n = 19) were then tested in the aided mode following a similar protocol but limited to high context materials with i-RRT assessment at SRT50 and SRT90. The i-RRT outcomes of listeners with HI were compared against the newly generated intelligibility-based normative references.

Results: All i-RRT outcome measures differed significantly across SRT levels, as expected. Even at matched levels of SiN understanding (i.e., SRT levels), low context sentences were associated with poorer recall, greater listening effort, and shorter tolerable time. Similarly, recall was poorer, and tolerable time was shorter when listeners were tested with co-located babble compared to spatially separated continuous speech-shaped noise. Test-retest reliability was lowest for low context recall scores in both noise configurations and for repeat scores in co-located babble noise; other measures showed moderate to excellent reliability. Relative to NH listeners, listeners with HI exhibited poorer recall (NH = 37.9%, HI = 29.3%) and higher ratings of listening effort (NH = 5.8, HI = 7.2 on a 10-point scale).

Conclusions: Semantic context, noise configuration, and hearing status were shown to affect secondary measures of SiN processing (i.e., recall/memory, listening effort, and tolerable time) even when task demands were equalized based on SiN intelligibility. This suggests that the cognitive demands of such conditions, and possibly others, may not always be reflected in SiN performance. Comparing a listener's i-RRT performance against normative references defined for different SRT levels may be useful for characterizing when hearing difficulties may involve factors which cannot be fully addressed by SNR improvement.

Extended High-Frequency Audibility, Masked Speech Recognition, and Scene Awareness

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Objectives: Human hearing at extended high frequencies (EHFs; >8 kHz) is valuable for speech perception, particularly when target talker EHFs have advantageous signal-to-noise ratios (SNRs) relative to masking noise EHFs. This advantageous SNR at EHFs occurs in natural settings, including in multi-talker environments where talkers have mismatched head orientations. This research examined effects of head orientation cues, spatial cues, and EHF hearing on speech-in-noise recognition and auditory scene analysis. We hypothesized that head orientation cues and EHF hearing would provide a benefit for auditory scene analysis and speech recognition.

Design: A series of studies tested adult listeners (N = approx. 40 per group per study) with normal hearing at standard audiometric frequencies (250 Hz - 8 kHz) and a range of pure-tone thresholds at EHFs (9 - 16 kHz). Masked speech recognition was tested by measuring speech reception thresholds (SRTs) using both sentence-level speech-in-speech tasks and digits-in-speech tasks. Spatial awareness was tested using talker head orientation discrimination and talker spatial identification tasks. Talker head orientation (facing vs. non-facing), talker spatial separation (co-located vs. separated), signal

bandwidth (full-band vs. low-pass filtered at 8 kHz), and reverberation (anechoic vs. reverberant) were manipulated. Both female and male speech were tested.

Results: Low-pass filtering at 8 kHz consistently produced a degradation in performance across tasks for both female and male speech. Speech recognition was better with EHF access, especially for conditions in which masker talkers were facing away from the listener. Listeners displayed greater acuity at talker head orientation discrimination when given access to EHFs. Detection of talker location based on head orientation cues was better and faster with EHFs. Full-band speech signals elicited more consistent repeated-measure responses than signals low-pass filtered at 8 kHz. Talker head orientation cues provided substantial benefit for speech recognition, with improvements in SRTs of up to 8 dB. There were complex interactions between head orientation, spatial separation, and availability of EHF cues, with the presence of head orientation and EHF cues reducing the influence of spatial cues, and vice versa. Listeners with elevated EHF pure-tone thresholds generally performed worse, although this finding was not consistent across tasks.

Conclusions: These findings suggest that EHF hearing improves listeners' abilities to parse the auditory scene and to perceive speech. EHFs provide talker head orientation cues, which in turn provide substantial benefits for speech recognition. Poor EHF audibility may lead to deficits in natural auditory scenes that listeners encounter in their daily lives. [Supported by NIH Grant DC019745]

Automatic Speech Recognition for Scoring of Audiologic Tests

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Objectives: Measurement of speech recognition abilities is a crucial component of both clinical and research practice in audiology. Despite the ubiquitous use of this approach, there remain several limitations which have persisted since the inception of tests of speech recognition. First, testing patients in a non-native language is problematic. Second, there may be unintentional bias on the part of the scorer. Finally, in-person scoring limits the number of individuals who can be tested. Here we address these issues through the use of automatic speech recognition (ASR), an approach which is increasingly feasible given advances in artificial intelligence and speech recognition systems.

Design: Participants included 28 native speakers of English. Half of these participants had normal hearing in both ears (no threshold > 20 dB HL from 250-8000 Hz), while the remaining half of participants had bilateral sensorineural hearing loss. All participants were tested on common audiologic tests of speech recognition. These included 1) CNC words, 2) the Words in Noise test (WIN), 3) the QuickSIN, and 4-5) AzBio sentences in quiet and with a +10 signal-to-noise ratio (SNR) in multi-talker babble. Responses were scored both by an audiologist, and by our automatic speech recognizer (ASR) by converting the participant response to text via the Whisper AI Large Recognizer (v20250625). We then examined the correspondence between audiologist and ASR scoring for each of these tests, and the

correspondence between six different audiologists for the same test. Finally, we are repeating this process for Mandarin audiologic tests of speech recognition in quiet and noise.

Results: Correspondence for human and ASR scoring was 93% for sentence-based tests, and 81% for monosyllabic words. This correspondence was similar for patients with and without normal hearing, and did not vary depending on the baseline level of performance. In a random sample of 100 discrepancies between human and ASR scoring, approximately 50% of the discrepancies can be readily addressed by tuning our system, including the resolution of homonyms, the ASR system switching languages, or recording errors. The remaining errors occurred either on part of the ASR system itself, or in some instances the audiologist. While preliminary and ongoing, our results show high levels, but not perfect correspondence between different audiologists, and that this approach is also feasible for scoring of other languages such as Mandarin.

Conclusions: These results demonstrate that Automatic Speech Recognition is a feasible approach for scoring audiologic tests of speech recognition in quiet and noise in patients with normal hearing or with hearing loss. This approach enables open-set speech recognition tests to be measured in virtually any language either in clinical environments or remotely, and thus may have numerous clinical or research applications. We are presently refining our system to maximize accuracy, and to better characterize discrepancies between human and ASR scoring.

NASEM Committee Recommendations on Measuring Outcomes in Adult Hearing Interventions

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Objectives: This session will describe the process undertaken by a committee of the National Academy of Science, Engineering, and Medicine (NASEM) on "Measuring Meaningful Outcomes in Adult Hearing Health Interventions" and the associated recommendations for research and clinical contexts.

Design: The NASEM process will be described. The importance of outcome assessment in both clinical and research activities related to hearing interventions will be discussed. The process for identifying the core set of outcomes will be explained including why specific outcomes were and were not included in the recommended core set. Research needs suggested by the committee will be reviewed.

Conclusions: The recent NASEM report on Measuring Outcomes in Adult Hearing Health Interventions provided a recommended core set of outcomes in clinical and research contexts. Implementation of the core set will be discussed along with further research needs.

Primary Care Hearing Program for Underserved Older Adults: Feasibility Trial Results

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Objectives: Age-related hearing loss has a substantial negative impact on communication and biopsychosocial health. Despite its prevalence, hearing loss is under-recognized and often undertreated, especially within marginalized communities. We hypothesize a hearing screening and point-of-care rehabilitation in primary care in will be more accessible and acceptable than traditional hearing rehabilitation for an older underserved population.

Design: Patients in a geriatric safety net clinic were approached and offered hearing screening as a quality improvement initiative using a self-report survey tool (HHI) and a tablet-based screener (Shoebox). We recruited 120 participants with measured hearing loss into a randomized clinical trial focused on achieving pre-specified feasibility endpoints using mixed methods comparing: (1) a referral to audiology (usual care) or (2) a point-of-care counseling session on alternative hearing rehabilitation including individualized patients' preferences (intervention). Eligibility criteria included age ≥60 years, English or Spanish proficiency, and no active use of hearing rehabilitation. Participant demographics including prior hearing care experiences, smartphone use, socioeconomic characteristics were collected along with quality-of-life questionnaires. The electronic health record (EHR) was accessed to track audiology visits.In the intervention arm, subjects were counseled on effective communication strategies, smartphone accessibility tools, and demonstration of a personal sound amplifier. All subjects received a follow-up call to confirm understanding and reinforce strategies. At final 3-month follow-up, the research team assessed actions taken, query of EHR and re-administering HHI-S to evaluate the intervention's impact on hearing and communication. We also collected qualitative data to understand context for future implementation through semi-structured interviews with participants (n=10) and clinic staff (n=10).

Results: We conducted hearing screening in 360/951 (34%) patients approached. Of patients screened, 230/360 (64%) screened positive for hearing loss. The median age of participants enrolled in the trial was 79 years of age (IQR=7) with a majority non-white, having an annual income<$20,000 and reporting an education level of high school or lower. We found a significant disconnect with only 17% of those with measured hearing loss self-reporting hearing difficulty. Participants in the intervention arm received counseling about age-related hearing loss and communication strategies, and in addition 23/60 (38%) chose a personal amplifier, 10/60 (17%) selected instruction on smart phone accessibility features, and three participants selected both a personal amplifier and smartphone tools. Of those randomized to usual care, 27/60 (45%) scheduled an audiology appt and 16/60 (27%) had completed an audiology visit during the study period. To date, our follow-up rate at 3 months is 66% with 109 participants having reached the final 3-month time point.

Conclusions: Our program offers a novel approach for hearing loss identification and at the same point of care, equips patients with tailored rehabilitation strategies that have met pre-specified feasibility targets for acceptability of this patient-centered communication counseling program in a primary care setting serving underserved older adults. Our mixed methods data emphasize that current care pathways are not adequately serving the needs of this vulnerable population. A future larger efficacy trial is planned powered to measure the impact of this program on patient health and quality of life.

Disentangling Speech-Noise Separability from Noise Suppression Aggressiveness Using Behavioral Testing

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Objectives: Artificial-intelligence (AI)-based noise reduction systems are increasingly integrated into everyday communication devices, yet their ability to enhance speech intelligibility for human listeners remains uncertain. Traditional descriptions of noise reduction performance often frame outcomes as a trade-off between noise-suppression aggressiveness and speech distortion, implying that greater suppression inevitably harms intelligibility. This study introduces a signal-detection-theory framework that distinguishes speech-noise separability (the system's ability to tell speech apart from noise) from bias (how aggressively it removes energy classified as noise). It was hypothesized that declines in intelligibility arise not merely from over-suppression but from poor speech-noise separability - when the algorithm confuses speech and noise.

Design: Ten listeners with typical hearing (ages 19-24 yr) repeated sentences from the Hearing in Noise Test mixed at -5 dB signal-to-noise ratio in either speech-shaped noise or multitalker babble. Stimuli were processed by one research-grade attentive recurrent network and five consumer-grade AI-based noise-reduction systems (Apple Voice Isolation, Krisp, Microsoft Teams, Nvidia RTX Voice, and Zoom). After each trial, participants repeated the sentence (speech intelligibility) and rated perceived noisiness on a 1 to 5 scale. Mixed-effects models assessed the effects of processing and noise type. Posterior estimates were recast in a signal-detection framework to derive indices of speech-noise separability (analogous to d'), bias (operating threshold), and area under the receiver operating characteristic curve (AUC) for each system.

Results: All systems reduced perceived noisiness relative to the unprocessed baseline ($p < .001$), but only the research-grade attentive recurrent network improved intelligibility. In speech-shaped noise, the five consumer-grade systems decreased intelligibility by 16 to 52 percentage points. In babble, these five systems decreased intelligibility by 18 to 45 percentage points. The ARN showed high speech-noise separability ($d' \approx 2.3$; AUC ≈ 0.95), while consumer systems clustered near chance ($d' \leq 0.5$; AUC ≈ 0.3-0.5). Several exhibited negative separability, performing worse than chance – effectively treating speech as noise. Only Apple Voice Isolation in babble displayed separability reliably above chance ($d' \approx 1.0$; AUC ≈ 0.75). Systems with similar separability differed in bias, revealing different trade-offs: for example, Microsoft Teams and Nvidia RTX Voice showed comparable separability but different thresholds, with Nvidia operating more aggressively and discarding more speech.

Conclusions: The view of noise reduction as a fixed trade-off between suppression strength and intelligibility oversimplifies the problem. Effective speech enhancement requires both accurate speech-noise separability and appropriate noise suppression aggressiveness (bias control). Consumer-grade AI systems currently achieve comfort gains by reducing background noise but display limited or even negative separability, leading to poorer intelligibility despite improved noisiness ratings. The research-grade attentive recurrent network demonstrates that simultaneous improvements in both are achievable when separability is high, although this currently requires substantial computational resources. Clinically and practically, these findings suggest that perceived noise reduction does not guarantee communicative benefit, and that algorithm evaluation should explicitly consider speech-noise separability rather than suppression aggressiveness alone.

PODIUM SESSION V: AMPLIFICATION

Everyday Hearing: A Week in the Life of Young Children with Hearing Loss

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Objectives: Consistent hearing aid (HA) use is crucial for young children with hearing loss to access spoken language and support language development. Yet, little is known about how these children use their hearing aids in daily life-when, where, and for how long they actually wear them, and in what listening environments they find themselves. Most studies rely on datalogging data collected between clinic visits, offering only a limited snapshot of real-world use. To obtain a more detailed picture, this study monitored daily hearing aid use daily over the course of one week. In addition, we examined parents' knowledge, confidence, and experiences regarding hearing aid management, acknowledging their key role in promoting consistent device use. This study provides new insights into the everyday auditory environments and hearing aid use patterns of young children with hearing loss.

Design: Eighteen toddlers with bilateral hearing loss using HAs participated in this study. Each child received seven identical sets of HAs-one for each day of a seven-day measurement period. The study devices matched the children's own HAs in model and settings and were verified using the Desired Sensation Level (DSL) v5.0 fitting protocol. After the measurement week, data from all devices were analyzed to determine daily hearing aid use and auditory scene classifications. Listening environments were categorized as Calm Situation, Speech in Noise, Comfort in Noise, Media Streaming, or RogerDirect. Both parents completed the SPISE-R questionnaire assessing their knowledge, skills, and confidence in HA management and kept a daily logbook documenting contextual details of hearing aid use.

Results: Daily HA use showed considerable variability both within and between participants, ranging from no use to 16 hours per day. On average, children wore their devices for 8.8 hours daily, while parents reported 9.3 hours. In 11 of 18 children, HA use differed by more than two hours between ears on at least one day during the measurement week. Listening experiences varied by primary daily setting: on days mainly spent at home with parents, 22% of HA use occurred in noisy environments, compared to 17% on days with grandparents. When attending daycare, nearly half (48%) of HA use occurred in noisy conditions.Over half of parents (53%) reported high confidence in determining whether the HAs were working properly, and nearly all (92%) felt confident inserting and keeping them on their child. Most parents (77%) reported good device-handling knowledge, but only 23% felt they understood what their child can hear with and without HAs.

Conclusions: Detailed monitoring of daily hearing aid use and listening environments over the course of a week provides valuable insight into when, how long, and in which situations children use their devices. Combined with information about parents' confidence and knowledge regarding hearing aid management, these findings highlight important factors that may influence consistent device use and support strategies to optimize hearing outcomes in young children.

Benefits of Early Device Fitting Persist into Late Adolescence

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Objectives: The purpose of this phase of the longitudinal outcomes of children with hearing impairment (LOCHI) study was to assess whether early device fitting leads to sustained benefits in developmental outcomes during late adolescence. The outcomes of interest were language, auditory, cognitive, reading, psychosocial and health-related quality of life.

Design: We assessed outcomes in 257 16-19 year adolescents with hearing loss (HL) who used hearing aids (HA) or cochlear implants (CI) unilaterally or bilaterally, and 70 age- and sex-matched peers with normal hearing (NH) who completed a subset of measures. Outcomes were obtained using standardized tests and questionnaires. Multiple linear regression compared HL with NH, adjusting for nonverbal IQ, socioeconomic status (SES), and gender. Among HL, to assess the effect of fitting age and other variables (additional disabilities, IQ, SES, gender) on the numerous outcomes, separate regressions within HA and CI users evaluated the effect of fitting age on factor scores derived per domain. Consistent with guidelines, early HA fitting was defined as ≤4 months and early CI fitting as ≤12 months. In the HA group, 39.2% were fit early. In the CI group, 26.3% were fit early.

Results: After adjusting for IQ, SES and gender, HA users were 0.1 to 0.6 SD lower than the NH cohort with the smallest differences occurring for self-report expressive language and the largest differences evident for reading. CI users were 0.3-0.7 SD lower than their NH peers, with the smallest differences occurring for self-report expressive language and larger differences for reading and cognitive measures. In both HA and CI users, larger differences from the NH group were evident for the late- than early-fitted. Regression on factor scores indicated that in both HA and CI users, the presence of additional disabilities was associated with worse outcomes and being male was associated with better outcomes in auditory, and emotion and behaviour. Once IQ, gender, SES, presence of additional disabilities and HL degree were also accounted for, the effect of HA fit time was not significant among HA users. By contrast, late provision of CI (ie.> 12 months) was associated with ~0.5-SD reduction in language, reading and cognitive factor scores.

Conclusions: HA provision by 4 months and CIs by 12 months is associated with sustained benefits through late adolescence. Delayed fitting has a more pronounced adverse impact for CI than for HA users.

Survey of Amplification Practices for Adults with Normal Pure-Tone Thresholds

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Objectives: Adults presenting with normal or near-normal pure-tone hearing thresholds that report auditory difficulties represent a growing clinical population. Despite increasing interest among audiologists in fitting low-gain hearing aids for this population, the current clinical approach for fitting these devices is not well-documented. This study aimed to address this gap in knowledge by: 1) determining how frequently audiologists recommend and fit amplification for adults with normal or near-normal audiometric thresholds; 2) identifying the primary patient complaints, clinical criteria, and

diagnostic tools used to support amplification decisions; 3) evaluating device types, fitting approaches, and outcome measures employed; 4) assessing audiologists' perceptions of treatment benefit, usage patterns, and hearing aid return rates; and 5) exploring clinician-identified barriers and facilitators to care, along with desired resources for improved decision-making.

Design: An online survey was developed and distributed to practicing audiologists across diverse clinical settings. Data were captured from over 150 audiologists working in hospitals, ENT clinics, military facilities, private practices, university settings, and Veterans Affairs medical centers. The survey assessed clinicians' experiences with and approaches to amplification for adults with normal hearing thresholds, including case frequency, clinical decision-making processes, fitting protocols, and outcome assessment strategies.

Results: Across all practice settings, some audiologists reported fitting amplification for adults with normal or near-normal hearing thresholds. The primary patient complaints driving consideration for amplification were listening effort and history of traumatic brain injury or concussion. Additional factors influencing fitting decisions included patient-reported functional difficulties, poor performance on speech-in-noise testing, and presence of tinnitus. Most audiologists reported applying 5-10 dB of gain across frequencies from 1000-8000 Hz. Subjective feedback and device data logging were the most commonly used outcome measures. Usage patterns indicated that the majority of patients wore their devices more than six hours per day. Nearly all responding audiologists reported that patients' self-reported benefit was generally positive or very positive. The most commonly cited barriers to providing amplification for this population included lack of clinical practice guidelines and patient stigma associated with hearing aid use.

Conclusions: These findings demonstrate that amplification for adults with normal or near-normal hearing thresholds is already a current clinical practice across diverse audiology settings. Audiologists are successfully fitting this population with low-gain hearing aids, with high daily usage and positive patient-reported outcomes. Listening effort, cognitive factors, a history of traumatic brain injury, speech-in-noise difficulties, and tinnitus appear to be key clinical indicators guiding amplification decisions beyond traditional audiometric thresholds. The positive usage patterns and subjective benefit reported suggest that low-gain hearing aids represent a viable intervention for appropriately selected patients. However, the lack of standardized clinical guidelines and persistent stigma present significant barriers to care. Future research should focus on developing evidence-based protocols and outcome measures specific to this population to support clinical decision-making and optimize patient outcomes.Disclaimer: The views expressed in this abstract are those of the authors and do not necessarily reflect the official policy of the Department of Defense or the U.S. Government.

Concurrent fNIRS, EEG, and Perception Reveal DNN Noise Reduction Advantages

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Objectives: To evaluate potential differences in two hearing aid noise reduction methods, this study compared aided performance on a speech stream segregation task (SSST) presented in a realistic noisy background. In the experimental condition, a novel deep-neural network noise reduction (DNN-NR) algorithm was combined with a fixed-directional microphone strategy. In the comparison condition, a traditional noise reduction scheme used adaptive directionality combined with dynamic noise cancellation. Main outcomes included performance accuracy for identifying target words in the speech streams and concurrent neural processing indexed with functional near-infrared spectroscopy (fNIRS) and electroencephalography (EEG). The primary question was whether the DNN-NR would provide any advantage in accuracy or any changes in neural processing associated with either communicative or cognitive function.

Design: The 8-week, cross-over field trial design included 24 experienced hearing aid users (ages 60 to 90 yrs) who were fitted with Phonak Audeo Sphere Infinio behind-the-ear hearing aids with closed dome fittings. One group of participants was randomized to spherical speech in loud noise (SSLN; i.e., DNN-NR) for four weeks followed by speech in noise (SPIN; i.e., traditional) for four weeks. A second group had the opposite order. Preference for SSLN or SPIN was based on live evaluation of auditory preference (LEAP) involving a 3-person conversation conducted in an acoustically controlled Live Lab. Target word accuracy in the SSST was based on the Theo Victor Michael corpus. Target word frequency (rare or frequent) was counterbalanced between trials to modulate cognitive load. Speech streams were presented from a single spatial location randomly chosen on each trial (-90 -45 0 45 or 90 deg). Concurrent with the behavioral SSST, neural processing was indexed by fNIRS (39 channels) and by EEG (32 channels). Both LEAP and SSST were presented in diffuse café+music+noise background.

Results: Target identification accuracy was significantly higher (~8 percentage points) in the novel SSLN than the SPIN condition. In the SPIN condition, target word accuracy was significantly higher for the frequent than the rare condition, reflecting the linguistic challenge associated with word frequency. Accuracy in the SSLN condition was not dependent on word frequency, possibly reflecting a signal processing advantage in SSLN that overcame the associated lexical challenge. Concurrent fNIRS data showed significant reduction in oxygenated hemoglobin (HbO) in right dorsolateral prefrontal cortex and left superior temporal gyrus, consistent with reduced cognitive and auditory neural energy demand in SSLN versus SPIN conditions. Concurrent EEG time-frequency analysis showed significant increased theta band activity in right temporoparietal junction consistent with improved neural speech tracking and auditory attention in SSLN versus SPIN. The SSLN advantages indicated in the SSST were mirrored by 2.5 to 1 preference in the LEAP task for SSLN over SPIN during multi-person active conversation. Variations among field trial groups and measurement points (baseline, crossover, end) will be discussed.

Conclusions: Concurrent measures of speech identification, changes in blood oxygenation indexed by fNIRS, and changes in neural processing indexed by EEG, along with subjective preference during natural conversation, provided consistent and converging evidence of the significant advantages of the DNN-NR over traditional noise reduction.

Relating Hearing Loss, Cocktail Parties, and Social-Emotional Health

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Objectives: Hearing loss is linked to increased risk of loneliness and depression, but the mechanisms underlying this relationship are not well understood. One hypothesis is that difficulty hearing, especially in noisy social environments, leads to avoidance of such situations over time, resulting in risk of loneliness and depression. Hearing aids may mitigate this risk by enabling continued participation in noisy social activities. This study tested these hypotheses by examining relationships among speech-in-noise perception, time spent in speech-in-noise environments, loneliness, and depression in three groups: young adults with normal hearing, older adults with hearing loss who do not use hearing aids, and older adults who use hearing aids.

Design: This observational, cross-sectional study included 54 younger adults (18-25 years) with normal hearing, 58 older adults (55-85 years) with age-related hearing loss who do not use hearing aids, and 52 older adults with age-related hearing loss who use hearing aids. Speech-in-noise ability was measured using SNR50s from a standard laboratory test. Loneliness and depression were assessed with validated clinical questionnaires. To quantify time spent in noisy social environments, participants wore audio recorders for one week (younger adults) or two weeks (older adults) during waking hours. Recordings were processed with a modified version of YAMnet, a deep neural network for sound classification. Then, the proportion of time each participant spent in speech-in-noise was computed. Regression-based moderated mediation analyses tested whether greater time in noisy environments predicted lower loneliness and depression, and whether this relationship was moderated by speech-in-noise ability. Analyses for older adults also compared hearing aid users and non-users.

Results: Among younger adults with normal hearing, spending more time in noisy social environments was directly associated with lower loneliness. This effect was larger for individuals with better speech-in-noise ability. For those with average or better speech-in-noise perception, there was also an indirect association between time in noise and lower depression. Older adults with hearing loss who do not use hearing aids showed a similar pattern. In contrast, hearing aid users demonstrated an unexpected result: increased time in noisy environments was directly related to lower loneliness and indirectly to lower depression, but only among participants with poorer-than-average speech-in-noise ability. Overall, hearing aid users and non-users did not differ significantly in the amount of time spent in noisy social environments or in social-emotional outcomes.

Conclusions: These findings support the hypothesis that hearing-related behaviors-specifically, time spent in noisy social environments and the ability to communicate within them-are linked to differences in social-emotional health. However, the role of hearing aids is complex. For non-users, the relationship between engaging in noisy social environments and well-being may be ability-drive: those who hear better participate more and feel less lonely. For hearing aid users, the relationship may instead be resilience-driven: those with poorer hearing ability who remain socially active may experience better social-emotional outcomes despite limitations. These results highlight the need for longitudinal research on how hearing loss and hearing aid use influence real-world listening behavior and social-emotional health over time.

Health-related Quality of Life Benefits of Hearing Aid Use

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Objectives: The American Academy of Audiology Writing Group on Health-related Quality of Life (HRQoL) Benefits of Hearing Aids conducted a systematic review with meta-analyses to: (1) establish a graded recommendation regarding the impact of hearing aid use on HRQoL, and (2) assess amplification benefits for balance, cognition, and mental health. This talk provides an overview of the findings for Aim 1.

Design: The research was a systematic review with meta-analyses. The population included adults over 18 years of age with mild to profound SNHL, residing independently or in assisted living facilities; individuals in acute care, nursing homes, or incarceration were excluded. Interventions were hearing aids that varied in style, power sources, signal processing, microphone technology, fitting arrangement, service delivery method, and payment type. Literature published through December 31, 2024, was identified via major medical databases including CINAHL, Cochrane Library, EMBASE, MEDLINE, PubMed, Scopus, Web of Science Citation Indexes, ISRCTN Registry, ClinicalTrials.gov, and the WHO International Clinical Trials Registry Platform. Covidence software facilitated study selection, quality assessment (using the Revised Cochrane Risk-of-Bias Tool for Randomized Trials: RoB 2), and data extraction. Random-effects meta-analyses estimated effect sizes for both disease-specific and generic HRQoL outcomes.

Results: The database search yielded articles (5 merged = 9,620), with one additional record identified via manual searching yielding 9,621 records. Following the removal of 5,383 duplicates, 4,238 articles underwent title and abstract screening, resulting in 76 articles for full-text review. Of these, 8 study protocols, 13 randomized controlled trials (RCTs), and one systematic review of RCTs were included. For disease-specific HRQoL measures, random-effects meta-analysis produced a mean effect size of 1.245 (95% confidence interval: 0.877 to 1.613; $Z = 6.635$; $p < 0.001$), based on 8 RCTs with a total of 2,350 participants. The I-squared statistic indicated that 93% of variance was attributable to true effects rather than sampling error, suggesting considerable homogeneity among the RCTs. The prediction interval (PI) was -0.082 to 2.572 indicating that the true effect size in 95% of all comparable populations falls in this interval. For generic measures, six RCTs involving 1,568 participants demonstrated a mean effect size of 0.307 (95% confident interval: 0.133 to 0.481; $Z = 3.463$; $p = 0.001$). The I-squared statistic indicated that 59% of the variance was attributable to true effects rather than sampling error indicating low-to-moderate heterogeneity among the RCTs. The PI indicated that the true effect size in 95% of all comparable populations lies between -0.187 to 0.801. It is important to note that a PI that crosses the zero line does not indicate nonsignificant findings, but that the treatment may not be effective in all populations.

Conclusions: This systematic review and meta-analysis of RCTs identified a large effect size for disease-specific HRQoL measures and a small effect size for generic HRQoL measures. According to the Oxford Center for Evidence-based Medicine (2009), the evidence warrants a Grade A recommendation

supporting the use of hearing aids to improve HRQoL among adults with SNHL. These robust findings suggest healthcare providers should inform patients of these benefits, and may encourage third-party payers to support hearing aid coverage for eligible individuals unable to afford them.

Hearing Health among Older Korean Americans: Findings from K-HEARS Screen

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Objectives: Hearing loss is highly prevalent, yet few older adults use hearing aids and disparities based on race, ethnicity, and socioeconomic position exist. With limitations in nationally representative data, little is known regarding the hearing health of older Asian Americans, much less among specific ethnic communities. Older Korean Americans (KAs) are predominantly monolingual first-generation immigrants and have some of the highest rates of poverty among Asian Americans as well as high rates of limited English proficiency, which may contribute to hearing health disparities. The prevalence of hearing loss and hearing aid use among older KAs is not well understood nor the potential role of community-based hearing screening in promoting hearing health.

Design: An observational hearing screening study was conducted to recruit participants aged 60 and older from KA churches in a metropolitan area to examine the prevalence of hearing loss and hearing care behaviors along with hearing health behaviors longitudinally. Faith-based organizations, such as ethnic churches, serve as epicenters for health promotion activities across diverse immigrant communities. We mobilized 18 Korean ethnic churches in the target area. Over seven months, a total of 513 older Korean Americans underwent hearing screening. The research team completed questionnaires at baseline, 1-week, 6- and 12-months post-screening. The KHEARS Screening study represents one of the largest cohorts of KA older adults with hearing loss.

Results: We investigated the prevalence of hearing loss in community-dwelling KA older adults (60+ years) residing in the Baltimore-Washington metropolitan area. Among the screened 513 older KAs, participants were a mean of 72.6 years old, 61.5% self-identified as women, 54.1%<$50K annual household income, and 97.8% reported limited English. We found that more than half (55.4%, 285/513) had a clinically significant hearing loss and 56% of individuals reported never having their hearing screened. Of those with hearing loss, 61% had a mild degree of hearing loss and 39% with moderate or greater degree of hearing loss. Despite high levels of hearing loss, prevalence of current hearing aid use was low (12%), similar to findings in other under-resourced communities.Overall, the vast majority of participants felt that hearing screening was helpful (85.8% 440/513). One week following the screening, many reported no worries related to the screening, with 54.5% (278/510) reporting no worries. Longitudinally, at 6-months post-screening, 90.4% (464/513) completed the assessment. Among participants with hearing loss, 14.9% (38/255) saw a specialist and, of those, 76.3% (29/38) were recommended a hearing aid and 7.1% (18/255) newly obtained a hearing aid. Overall, at 6-months

follow-up, 10.1% (47/464) took some action following hearing screening. At 12-months, 85% (436/513) completed the assessment. Among participants with hearing loss, 22.3% (54/242) saw a specialist and, of those, 70.4% (38/54) were recommended a hearing aid and 9.1% (22/242) newly obtained a hearing aid. Overall, at 12-months follow-up, 14.4% (63/436) took action following hearing screening.

Conclusions: To the authors' knowledge, these findings represent the first estimates regarding hearing health among older KAs. Our findings demonstrate the utility of community-based hearing screening as a tool to enhance access to hearing care.

Can Hearing Intervention Build Cognitive Reserve in Older Adults?

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Objectives: Hearing loss is highly prevalent in older adults, is associated with significantly increased risk of cognitive decline/dementia relative to degree of loss, and is estimated by the Lancet Commission to be the equal largest worldwide potentially modifiable risk factor for dementia in developed countries. Hearing aids and cochlear implants are highly effective in improving speech perception and communication and could also be an effective intervention to build cognitive reserve in this population, delaying the onset of cognitive decline/dementia and promoting healthy aging and economic benefits. However, due to methodological limitations in many studies to date, the effects of hearing intervention on cognitive performance and dementia risk are unclear. The aim of these two studies (ENHANCE and COCHLEA) is to investigate the effects of hearing aid and cochlear implant use on cognitive performance in older adults across the trajectory of hearing loss.

Design: Two prospective longitudinal observational studies investigated cognitive performance in older adults (aged 60+ years) across the entire spectrum of hearing loss with hearing aids or cochlear implants through to 4.5 years post-device fitting, compared with that of a group of community-living adults with untreated hearing loss (Australian Imaging, Biomarker and Lifestyle Flagship Study of Ageing; AIBL). All participants were assessed at 18-month intervals from baseline using the same measures. Importantly, cognitive performance was assessed using a visually (not auditorily) presented battery, and dose (hours of use/day) and speech perception benefits were measured objectively. Five domains of cognitive function were assessed, rather than only global function. Panel regression was used to compare cognitive trajectories. These results are interim, as follow-up is not yet completed.

Results: On average, both groups of device users demonstrated no evidence of cognitive decline. There was significantly improved performance in executive function and working memory, and stability in attention, psychomotor function, and visual learning at 4.5-year follow-up. Effect sizes were larger for participants with more severe hearing loss, with amount of device use and age at device fitting predicting

cognitive trajectories. Comparatively, AIBL participants showed significantly greater worsening performance per year in attention and psychomotor function, and stability in working memory and visual learning.

Conclusions: These results provide high quality evidence that hearing interventions may delay cognitive decline and/or improve cognitive performance in older adults with mild through to severe-profound hearing loss, building cognitive reserve and delaying cognitive decline.

PODIUM SESSION VI: PHYSIOLOGY AND OBJECTIVE MEASURES

DPOAE Input-Output Functions in Preterm Neonates

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Objectives: Functional cochlear development in preterm infants is poorly understood, despite preterm birth accounting for roughly 10% of live births worldwide and 12% in the United States. Preterm infants are 20-30 times more likely to develop sensorineural hearing loss (SNHL) than full-term infants and are at increased risk for progressive and delayed-onset auditory deficits. Temporal bone studies and fetal imaging reveal structural cochlear immaturities around 36 weeks gestational age (GA), and preterm infants may also present additional outer hair cell deficits. These structural vulnerabilities suggest that preterm infants may experience early functional alterations in cochlear mechanics, yet key features such as compressive nonlinear function remain largely uncharacterized. Distortion-product otoacoustic emission (DPOAE) growth functions provide a sensitive, noninvasive tool to assess cochlear amplifier function, capturing both the growth and saturation of cochlear responses. The present study aimed to examine cochlear compressive nonlinearity in preterm infants. We hypothesized that preterm infants would exhibit weakened cochlear compression and altered DPOAE growth functions relative to term infants and adults, reflecting subclinical cochlear dysfunction. Characterizing these functional deficits may reveal early markers of cochlear impairment and inform strategies for early detection and intervention to reduce long-term SNHL risk in preterm populations.

Design: Ten preterm infants (25-36 weeks GA; 5 females), 15 full-term infants (37-40 weeks GA; 5 females) and 30 normally hearing young adults (18-34 years; 20 females) participated in this study. DPOAE growth functions were recorded using L2 levels from 20 to 70 dB SPL with the scissors paradigm. To optimize the signal-to-noise ratio (SNR), a fine-structure peak was identified near the f_2 frequencies of 2kHz and 4kHz. The resulting input/output functions were analyzed using segmented linear regression with a single breakpoint, allowing derivation of cochlear compression metrics, including the low-level slope (S1), compression slope (S2), and the breakpoint. Linear mixed-effects models were then applied to evaluate group differences in S1, S2, and the breakpoint. A minimum of 6-dB SNR was required for analysis.

Results: Preliminary analyses were conducted for L2 at 65 dB SPL. Mean DPOAE magnitudes (in dB SPL) for 2kHz were lower in preterms (9.77; ± 5.15) compared to both full-terms (9.79; ± 11.78) and young

adults (11.49; ± 6.44), but full-terms showed lower responses (-0.99; ± 8.30) at 4kHz compared to preterms (2.13; ± 6.70) and young adults (9.87; ± 6.04). Both infant groups exhibited lower mean DPOAE magnitudes and SNRs compared to young adults. DPOAE growth functions were successfully modeled using segmented regression with acceptable goodness of fit. Detailed analyses to compare estimated slopes and compression threshold across groups are currently underway.

Conclusions: These preliminary findings demonstrate that preterm and full-term infants exhibit reduced DPOAE magnitudes compared to adults, suggesting early cochlear functional differences. Segmented regression provided a reliable method for modeling DPOAE growth functions, supporting its use in assessing cochlear compression. Additionally, further analyses will clarify group differences in compression slopes and thresholds, providing insight into immaturities in cochlear compressive nonlinearity in preterm infants. Data collection is ongoing for infant groups.

Tuning in Tiny Ears: Optimizing Extended-High-Frequency DPOAE Levels in Newborns

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Objectives: The purpose of this study is to identify the optimal combination of stimulus levels (L_1 and L_2) and frequency ratio (f_2/f_1) that produce the largest extended-high frequency (EHF) distortion product otoacoustic emission (DPOAE) levels at $2f_1–f_2$ in newborns using swept-level paradigms. Establishing ideal parameters for EHF DPOAEs may improve the accuracy and sensitivity of cochlear assessments in newborns, particularly for early detection of changes related to ototoxicity or other auditory risks. Because newborn ear canals and middle ear properties differ from those of adults, existing clinical parameters (e.g., L_1/L_2 = 65/55 dB SPL; f_2/f_1=1.22) may not effectively evoke strong or reliable responses at the highest frequencies of hearing. By varying stimulus parameters and analyzing which combinations yield the most robust and repeatable DPOAE responses, this study aims to define optimal recording parameters that enhance the clinical utility of measuring EHF DPOAEs for evaluating newborn cochlear function.

Design: To date, 27 healthy newborns who passed their automated auditory brainstem response (ABR) hearing screening were recruited for testing. DPOAEs were measured at both conventional and EHFs (2-16 kHz) using a swept-level paradigm and simultaneous assessment of two frequency pairs within a single recording. The pairs tested were 2 and 10 kHz, 4 and 12 kHz, 6 and 14 kHz, and 8 and 16 kHz. Five f_2/f_1 ratios (1.10, 1.15, 1.20, 1.25, and 1.30) were evaluated, with varied stimulus levels. Stimuli were generated using an RME Babyface interface connected to an Etymotic Research ER-10X extended-bandwidth probe system. Calibration for the stimulus levels was enhanced using forward pressure level (FPL). For each frequency pair, the combination of stimulus levels and ratio that produced the largest DPOAE level were identified. These optimal parameters were used to characterize and assess repeatability of newborn EHF DPOAE response patterns.

Results: The greatest DPOAE levels across all frequencies were recorded when L_1 (65 dB FPL) was greater than L_2 (57 dB FPL). The ratio resulting in the largest DPOAE level varied with frequency with wider ratios needed at lower frequencies and narrower ratios required at higher frequencies. DPOAEs

measured with ideal stimulus parameters in newborn ears revealed average levels of 16 and -1 dB SPL for conventional and EHFs, respectively.

Conclusions: The largest DPOAE levels were recorded when L_2 was lower than L_1, as has been reported previously. Ideal stimulus ratios (1.21) for eliciting DPOAEs are comparable to other reports examining newborn ears at conventional frequencies. However, at EHFs even narrower ratios (1.15) were required to generate the largest DPOAE levels in newborns compared to younger (1.17) and older children (1.18). DPOAE levels measured with ideal stimulus levels and ratios are larger on average than using typical clinical stimulus parameters. Using optimal stimulus parameters to evoke EHF DPOAEs in newborn ears will enhance our ability to identify the earliest signs of cochlear damage.

Polygenic Factors Affect Young Adults' Middle Ear Muscle Reflex Thresholds

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Objectives: Although certain monogenic conditions have been shown to impact the function of the middle ear muscle reflex (MEMR), little is known about the genetic basis of its regular functioning. MEMR is regularly measured as part of audiological assessment and has been shown to potentially be associated with several different auditory pathologies, including hyperacusis, auditory neuropathy, and cochlear synaptopathy. Better understanding of the underlying biology and associated genetics of the MEMR is essential for both basic science purposes and could lead to further clinical applications of reflex testing.

Design: Puretone- and wideband-elicited MEMR thresholds were assessed in a group of 357 healthy young adults with self-reported normal hearing. 7218 single-nucleotide polymorphisms (SNPs) associated ($p< 5x10-6$) with age-related hearing loss (ARHL) in a previously performed genome-wide association study meta-analysis (meta-GWAS) were selected for analysis. Linear mixed effects models (LMM) were used to assess the effect of individual SNPs on MEMR thresholds. SNP's direction of effect on MEMR thresholds was compared to direction of effect in meta-GWAS using a chi-squared test. SNPs were mapped to their associated genes using ANNOVAR, then principal component analysis was performed to create a set of independent gene principal components (GPCs) for each gene. LMM was used to assess the effects of genes, represented by their GPCs, on MEMR thresholds.

Results: 254 SNPs were significantly associated ($p< 0.05$) with differences in MEMR among healthy young adults with normal hearing. When compared with the results of meta-GWAS, SNPs significantly associated with higher MEMR thresholds, i.e., a less active reflex, were significantly ($p< 0.001$) more likely to be associated with a lower likelihood of ARHL in meta-GWAS, and SNPs associated with lower MEMR thresholds, i.e., a more active reflex, were significantly more likely to be associated with greater likelihood of ARHL in meta-GWAS. Of 419 mapped genes, 24 were significantly associated with differences in MEMR thresholds among healthy young adults.

Conclusions: These results show that individual genetic variations associated with ARHL, as well as their mapped genes, are significantly associated with differences in MEMR thresholds among healthy young adults with normal hearing. This suggests that genetic effects influencing the auditory system later in life may also be influencing auditory function from a young age. These results suggest a consistent relationship between SNPs' effects on ARHL likelihood and MEMR thresholds. These results provide promising directions for future research, including localizing the expression of genes associated with

MEMR for biological insight and further investigating the consistent relationship between likelihood of ARHL later in life and young adult MEMR thresholds.

Unphased: The Medial Olivocochlear Reflex Doesn't Care About Binaural Phase

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Objectives: The medial olivocochlear reflex (MOCR), the final efferent stage to the cochlea, modulates cochlear gain, yet its functional role in humans remains debated. The MOCR is hypothesized to be otoprotective and aid in vertical plane localization and signal detection in noise. Despite the presence of binaural-specific neurons and potential inputs from both medial and lateral superior olives (M/LSO), most physiological evidence indicates that the MOCR integrates acoustic energy over time and across ears. We asked whether MOCR output is sensitive to interaural phase differences in binaurally dynamic stimuli. If so, the MOCR could play a role in adjusting binaural phase in the cochlea.

Design: To probe interaural phase sensitivity with minimal-to-no level difference between ears, we used binaural beats, a percept that arises only when phase information from the two ears is centrally fused. Click trains were delivered to one ear at 80 Hz and to the other at 80 Hz + Δf, with Δf = 0.25, 0.5, or 0.75 Hz to generate binaural beats percept at Δf Hz. A level-control condition presented 80 Hz trains to both ears but with amplitude modulation (AM) for one ear at 0.75 Hz to benchmark the known MOCR tracking of slow envelope fluctuations. A baseline condition presented identical unmodulated 80 Hz trains bilaterally. Conditions order was randomized across participants, and the ear receiving the fixed 80 Hz trains were flipped between left and right ears in two separate conditions. MOCR activity was indexed from click-evoked otoacoustic emissions using the MOCR time-course approach: we modeled and removed the reflexive exponential activation component and tested residuals for modulation at the beat (Δf) frequencies. As a neurophysiological check that binaural beats were elicited, we concurrently recorded 80 Hz auditory steady-state responses (ASSR) evoked by the same click trains. We also asked participants to report on the beat percept after every condition. Twenty young normal hearing adults participated in the study.

Results: ASSR confirmed robust binaural-beat responses in the afferent pathway. The change in ear receiving the fixed 80 Hz trains did not affect these results but produced interesting response phase shifts as a function of time. In contrast, MOCR output showed no significant modulation at the beat frequencies for either train phase. The level-control (AM) clicks produced measurable MOCR modulation in approximately half of participants and no MOCR modulations were observed in the baseline condition as expected.

Conclusions: These data indicate that, in humans, at least as measured using OAEs, the MOCR behaves predominantly as an energy integrator with limited sensitivity to interaural phase, presumably due to its relatively long temporal constants. Any putative binaural-comparator inputs (e.g., from MSO/LSO) are not evident in the efferent output measured at the cochlea with OAEs and are likely outweighed by inputs from energy-integrating pathways (e.g., T-stellate/small cells in the cochlear nucleus). Functionally, this "unphased" property may be advantageous: a stable efferent gain control avoids rapid phase-contingent

fluctuations ("shaky-video" like effects), thereby preserving the fidelity with which subtle amplitude and phase cues are encoded by the afferent system.

Hidden Hearing Loss: Cochlear Synaptopathy May Remain Elusive in Humans

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Objectives: In recent years, cochlear synaptopathy in humans has emerged as a major source of controversy and replication challenges. While animal studies show synaptic loss can persist after outer hair cell recovery, translating these findings to humans is difficult. Despite over a decade of research, reliably identifying synaptopathy using auditory evoked potentials remains challenging, as each method has notable limitations, even for detecting group-level differences. Envelope following responses (EFRs) have been proposed as a potentially more robust measure, based on high-threshold, low-spontaneous-rate fibers phase-locking to temporal envelopes. Behavioral and electrophysiological biomarkers show weak and variable correlations with peripheral neural integrity, highlighting the need for systematic evaluation.Meta-analysis provides a high level of clinical evidence and a framework to resolve inconsistencies. This presentation summarizes four key efforts: 1) a systematic review and meta-analysis of 22 studies (~850 participants) assessing EFR reliability for detecting cochlear synaptopathy; 2) investigations of MEMR in relation to extended high-frequency (EHF) thresholds; 3) an experiment examining EHF sensitivity and EFRs; and 4) analysis of cochlear compression effects on EFR metrics. Collectively, these studies examine the limitations of electrophysiological biomarkers and asses the overall quality of the evidence for synaptopathy in humans.

Design: A multi-modal, cross-sectional study with integrated meta-analysis was conducted. Experiment 1 measured MEMR growth functions from 60 to 95 dB HL in adults with normal audiograms and varied EHF thresholds (10, 12.5, and 16 kHz; n = 83). Experiment 2 measured suprathreshold EFRs at 40% and 100% modulation depths and EHF thresholds (n = 30). Experiment 3 measured EFRs and distortion-product otoacoustic emission (DPOAE) growth functions from 20 to 70 dB SPL for f_2 = 4 kHz (n = 35). DPOAE growth functions were fitted with segmented regression to obtain low-level slopes, compressive slopes, and breakpoints. Linear mixed-effects models examined relationships while adjusting for covariates. Experiment 4 (meta-analysis) used random-effects models to estimate pooled effect sizes, with subgroup analyses for etiology-specific effects (e.g., noise exposure, aging, tinnitus), heterogeneity, and publication bias.

Results: Experiment 1 showed that higher EHF thresholds were associated with shallower MEMR growth functions (estimate = −0.006, p = 0.025), adjusting for ear, sex, age, and standard-frequency thresholds. Experiment 2 revealed a negative correlation between EHF thresholds and EFRs at 40% modulation depth (r = −0.395, p = 0.015). Experiment 3 found that compression slope was positively associated with EFR strength at 40% depth (r = 0.4, p = 0.009), indicating stronger compression corresponded to lower EFRs. Meta-analysis revealed small pooled effects (−0.52 to 0.63) that were not statistically significant regardless of modulation type and depth, and no etiology-specific subgroup showed consistent differences.

Conclusions: EHF loss influences peripheral neural measures, with higher thresholds associated with shallower MEMR growth functions and reduced EFRs at low modulation depths. Cochlear compression also affects EFR strength, with stronger compression corresponding to lower suprathreshold responses, highlighting the role of nonlinear cochlear mechanics. Collectively, these findings suggest that subclinical

cochlear damage can confound measures traditionally used as proxies for cochlear synaptopathy. Including meta-analytic results, the evidence for cochlear synaptopathy in humans remains tenuous.

Subcortical Encoding of Temporal Envelopes Facilitates Speech Stream Segregation

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Objectives: In everyday acoustic environments, listeners must segregate target speech from competing sounds-a challenge known as the cocktail party problem. Both energetic and informational masking can interfere with speech perception, yet the neural mechanisms supporting speech-in-noise understanding remain unclear. The neural representation of periodicity at the brainstem level is thought to contribute critically to this ability. Envelope following responses (EFRs) provide an objective measure of brainstem temporal envelope encoding and can be assessed using amplitude-modulated stimuli with varying modulation depths. Low modulation depths closely mimic degraded envelope cues encountered in noise and may reveal the efficiency of brainstem encoding of periodicity, which supports talker fundamental frequency extraction and sound segregation. In this study we measured EFRs to amplitude modulated tones at low and high modulation depths and related this with speech-in-speech masking performance. We hypothesize that EFR metrics obtained at low modulation depths will correlate with speech perception in collocated, two-talker (sex-mismatched) conditions, but not with performance in speech-shaped noise, reflecting distinct neural mechanisms for informational versus energetic masking.

Design: The study included 37 young adults (aged 18-31 years; mean age = 20. 54 years; 8 males). EFRs were recorded using a 4000 Hz pure tone amplitude-modulated at 101 Hz. Two modulation depths were tested: 100% and 40%. The recorded waveforms were analyzed using a wavelet-based approach to compute phase-locking values (PLVs) and a fast Fourier transform (FFT) method to estimate signal-to-noise ratio (SNR) values. Speech recognition thresholds (SRTs) were measured using digit stimuli presented in the presence of either speech-shaped noise or two-talker maskers. The two-talker maskers included both same-sex and sex-mismatched talker conditions and talker-cues release from masking was computed.

Results: Mean talker-cues release from masking was 4.5 dB (SD=2.9). Initial correlation analyses showed that at the 40% modulation depth, PLV was significantly associated with talker-cues release from masking (r= ÔÄ≠0.38, p = 0.009). At 100% modulation depth, no significant relationship was observed. There was no relationship was observed with the speech shaped noise and the EFR metrices. Additional analyses that consider covariates are underway.

Conclusions: Subcortical encoding of temporal envelope at low modulation depths were correlated with the speech-on-speech masking performance especially when the talker cues are available. This highlights the importance of sustained envelope encoding in extracting pitch information from a talker during the stream segregation process. However, it may not directly relate to speech perception in the presence of speech-shaped noise.

Electrophysiological Measures of Binaural Hearing at the Brainstem Level

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Objectives: Binaural hearing refers to the auditory system's ability to integrate input from both ears to support spatial listening, speech understanding in noise, and sound localization. Measures of binaural processing serve as key indicators of auditory processing integrity, including binaural integration, interaction, and separation. One objective paradigm for assessing binaural hearing is the binaural interaction component (BIC) as an electrophysiological measure. The BIC is defined as the amplitude difference between the summed monaural responses and the binaurally evoked response, recorded from brainstem to cortical levels. The ABR is clinically valuable as the most widely used electrophysiological test. Low-frequency stimuli may be advantageous for recording the BIC in patients with residual low-frequency hearing, especially when evaluating outcomes of interventions such as hearing aids, cochlear implants, or bimodal devices. To date, relatively few studies have examined the relationship between BIC measures and behavioral indices of binaural performance. Therefore, the study aims to identify electrophysiological markers of binaural processing at the brainstem level by assessing the ABR-BIC to low-frequency tone bursts. Additionally, the study examines the degree to which they serve as neural correlates of behavioral binaural performance in young adults with normal hearing.

Design: Binaural processing was measured behaviorally and electrophysiologically in 29 young adults (21-29 years) with symmetrical normal hearing at 250-8000 Hz (≤20 dB HL), and symmetrical word recognition in quiet (ranging from 88-100 scores). Three behavioral tasks from CAPD battery were administered: Auditory Figure-Ground (AFG), 500-Hz Masking Level Difference (MLD), and Spondee Binaural Fusion (SBF). ABR recordings were obtained using 250-Hz and 500-Hz tone bursts presented at 100 dB peSPL under three stimulation conditions: right monaural stimulation, left monaural stimulation, and binaural stimulation. The BIC was derived by subtracting the binaural ABR from the summed monaural ABRs, with BIC peaks labeled Vd and VId, respectively.

Results: ABR-BIC Latencies were significantly longer for 250-Hz than 500-Hz, with VId consistently occurring later than Vd, suggesting that Vd and VId represent distinct BIC waves. However, ABR-BIC amplitude showed a frequency-dependent pattern. The amplitude of Vd was significantly larger than that of VId at 500-Hz, whereas at 250-Hz, the amplitude of VId was slightly larger, suggesting that low-frequency stimuli more effectively activated the later BIC peak. A significant relationship was found between ABR-BIC amplitude of VId and behavioral measures, specifically SBF scores ($rho = 0.36$, $p = 0.006$), with stronger correlation observed at 250 Hz ($rho = 0.43$, $p = 0.019$), indicating that greater VId amplitude was associated with higher SBF scores.

Conclusions: ABR-BIC waves Vd and VId may represent distinct electrophysiological markers reflecting different binaural generators at the brainstem level. ABR-BIC amplitudes showed frequency-dependent effects, with the later VId peak being more sensitive to lower frequencies, likely due to stronger low-frequency phase locking at higher auditory centers. Notably, VId amplitude may serve as a neural correlate of binaural fusion performance at the brainstem level, with this relationship most evident at 250-Hz tone burst. These findings provide a reference point for comparison with data from older adults in the ongoing investigation of age-related changes in binaural interaction.

Low-Frequency Cochlear Compressive Nonlinearity Altered by Extended High-Frequency Hearing Loss

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Objectives: Sensorineural hearing loss arises from damage to the cochlea. Such damage often develops gradually, preceding detectable changes on an audiogram. A key feature of cochlear mechanics is its compressive nonlinearity, which supports wide dynamic range, sharp frequency selectivity, and accurate encoding of complex sounds. Early disruptions to this nonlinearity can remain subclinical; for example, cochlear compression weakens with age even when hearing thresholds are unaffected. Extended high-frequency (EHF) hearing loss has emerged as a sensitive early marker of cochlear damage. EHF thresholds predict future declines in standard-frequency hearing and are associated with reduced otoacoustic emissions (OAEs) and broadened cochlear filter bandwidths at lower frequencies, suggesting that cochlear function may be compromised before conventional audiograms reveal deficits. Yet the impact of EHF loss on cochlear compressive mechanisms remains poorly understood. The present study tested the hypothesis that EHF hearing loss is associated with broader cochlear dysfunction, manifesting as altered cochlear gain and compression at lower frequencies, as estimated from distortion-product OAE input/output functions. Additionally, we examine how recreational noise exposure and age contribute to cochlear compressive function in adults with clinically normal audiograms. Understanding these relationships may enable earlier detection of cochlear dysfunction and inform interventions to preserve auditory function before overt hearing loss emerges.

Design: Sixty-eight adults (ages 18-34) with normal audiograms participated in this study. Noise exposure was estimated using the Noise Exposure Structured Interview. DPOAE input/output functions were measured with L2 levels ranging from 20 to 70 dB SPL using the scissors paradigm. We employed an innovative approach by locating a fine-structure peak near the f_2 frequencies (1, 2, 4, and 6 kHz) to maximize the signal-to-noise ratio (SNR). Input/output functions were modeled using segmented linear regression with a single breakpoint, from which cochlear compression metrics—low-level slope (S1), compression slope (S2), and the breakpoint—were derived. Linear mixed-effects models were used to examine the effect of EHF sensitivity on S1, S2, and breakpoint while adjusting for age and noise exposure.

Results: DPOAE input–output functions were well fit using the segmented regression method, with acceptable goodness of fit across participants. Preliminary analyses revealed a significant age-related decline in EHF sensitivity ($r=0.40$, $p< 0.0001$). Elevated EHF thresholds were significantly associated with reduced DPOAE magnitude and SNR, particularly at 4 kHz (all $p<0.05$) and 6 kHz (all $p<0.01$). In contrast, no significant associations emerged at 1 or 2 kHz. Higher EHF thresholds were also linked to alterations in DPOAE compressive slope and breakpoint estimates at 4 kHz, with further analyses ongoing.

Conclusions: Elevated EHF thresholds, even in individuals with normal audiograms, are associated with weakened cochlear mechanics. Subtle outer hair cell dysfunction in the basal cochlea appears to reduce responses at lower frequencies, reflecting early changes in nonlinear cochlear processing. These findings suggest that EHF hearing loss marks early-stage cochlear damage extending beyond the basal region, affecting cochlear gain and compression at standard frequencies. Further analyses will clarify how EHF loss relates to specific compression metrics.[The project is partly supported by NIH/NIDCD R01DC018046.]

EARLY CAREER PODIUM SESSION I:

Outcomes of a Pilot Screening Program for Age-Related Hearing Loss

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Objectives: Systematic screening for age-related hearing loss could promote its awareness and earlier detection and management. This study reports the outcomes of a large-scale pilot screening program for age-related hearing loss.

Design: A pilot program to screen for age-related hearing loss was implemented in two Family Medicine and three Otolaryngology (ENT) clinics at the Medical University of South Carolina between July 2017 and December 2020. Following meetings with key stakeholders, the screening program was created in the Epic electronic health record (EHR). All processes, including generating automatic referrals to audiology clinics, were integrated into Epic. During the appointment intake session, clinical practitioners were prompted through the EHR to ask patients aged ≥65 years 3 simple screening questions with branching logic: (1) Do you think you have a hearing loss?; if "Yes," (2) Are you being treated for hearing loss?; if "No," (3) Would you like a referral to audiology?; if "Yes," an automatic referral was generated; if "No," "Why not?". We report the outcomes of this program in terms of responses to screening questions and the demographic and clinic-level factors associated with responses. In addition, we report the association of screening with hearing health care use (visit to audiology), defined as the presence of ≥1 hearing-related procedural/diagnostic code in patients' EHR within 1 year, by comparing patients who underwent screening with a group of non-screened patients (a 'control group' who did not participate in the pilot program). Results are presented as odds ratios (OR) with 95% confidence intervals (CI).

Results: This study includes 5,360 screened and 4,106 non-screened patients. Screened (mean age 73.0 [SD 6.7] years; 58.3% female) and non-screened patients (mean age 72.0 [SD 6.7] years; 56.4% female) were matched for age and sex. Among screened patients, 43% reported hearing loss, 38% of whom reported not being treated. Among patients who reported hearing loss and no treatment, 51% requested a referral to audiology. Patients who declined a referral reported not wanting treatment now (42%), having other priorities (8%), intention to seek treatment elsewhere (7%) and not being able to afford a hearing aid (3%). Demographic factors (age, sex, race, insurance, marital status) and clinic-level factors (date of screening, provider, clinic location) were associated with responses to screening questions. Among patients who requested an audiology referral, 52.4% used hearing health care; of those patients, 21.5% obtained hearing aids. For patients seen in Family Medicine clinics, screening was associated with an over five-fold higher likelihood of hearing health care use in a multivariable model (OR 5.36 [CI 1.92, 14.94]).

Conclusions: This screening program identified a high proportion of adults aged ≥65 years with perceived hearing loss, many of whom were untreated and were interested in a referral to audiology.

Approximately half the patients who requested a referral were seen in audiology, nearly a quarter of whom obtained hearing aids. Patients screened in Family Medicine clinics (vs control group) were over 5 times more likely to use hearing health care. Hearing screening among older adults could facilitate its timely identification and management.

Target-Shift and Target-Motion Release from Masking Using Continuous Speech

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Objectives: Spatial release from masking is widely used to assess individual sensitivity to spatial hearing. Traditionally, it has been examined with both the target and masker(s) presented at fixed azimuthal locations. This study investigated how dynamic spatial cues, continuously updated by either systematic or random target motion, influence spatial release from masking compared to a stationary-target condition.

Design: Twenty young adults with normal hearing completed continuous number categorization tasks in multi-talker noise, indicating whether each number in the concatenated monosyllabic target speech stream was greater or less than five. Two masker streams (one male and one female) were presented together from the front loudspeaker, while the target stream was either co-located with or spatially separated from the maskers. The task was performed under three conditions: (1) stationary target, (2) progressively moving target, and (3) randomly moving target. In the stationary condition, the target locations were fixed at azimuths of 0°, −7.5°, −15°, −22.5°, −30°, −45°, and −60°, under varying target-to-masker ratios (TMRs) ranging from −18 to 0 dB. In the two moving conditions, the target was presented at a fixed −9 dB TMR. Additionally, the progressive moving condition was conducted at a level relative to each individual's performance in the co-located, stationary condition, corresponding to the TMR that yielded 50% accuracy. At a spatial resolution of 7.5°, the target stream moved back and forth over a range between −60° and 60° either progressively (smoothly) in azimuth or randomly, jumping from location to location. Behavioral results were further compared with predictions from a modified binaural short-time objective intelligibility (MBSTOI) model using a KEMAR manikin.

Results: In the electroacoustic analysis, MBSTOI exhibited a shallow V-shaped pattern centered around 0° (co-located) and reached its maximum when the target was separated by ±52.5° from the maskers. Behavioral results also showed a V-shaped pattern across all test conditions. The progressively moving target condition produced the highest co-located accuracy but demonstrated a slower spatial release from masking compared to the stationary and randomly moving conditions. The lowest co-located accuracy was observed in the randomly moving condition, which displayed the steepest masking release curve. An angular separation of 15° resulted in near-ceiling performance, with an improvement of approximately 30% in both the stationary and randomly moving conditions. However, under the progressively moving condition at the TMR yielding 50% co-located performance, roughly 30° of separation was required to achieve near-ceiling accuracy.

Conclusions: These findings indicate that predictable dynamic cues from systematic target motion enhance stream segregation near co-location compared to static cues in the stationary condition.

However, continuous motion may diminish inherent sensitivity to static spatial cues at a given location or delay the effective exploitation of those cues.

Development of a Hearing Loss-Focused Music Enjoyment Instrument

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Objectives: Validated instruments assessing the musical experience of individuals with hearing loss (HL) have focused predominantly on cochlear implant (CI) users and primarily targeted perceptual abilities such as pitch and timbre recognition. While these assessments have advanced understanding of auditory perception, they overlook the broader emotional, cognitive, and social dimensions that constitute musical reward (i.e., music enjoyment or appreciation). In addition, musical experiences of hearing aid (HA) users and unaided individuals with HL, who represent most of the HL population, remain understudied relative to CI users. Existing measures of music reward developed for normal hearing (NH) individuals have not been validated in the HL population and do not account for the significant impact of HL on music appreciation. This study aims to develop an item bank that will serve as the foundation for a patient-reported outcome measure (PROM) assessing musical reward and its hearing-related contributing factors across the adult HL spectrum.

Design: Following Patient Reported Outcomes Measurement Information System (PROMIS) guidelines, participants with a range of HL and hearing device usage were recruited to develop the initial item pool. Forty-seven adults (mean age 54 years, range 18-89) representing diverse age, education, musical background, hearing device usage, and HL severity (4 NH, 5 unaided HL, 22 HA, 16 CI) participated in semi-structured interviews exploring their musical experiences until data saturation was reached. An abductive mixed-methods approach was used to iteratively refine the conceptual model of musical reward, integrating qualitative patient insights and existing theoretical frameworks. Two reviewers independently coded interview transcripts and synthesized key themes into domains representing musical reward and hearing-related factors. After defining domains, an initial item pool was generated based on existing validated constructs and emergent qualitative findings. Cognitive interviews were conducted with 20 participants not involved in initial interviews to ensure item clarity. All data were

reported according to the Consolidated Criteria for Reporting Qualitative Research. Recruitment occurred through a tertiary referral center and community HL support groups.

Results: After thematic analysis, we developed a conceptual framework describing how hearing-related factors interact to shape music engagement, and ultimately, musical reward. Five key hearing-related factors (musical preference, music perception, listening environment, sound quality, and social interaction) enable or constrain two modes of music engagement: passive (listening) and active (e.g., participation in a musical activity such as singing or playing an instrument). Through these engagement pathways, individuals reported diverse emotional responses (e.g., nostalgia, joy) and described using music for mood regulation, both of which moderate overall musical reward. Using this framework, we developed an initial item pool of 88 items covering hearing-related factors, modes of engagement, and reward. Cognitive interviews with 20 new participants confirmed item clarity and comprehensibility

Conclusions: Key informant interviews with target population stakeholders provide a robust foundation for developing a HL-specific music enjoyment PROM. This study establishes a multidimensional, patient-centered framework capturing contextual factors influencing music enjoyment in HL. The resulting item pool lays the groundwork for psychometric validation and item calibration to develop a standardized PROM accurately reflecting lived experiences of musical reward across the spectrum of HL.

Hearing Aid Benefit in Adults: Interactions Between Temperament and Self-Efficacy

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Objectives: Adults with hearing loss show large variability in subjective hearing aid (HA) outcomes, even after accounting for demographic and audiologic factors. Outcomes such as HA benefit have been examined through descriptive trait-based characteristics (e.g., personality), which demonstrate only modest effects. Temperament reflects biological processes underlying regulatory abilities and reactivity that contribute to constructs such as personality, and inclusion of temperament in investigations allows for theoretical exploration within interactive models that account for how multiple individual characteristics influence outcomes. This study investigated (1) the relationship between temperament and HA benefit in adults and (2) whether HA self-efficacy (a factor commonly targeted during intervention) moderates this relationship.

Design: Sixty-one adults with bilateral sensorineural hearing loss (mean age = 73.46 years, SD = 7.16) were recruited from the Veterans Affairs Northeast Ohio Healthcare System. Participants were binaural users of Phonak receiver-in-canal HAs for at least 6 months, passed a cognitive screening, and underwent HA verification. The design was cross-sectional and used validated self-report questionnaires to assess individual-level characteristics: adult temperament (Adult Temperament Questionnaire–Short Form; ATQ-SF), HA self-efficacy (Measure of Audiologic Rehabilitation Self-Efficacy for Hearing Aids; MARS-HA), and perceived HA benefit (three subscales of the Abbreviated Profile of Hearing Aid Benefit; APHAB).

Results: Surgency-Extraversion was positively correlated with HA Self-Efficacy, $r(61)=.277$, $p=.030$. Both Effortful Control, $r(60)=.298$, $p=.021$, and Surgency-Extraversion, $r(61)=.258$, $p=.045$, were positively correlated with APHAB scores. The moderation model, $R2=0.17$, $F(4,55)=2.77$, $p=.036$, examining the interaction between Effortful Control and HA Self-Efficacy, $\Delta R2=0.07$, $F(1,55)=4.48$, $p=.039$, revealed that

Effortful Control was positively associated with APHAB scores when HA Self-Efficacy levels were moderate (b=11.51, p=.006) to high (b=19.03, p=.004). The model, R2=0.13, F(4,55)=2.18, p=.083, that included the interaction between Surgency-Extraversion and HA Self-Efficacy, ΔR2=0.06, F(1,56)=3.67, p=.060, was marginally significant. However, there was evidence that Surgency-Extraversion was positively associated with APHAB scores when HA Self-Efficacy was low (b=13.38, p=.010). Similarly, the model, R2=0.09, F(4,55)=1.54, p=.228, examining the interaction between Orienting Sensitivity and HA Self-Efficacy, ΔR2=0.05, F(1,56)=3.26, p=.076, showed marginally significant effects, with evidence of a negative association between Orienting Sensitivity and APHAB scores when HA Self-Efficacy was high (b=-11.37, p=.043).

Conclusions: Preliminary results suggest that adults with temperaments consistent with positive emotionality and self-regulation appear to present with traits that may facilitate greater perception of HA success within the domains of benefit assessed in this study. Increased levels of HA self-efficacy appear to support adults with greater self-regulation, but there was evidence that adults with greater positive emotionality perceived high levels of HA benefit even with low HA self-efficacy, perhaps highlighting resiliency for adults with positive dispositions in the presence of low HA self-efficacy. The evidence of lower perceived benefit associated with adults high in perceptual sensitivity and self-efficacy may highlight the need for additional support for adult HA users prone to sensory overstimulation. These findings have important clinical implications on patient-centered care practice during HA interventions and aural rehabilitation.

Mapping the Multisystem Burden of Tinnitus: Subtype-Specific Comorbidity Patterns Across the Health Phenome

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Objectives: Understanding how tinnitus relates to other health conditions is crucial for improving prevention and treatment strategies. While tinnitus subtypes vary widely in their clinical presentations, their distinct comorbidity landscapes remain largely unexplored. This study aims to fill this critical gap by systematically mapping the associations between diverse health conditions and tinnitus subtypes across the entire health phenome in a biobank-scale cohort.

Design: A cross-sectional, data-driven, hypothesis-free Phenome-Wide Co-occurrence Association Study (PheCAS) was conducted to analyze patterns of co-occurring clinical health conditions with tinnitus. Baseline data from the UK Biobank database (2006-2010; n = 186,363) was utilized to investigate the associations between 3,612 health conditions, derived from ICD-coded electronic health records mapped to phecodes, and self-reported tinnitus. Tinnitus subtypes were classified by occurrence (Frequent, Occasional, and Remitted) and severity (Bothersome and Non-bothersome). Logistic regression models were used to evaluate co-occurrence patterns between each phecode and tinnitus subtypes. The results of the PheCAS were evaluated using enrichment analysis, where a hypergeometric test was performed to identify trait categories significantly overrepresented among comorbidities associated with each tinnitus subtype. Categories with an adjusted false discovery rate (FDR) p-value< 0.05 were considered significantly enriched.

Results: Results of PheCAS identified comorbidities associated (FDR p< 0.05) with five tinnitus subtypes based on occurrence and severity, including 191 comorbidities for frequent, 194 for occasional, 258 for remitted, 416 for bothersome, and 200 for non-bothersome tinnitus. Gastroesophageal reflux disease, asthma, hearing impairment, Meniere's disease, irritable bowel syndrome, angina pectoris, major depressive disorder, anxiety disorders, diaphragmatic hernia, and gastritis emerged as the top predictors across all five tinnitus subtypes. The results of enrichment analyses revealed that gastrointestinal and respiratory traits were significantly enriched across all five tinnitus subtypes, whereas mental health traits showed significant enrichment only for bothersome tinnitus.

Conclusions: This PheCAS systematically mapped comorbidity patterns for tinnitus subtypes, revealing distinct multisystem patterns of association. By systematically evaluating 3,612 health conditions across 18 major disease categories, we demonstrate that tinnitus is linked to a diverse range of conditions spanning gastrointestinal, respiratory, cardiovascular, neurological, mental health, and hearing-related domains. These findings underscore the complex and heterogeneous nature of tinnitus, revealing distinct comorbidity patterns across tinnitus subtypes. The results are consistent with the polygenic inheritance of tinnitus, suggesting that a personalized, system-level approach is essential for advancing precision medicine in the assessment and management of tinnitus subtypes.

EARLY CAREER PODIUM SESSION II:

Distortion Product Otoacoustic Emission (DPOAE) with Tympanometry and Conditioned Play Audiometry (CPA) Protocols for Preschool Hearing Screening: A Comparative Study

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Objectives: 1) To compare the pass and fail rates of the DPOAE+ Tympanometry and CPA protocol in a preschool hearing screening. 2) To compare the time to complete the test for DPOAE+Tympanometry and CPA protocol.

Design: A prospective cross-sectional study was done on 40 preschool children, 5-6 years old, at Santa Barbara Central Elementary School. They underwent: 1) DPOAE + Tympanometry) and 2) Conditioned Play Audiometry. The time to complete the tests was compared using a paired sample T-test. Results for both protocols were compared using the McNemar Test of Proportion.

Results: There was a significant difference ($p<0.001$) between the time to complete the DPOAE+Tympanometry protocol ($x=4.43$ min, $SD=1.11$) and the CPA protocol ($x = 5.55$ min $SD= 1.47$). The PASS rate for CPA is 77.5%, while that of the DPOAE +Tympanometry is 67.5%. The REFER rate for CPA was 22.5% while that of DPOAE+ Tympanometry is 32.5%. Fifty-eight percent of participants had a PASS result, and 13% had a REFER result on both protocols. Thirty percent of participants presented with conflicting results. The McNermar proportion test revealed insufficient evidence to reject the null hypothesis ($p=0.388$); therefore, there is no statistical difference between the results of both protocols.

Conclusions: There was no significant difference in the results of the DPOAE+Tympanometry and CPA screening protocols. The DPOAE+Tympanometry protocol is significantly faster to complete. Therefore,

the DPOAE+Tympanometry screening protocol is a good alternative to screen preschool children less than 6 years old for on-site testing.

Perceived Self-Competency in Children Who Are Hard of Hearing

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Objectives: Positive psychosocial outcomes are critical to overall development for all children. However, our understanding of psychosocial development in children who are hard of hearing (CHH) is limited. In the current study, we will focus on one area of psychosocial development, perceived self-competence, defined as one's competence in skill areas necessary to deal with life events. We hypothesize that hearing group and sex will predict self-competency. We also hypothesize that degree of hearing loss will impact self-competence across domains. Finally, we hypothesize that spoken language outcomes will predict self-competency.

Design: The current study included 107 CHH and 61 children with typical hearing. These children were part of the Outcomes of Children with Hearing Loss Consortium, a longitudinal examination of developmental outcomes in CHH across hearing, language, academic, and psychosocial outcomes. Data from 2nd and 4th grade visits were included in the current analysis. Perceived self-competence was measured via the Perceived Competence Scale for Children, which was comprised of 21 questions and 6 domains (communication, teasing, friendship, physical appearance, empathy, and self-esteem). Instructions and questions were recorded and played aloud for the child, as well as presented visually via PowerPoint. More positive self-identification earned a higher score, with potential scores ranging from 1-4 on each question. Linear mixed models were used to assess the effect of hearing loss group (typical hearing, hard of hearing), sex, and grade on total score for perceived self-competence. We also examined effect of domain, degree of hearing loss (typical hearing, mild, moderate, severe) and grade on scores, including participant as a fixed effect. Finally, we examined the effect of spoken language outcomes on perceived self-competence scores.

Results: Results indicate a significant effect of hearing loss group on perceived self-competency, such that CHH had poorer total scores on the questionnaire than children with typical hearing. No effects of grade or sex were present. Domain-specific analyses revelated that within the domains of teasing, children with severe hearing loss showed the least adequate self-competency (i.e., reported identifying with being teased more often), compared to children with typical hearing, mild hearing loss, and moderate hearing loss. Children with mild hearing loss showed significantly poorer self-competency on friendship and physical appearance domains compared to children with typical hearing. There were no significant differences between groups on communication, empathy, or self-esteem domains. Analysis of spoken language outcomes is forthcoming.

Conclusions: As hypothesized, CHH show poorer perceived self-competence than children with typical hearing. Domain specific effects suggest that children with mild hearing loss may be at greater risk for poorer psychosocial outcomes, such as less comfort with their appearance and poorer quantity and quality of peer relationships relative to their typical hearing peers. Likewise, children with severe hearing loss were at significantly higher risk for self-reported teasing and bullying compared to typical hearing

and other hard of hearing peers. Families, teachers, and clinicians of CHH should consider these risks for psychosocial challenges when evaluating a child's holistic functioning and well-being.

Deep Learning Extraction of Audiogram Data from Electronic Health Records

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Objectives: Electronic health records (EHRs) store images of audiogram test sheets that are valuable for epidemiologic research, clinical decision support, and predictive modeling, but which remain largely inaccessible for structured analysis at scale. Our objective was to develop a method to automatically extract structured hearing threshold data from hand-filled audiogram test sheets.

Design: We developed and validated a method using a convolutional neural network-based object detection model (You Only Look Once; YOLO) to automatically extract and localize hearing threshold data from hand-filled audiograms. We randomly sampled 398 audiograms completed between Jan 1, 2014 and Dec 31, 2022 at a single academic health network, stratified to ensure balanced representation of normal hearing, symmetric sensorineural, asymmetric sensorineural, conductive, and mixed hearing loss. For each image, threshold values were manually extracted and bounding boxes were placed around audiometric symbols and axis labels by two trained annotators to provide human-labeled data for model training and evaluation. The data were split with 80% used for training and 20% reserved for model evaluation.

Results: The pipeline begins with image cropping to isolate the pure-tone plot to improve computation efficiency. Next, a pretrained YOLO model is fine-tuned using 319 cropped images to detect and classify each of 8 audiometric symbols representing all combinations of: left/right ear, air/bone conduction, masked/unmasked conditions. In parallel, another YOLO model is fined-tuned to identify axis labels representing frequency (Hz, x-axis) and hearing level (dB HL, y-axis), Finally, the coordinate calibration stage maps the detected symbols from pixel space to audiogram coordinate space, and the digitization module outputs the corresponding frequency-threshold pairs for each symbol. Symbol frequency detection achieved a precision of 1.00 (the model correctly identified the frequency coordinate for all symbols it identified), recall of 0.93 (the model successfully identified 93% of all symbols) and F1 score of 0.96 (the harmonic mean of precision and recall that balances both metrics for an overall evaluation of model performance). Symbol threshold detection yielded precision, recall, and F1 score of 0.92 each. When both frequency and threshold coordinates were jointly evaluated, the model maintained precision of 0.93, recall of 0.93, and F1 score of 0.92. Since symbol frequency detection precision was 1.00, the mean absolute error (MAE) for frequency was 0 Hz. Among the 8% of symbol thresholds that were incorrectly estimated, the MAE was 5 dB HL.

Conclusions: The deep learning approach reliably extracted hearing threshold data from scanned clinical audiograms with perfect accuracy for identifying the frequency of all symbols and near-perfect accuracy for all thresholds with clinically acceptable error. Automation of extracting structured data from audiograms stored as images in the EHR unlocks a rich historical data resource for hearing health

research and supports efforts towards a learning health system for hearing care. Current work is limited to a specific audiogram test sheet layout from a single institution and extraction of pure tone thresholds. Ongoing development will expand generalizability across diverse formats and develop models for concurrent extraction of impedance and speech testing results.

Phoneme-level Processing Deficits Reveal Speech Perception Challenges in Middle-age

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Objectives: Speech perception challenges often emerge in middle-age, even in the absence of hearing loss. These subclinical challenges account for more than 10% of adults seeking clinical evaluation for listening difficulties, underscoring the need to understand mechanisms beyond peripheral hearing loss. Recent neurophysiological data suggests the presence of neural dedifferentiation in middle-age based on less specialized and more widespread cortical processing of phonemes. This neural dedifferentiation is characterized by less neural specificity both for phonemes within a manner class (e.g., stops) and between manner classes. Here, we test the extent to which perceptual discriminability of phonemes within a manner class is impaired in middle-age. To understand the mechanism underlying potential behavioral deficits, we applied a neurobiologically grounded drift-diffusion model to quantify decisional processes involved in the acoustic-to-phonetic mapping that underlies speech perception. The drift-diffusion model assumes that this mapping process outputs sensory evidence that is accumulated through an increase in neuronal firing rates, reflecting the quality of evidence and processing speed, until a threshold is reached and a response is made. We hypothesized that middle-aged adults would show poorer perceptual discriminability of phonemes than younger adults due to poor sensory evidence accumulation from phonemic information, despite normal hearing. We also compared syllable-level perception against word-level and sentence-level perception from the Words in Noise and Quick Speech in Noise (QuickSIN) tests, respectively, to understand how local- and global-context may aid middle-aged listeners.

Design: Twenty-nine younger (18-25 years) and twenty-six middle-aged (40-55 years) adults with normal hearing categorized stop phonemes in syllable-context (/ba/, /da/, /ga/) in quiet and in speech-shaped noise at signal-to-noise ratios: +8, -2, -6, and -9 dB. We simultaneously analyzed categorization accuracy and response times using a drift-diffusion model to examine the quality of evidence accumulated and the evidence threshold listeners needed to meet to make a decision. Higher evidence accumulation rates reflect better evidence quality and thus faster processing speeds, and higher thresholds suggest more cautious responding

Results: Compared to younger adults, middle-aged adults had significantly lower accuracies and longer response times in quiet and at easier signal-to-noise ratios, indicating poorer discriminability of within-class phonemes even in quiet listening conditions. The drift-diffusion model revealed that middle-aged adults were just as cautious as younger adults to make a response, but the quality of sensory evidence was poorer in middle-age, resulting in reduced processing speeds. Further, age-related differences in perception decreased with increasing contextual information, suggesting that speech-in-noise tests with more local- and global-context may minimize middle-age speech perception challenges.

Conclusions: Our results suggest that middle-aged speech perception challenges in the absence of peripheral deficits may derive from poor acoustic-to-phonetic mapping. In the context of neural dedifferentiation, less neural specificity for phonemes may lead to poor sensory evidence accumulation, and thus, slower neuronal firing rates to accurately discriminate phonemes from others within its own class. Additionally, our findings encourage the use of syllable-level speech perception tasks as a method for identifying speech perception challenges in middle-aged adults with normal hearing, as the traditional QuickSIN and Words in Noise tests minimized age-group differences.

Extended High-Frequency Loss Reveals Subclinical Cochlear Dysfunction Beyond Suprathreshold Processing

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Objectives: How extended high-frequency hearing loss (EHFHL) contributes to difficulty understanding speech in noise (SiN) is not yet fully understood. One possibility is that EHFHL reflects early, subclinical cochlear damage that extends into standard-frequency regions, degrading suprathreshold auditory processing before threshold elevation is evident on the audiogram. This study aimed to determine whether such early cochlear dysfunction is linked to impaired SiN perception in school-aged children with EHFHL.

Design: Seventy-eight participants aged 8-17 years (mean = 12.1 ± 2.8) with clinically normal standard audiograms completed extended high-frequency (EHF) audiometry; SSQ-12 (Speech, Spatial and Qualities of Hearing Scale); chirp transient otoacoustic emissions (TEOAE; 0.5-14.7 kHz); Portable Automatic Rapid Testing (PART) measures of spectral, temporal, and spectrotemporal modulation sensitivity; and sound-field Digits-in-Noise testing under co-located (0°) and spatially separated (±90°) conditions. Participants were classified as normal EHF (67.9%) or EHFHL (26.9%) based on thresholds >20 dB HL at any EHF (10-16 kHz).

Results: Despite clinically normal audiograms, children with EHFHL showed elevated standard-frequency thresholds and reduced TEOAE output at those frequencies, indicating subtle outer-hair-cell dysfunction. For SiN perception, speech reception thresholds (SRTs) measured with spatial separation were weakly but significantly predicted by the mean of EHF hearing thresholds and TEOAEs, suggesting limited contribution of high-frequency integrity to spatial release from masking. Age strongly influenced SiN performance, with older children outperforming younger listeners. In contrast, PART measures were not associated with TEOAEs or hearing thresholds, and did not predict SRTs. SSQ-12 scores, particularly the

SiN subscale, showed a weak but significant association with spectral and spectrotemporal modulation, indicating early perceptual awareness of modulation difficulty even when behavioral SiN performance is relatively preserved.

Conclusions: EHFHL reflects early cochlear dysfunction measurable at standard frequencies, yet this subclinical damage does not affect all suprathreshold auditory processes. SiN performance showed age-dependent changes with only weak reliance on high-frequency integrity, whereas PART modulation-based measures appeared less sensitive to these early cochlear changes. The mild degree of EHF loss in this cohort likely limited the extent to which early cochlear damage translated into measurable speech-in-noise deficits. Together, these findings suggest that EHFHL may act as an early marker present before SiN deficits fully emerge.