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PODIUM ABSTRACTS

PODIUM SESSION I: HEARING AIDS & INTERVENTION

Pre-Fitting Determinants of Hearing Aid Persistence Among 284,175 US Veterans

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Objectives: Determine demographic, audiologic, and health-related factors associated with two-year hearing aid use persistence among US Veterans aged 50 years and older.

Design: We used electronic health records data from the US Department of Veterans Affairs (VA) healthcare system. The initial dataset included all patients for whom hearing aids were ordered through VA audiology over a 30-month period. Patients aged 50 years and older and with hearing loss were included in this set of analyses. We used multivariable adjusted logistic regression models to determine associations between patient characteristics available at the time of the hearing aid fitting, and long-term (two-year) hearing aid use persistence (given hearing aid uptake). The latter was defined by a metric constructed from longitudinal battery reorder data. Demographic factors included in the model were age, race, ethnicity, income, marital status, and rural-urban commuting area code. Audiologic factors were PTA (0.5-4.0, averaged across ears), categorized as mild (25-40 dB HL), moderate (>40-60 dB HL), severe (>60-80 dB HL) and profound (>80 dB HL). PTA asymmetry was calculated as the absolute difference between right and left PTA. Audiogram slope was calculated as the slope of the regression line across thresholds at all frequencies 0.25-8.0, averaged across ears. Audiogram complexity (ΔOD) was calculated as the difference between the highest and lowest octave-wise difference in thresholds. Hearing-aid user type (new, experienced) was defined based on previous VA hearing aid orders. Health-related factors included diagnosed dementia, mild cognitive impairment, mental health conditions, a multi-morbidity index across body systems, and the presence/absence of at least one in-patient hospital stay within 5 years prior to the hearing aid order.

Results: This study includes 284,175 VA patients (98.4% male), with a mean age of 74.6 (SD 9.8) years, and mean PTA of 50.8 (SD 14.4) dB HL. In a multivariable model, there was a nonmonotonic trend with age, with those aged 70-79 years showing the largest odds of persistence. Also in the multivariable model, higher PTA was associated with increased odds of hearing aid use persistence, whereas Black and other races, Hispanic ethnicity, lower income, and not being married were associated with lower odds of hearing aid use persistence. Higher PTA asymmetry, steeper audiogram slope, a more complex audiogram, and being a new hearing aid user were additionally associated with lower odds of persistence, as were health-related factors of a diagnosis of dementia, other mental health conditions, more comorbidities, and history of in-patient visit(s).

Conclusions: Demographic, audiologic, and health-related factors all influenced hearing aid use persistence. While these factors are unchangeable at the time of audiological care, an improved understanding of these factors can inform clinical decision making and/or the provision of support and interventions aiming to improve hearing aid use.

Nested Trial of Telehealth versus Conventional Hearing Care in ACHIEVE

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Objectives: The Aging & Cognitive Health Evaluation in Elders (ACHIEVE) was a randomized control trial of hearing intervention against a health education control on 3-year cognitive trajectories (n=977) at four sites in the United States (Jackson, MS, Forsyth County, NC, Minneapolis, MN, Washington County, MD). The ACHIEVE Hearing Intervention Follow-Up (HIFU) study [Clinicaltrials.gov NCT05070429; NIH funded R01DC019408] is a nested randomized trial that compared 1-year daily hours of hearing aid use (primary) and hearing and communication outcomes (secondary) between telehealth (experimental) and a continuation of conventional in-person hearing care (control) models.

Design: Participants in the hearing intervention arm of the ACHIEVE parent trial who attended all intervention visits and were willing to be randomized were eligible for the ACHIEVE HIFU study. Eligibility for the initial ACHIEVE trial further included being community-dwelling, between 70-84 years, better-ear 4-frequency (0.5 to 4 kHz) pure-tone average ≥30 and<70 dB, and Mini-Mental State Exam ≥23 for ≤ high school degree; ≥25 for ≥ some college. Consented participants were randomized to continued conventional in-person care (control) or a telehealth audiology care model (experimental) arm characterized by synchronous and asynchronous telehealth support provided through the GrandPad™ tablet (GrandPad, Minnetonka, MN) designed for use by older adults. An accompanying abstract to the 2025 American Auditory Society Meeting will describe the intervention design and implementation in detail. Daily hours of hearing aid use from hearing aid software [primary outcome], Hearing Handicap Inventory for the Elderly-Screener (HHIE-S), and International Outcome Inventory for Hearing Aids were measured 1-year post randomization. One-year outcomes were compared between groups using attrition-weighted regression model with an identity link and a bias corrected and accelerated bootstrap resampling procedure (10,000 replicants) to account for non-normal distribution of the primary outcome. Planned sensitivity analyses included the use of self-reported hours of use (as opposed to

device reported), inclusion of an interaction variable for recruitment source, and restriction by hearing aid type (e.g., technology level).

Results: 339 of 490 participants in the ACHIEVE intervention arm enrolled in ACHIEVE HIFU (54.9% female, mean age=78.9 years (SD=3.9), 89.1% White, 54% with at least some college, mini-mental state exam mean=28.2 (SD=1.8), and 4-frequency pure-tone average mean=42.7 (SD=7.9)). Distribution of baseline variables were similar between the telehealth (n=163) and continued conventional care (n=176) groups. Overall, no statistical differences were found at one-year post intervention on any primary or secondary outcomes. One-year device-derived hours of hearing aid use were 7.2 (SD=5.0) in the telehealth intervention and 7.4 (SD=5.2) in the conventional care arms (β=0.119; 95%CI=-0.394,0.632; p=0.65). One-year HHIE-S scores were 7.4 (SD=5.0) and 7.6 (SD=7.1) in the telehealth and conventional delivery arms, respectively (β=-0.925; 95%CI=-2.924,1.074; p=0.36). Further, a prior sensitivity analyses revealed no differences by recruitment source or hearing aid technology level nor when using self-reported daily hours of hearing aid use.

Conclusions: No statistical differences were observed 1-year post randomization to telehealth and conventional hearing care delivery arms. The inherent superiority design of the trial limits inference on equivalence of models. However, future studies designed to assess non-inferiority or equivalence between modes that include cost-efficiency analyses are warranted as telehealth may represent a patient-centered alternative to standard in-person care among older adults when designed with patient-centered needs in mind.

Effect of Hearing Intervention on White Matter Hyperintensity Volume: Findings from a Secondary Analysis of the ACHIEVE Randomized Trial

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Objectives: Hearing intervention may be effective for slowing macrostructural changes in the brain associated with dementia. Effects of hearing intervention on white matter hyperintensity volume, a characteristic of cerebral small vessel disease associated with accelerated cognitive decline and dementia, have yet to be investigated. In a secondary analysis of the Aging and Cognitive Health Evaluation in Elders (ACHIEVE) study we investigate effects of hearing intervention vs. health education control on 3-year changes in white matter hyperintensity volume.

Design: The ACHIEVE study enrolled 977 community-dwelling adults aged 70-84 years at baseline (2018-2019) with untreated hearing loss (better ear pure tone average [0.5-4 kHz] ≥30 and<70 dB HL) and without substantial cognitive impairment from four sites across the U.S. (Jackson, MS, Forsyth County, NC, Minneapolis, MN, Washington County, MD). Participants were randomized to hearing intervention

(provision of hearing aids and related technologies, counseling, and education) or health education control (individual sessions with a health educator covering topics, relevant to chronic disease and disability prevention) and followed semi-annually for 3 years. A subset of participants (n=445) received MRI scans at baseline and at Year 3. Sagittal T2 FLAIR was performed on Siemens scanners by trained technicians using a standardized protocol. White matter hyperintensity volumes were quantified centrally using a semi-automated algorithm. Regions of interests were defined using the MCALT atlas. White matter hyperintensity volume was log transformed prior to analysis. Linear mixed effects models tested whether 3-year change in white matter hyperintensity volume differed by intervention assignment. The model included total intracranial volume (time-varying covariate) and baseline demographic characteristics, hearing loss severity, self-reported cigarette and alcohol use, body mass index, self-reported physician diagnosis of hypertension, diabetes, and high cholesterol, and study design characteristics (time-invariant covariates). An interaction with time was specified with each time-invariant covariate. Missing baseline measures were imputed and inverse probability of attrition weights were integrated into the model to account for informative attrition.

Results: At baseline, participants (n=445) were a mean age of 76.4 years (SD: 4.0), 50.3% female, and 87.9% White. The mean 4-frequency pure tone average (PTA) was 39.3 (SD: 7.0) and mean Mini-Mental State Examination Score (MMSE) was 28.2 (SD: 1.7). Estimates from covariate-adjusted analyses demonstrated a beneficial effect of hearing intervention vs. health education control on slowing increases in white matter hyperintensity volume over 3-years in the whole brain (intervention: 0.172 [95% CI: 0.115, 0.228], control: 0.255 [95% CI: 0.203, 0.308], difference: -0.084 [95% CI: -0.161, -0.006]). Across the lobar regions, effects were consistent in the frontal lobe, occipital lobe, and deep grey and white matter. Effects in the temporal and parietal lobe were similar but confidence intervals were wider.

Conclusions: Hearing intervention is potentially effective for slowing increases in white matter hyperintensity volume. The mechanisms linking hearing loss to white matter hyperintensity volume and the potential protective effect of hearing intervention need further investigation. Findings add to existing evidence supporting hearing intervention as a low-risk strategy for maintaining brain and cognitive health.

Factors Associated with the Cognitive Benefits of Hearing Intervention

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Objectives: The Aging and Cognitive Health Evaluation in Elders (ACHIEVE, Clinicaltrials.gov Identifier: NCT03243422) randomized controlled trial investigated the effect of an evidence-based hearing intervention, including hearing aids, hearing assistive technologies, and hearing loss self-management support versus a health education control on 3-year cognitive change among dementia-free older adults with untreated hearing loss. Participants were recruited from the Atherosclerosis Risk in Communities (ARIC) study (n=238) or de novo from the community (n=739). The hearing intervention slowed cognitive decline by 48% in ARIC participants, but not in healthy de novo volunteers. This secondary analysis of the ACHIEVE trial investigated who benefited the most from hearing intervention.

Design: We first developed a predictive model of cognitive decline (r-square 81.9%) from a sample of 2,692 dementia-free ARIC participants who did not participate in ACHIEVE. The predictive model included baseline measures of demographics, hearing, lifestyle, cardiovascular health, mental health,

cognitive function, physical function, and functional limitations. The predictive model was applied to baseline measures of ACHIEVE participants (N=977) to calculate their predicted risk of cognitive decline. The intention-to-treat effect of the hearing intervention on 3-year cognitive change was examined in a mixed effects model that included random treatment assignment, the predicted risk of cognitive decline, time from baseline, a 2-way interaction between predicted risk and time, a 2-way interaction between treatment and time, and a 3-way interaction between time, predicted risk, and treatment. The model adjusted for baseline measures of hearing loss, recruitment source (ARIC or de novo), site, age, sex, education, and the presence of APOE ε4 alleles.

Results: At the ACHIEVE baseline (2018-19), 523 participants were women (53.5%), 112 participants were Black (11.5%), the mean (SD) age was 76.8 (4.0) years old, and the mean 4-frequency pure tone average was 39.4 dB (6.9). Among participants in the top quartile of risk, cognitive decline in the hearing intervention group was 61.6% (95% CI 33.7%, 94.1%) slower than the control group. Across measured risk factors for cognitive decline, some of the most pertinent for predicting who may benefit from treatment included age, cognitive function, the magnitude of hearing loss, the presence of APOE ε4 alleles, depressive symptoms, functional limitations, and difficulties with activities of daily living.

Conclusions: Our findings suggest that best-practices hearing intervention may result in short-term cognitive benefits for older adults with untreated mild-to-moderate hearing loss and multiple risk factors for cognitive decline. Whether these benefits are sustained after 3 years is unknown, as is whether other adults with fewer risk factors may experience benefit with longer treatment. Long-term follow-up of the ACHIEVE cohort will help address these questions.

Preliminary Results on a Cost-Effectiveness Analysis of the ACHIEVE Hearing Intervention

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Objectives: To investigate the cost-effectiveness analysis (CEA) of a manualized best-practices hearing intervention in terms of Mini-Mental State Examination (MMSE) cognitive scores over a 3-year period in the Aging and Cognitive Health Evaluation in Elders Study (ACHIEVE, Clinicaltrials.gov ID: NCT03243422). The ACHIEVE randomized controlled trial examined the effect of a hearing intervention on cognitive decline among older adults with hearing loss when compared to a successful aging health education control group. The present analysis will provide valuable information on cost-effectiveness of the ACHIEVE hearing intervention for reducing cognitive decline.

Design: We enrolled N=977 older (70-84 years) community-dwelling adults with mild to moderate untreated hearing loss (PTA4 ≥ 30 and<70 dB HL) and without substantial cognitive impairment from four U.S. sites A total of N=490 participants were randomized to the intervention group. The ACHIEVE

hearing intervention included audiologist-fit and -verified hearing aids, other hearing assistive technologies (e.g., streamers, TVLinks), in addition of counseling, support, and device maintenance services throughout the length of the three-year study. Participants assigned to the control group (N=487) received education services on topics related to chronic disease management and disability reduction, which were delivered by a certified health educator. Number and length of the interactions between participants and the health educator mirrored that of participants in the hearing intervention.Intervention costs were calculated from the perspective of the health provider over a three-year horizon. The costs of the ACHIEVE hearing intervention were calculated including only the costs of professional services (the number and duration of encounters between participants and study audiologist and the pre-tax hourly wage of study staff plus a 46% rate for fringe benefits) and dispensed technologies (wholesale cost to hearing care provider). Total average cost differences between control and intervention groups were computed and incremental cost-effectiveness ratio (ICER) estimated. Confidence intervals for average costs and ICERs were obtained using bootstrap methods. Difference between groups for the change in MMSE scores three years after enrollment was assessed using linear mixed effect regression models under the intention-to-treat

Results: Three years after randomization, we estimated a difference of 0.28 (95% confidence interval (CI): 0.01-0.55) points between intervention and control groups in change MMSE scores. The average cost of the ACHIEVE hearing intervention was estimated at $3,900.53 (95% CI: 3,818.18-3,981.90) per participant with the estimated an average cost of professional services and technology being $692.22 (95% CI: 681.65-702.80) and $3,208.31 (95% CI: 3,130.46-3,286.16) respectively. We estimated an ICER of 13,917.76 (95% CI: 13,627.18-14,208.33) between intervention and control groups. In other words, we estimated that a one-point difference in MMSE decrease over a three-year period costs around $13,917.76 dollars.

Conclusions: The ACHIEVE hearing intervention is a non-pharmacologic, low-risk intervention that was associated with a decrease in cognitive decline, as measured by change in MMSE scores, at a cost of ~$14K per MMSE point, over a period of three years. In comparison, when compared to a placebo, anti-amyloid drug treatments yielded an ICER of $60,516.82/MMSE at 76 weeks. These results allow the comparison of a the ACHIEVE intervention for evidence-based decision making.

The Integrated Digit-in-Noise Test for Hearing and Cognitive Screening

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Objectives: The Integrated Digit-in-Noise Test (iDIN) extends the Digit-in-Noise Test (DIN) by using 2 to 5-digit sequences. Participants repeat digits in forward or backward order. Speech Reception Thresholds (SRTs) are measured as the signal-to-noise ratios (SNRs) at which 50% of digit sequences are identified correctly. Lower cognitive demand tasks, such as 2- or 3-digit forward recall, are suitable for hearing screening, while 5-digit forward and 3-digit backward recalls, requiring more cognitive effort, could indicate cognitive capacity. The difference in SRTs between high and low cognitive demand conditions serves as an indicator for cognitive screening. This study examined the effectiveness of 3-digit SRTs for hearing screening and two indicators-SRT differences between 3-digit sequences with backward and forward recall (SRT3b-3), and SRT differences from 5-digit to 3-digit sequences (SRT5-3)-for cognitive screening.

Design: Participants were 159 community older adults, aged 76.9 ± 8.4 years, with a better ear pure tone average (PTA) of 40.9 ± 12.7 dB HL at 0.5, 1, 2, and 4 kHz. The education level of participants was 6.4 ± 4.6 years. Participants completed the Hong Kong version of the Montreal Cognitive Assessment (MoCA) and the Cantonese iDIN, which involved 3-digit sequences with both forward and backward recall, and 5-digit sequences with forward recall.

Results: Significant correlations were observed between better PTA and 3-digit SRT (rs = .714, p< .001). Out of 159 participants, 107 had a better ear PTA greater than 35 dB HL. ROC curve analysis revealed that the AUC for detecting hearing loss > 35 dB HL using the 3-digit SRT was 0.845. Using a -7.5 dB SNR cutoff, the sensitivities and specificities for 3-digit SRT were 0.81 and 0.75, respectively.Out of the total participants, 98 passed and 61 failed the MoCA. No significant correlation was observed between better PTA and SRT5-3 or SRT3b-3. However, MoCA scores significantly correlated with SRT5-3 (rs = -.340, p< .001), and SRT3b-3 (rs = -.477, p< .001). The AUC for distinguishing participants who failed or passed the MoCA using SRT3b-3 and SRT5-3 was 0.781 and 0.687, respectively. With a cutoff at 2.3 dB, SRT3b-3 demonstrated a sensitivity of 0.82 and a specificity of 0.68; with a cutoff at 4.4 dB, SRT5-3 demonstrated a sensitivity of 0.72 and a specificity of 0.78.

Conclusions: The 3-digit SRTs are effective indicators for hearing screening, while SRT3b-3 could be used to indicate cognitive function. The test is short and easy to administer. The iDIN has the potential for clinical use in identifying complexities beyond hearing loss.

PODIUM SESSION II: LISTENING ENVIRONMENTS

Acoustic Environments for Children who are Deaf or Hard of Hearing

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Objectives: Children who are Deaf or Hard of Hearing (CDHH) developing spoken language are at heightened risk of language delays. Language difficulties in CDHH are partially influenced by hearing-related factors (e.g., age of amplification) and reduced exposure to caregiver language input. Recent models of language acquisition suggest that environmental noise further limits access to caregiver input in the real-world. In fact, prior work in our lab demonstrated that access to language measure using speech-to-noise ratios in the real-world predict variability in language outcomes in children with typical hearing, beyond the effect of caregiver input. Building on this premise, we propose that CDHH exposed to both limited caregiver input and reduced access to language are at the greatest risk for language delays. This talk emphasizes the importance of measuring the quality of the acoustic environments of children with hearing loss. We discuss 1) how existing wearable devices can be used to objectively measure children's auditory experiences, including children's access to language input, and 2) how these auditory experiences relate to their language outcomes.

Design: We are currently recruiting a heterogenous group of 40 preschool CDHH (aged 3 to 6 years) and an age-matched control group of children with typical hearing. We aim to develop and assess the effectiveness of a novel and ecologically valid Speech Accessibility Index (SAI). The SAI is designed to quantitatively evaluate children's access to language in real-world environments. The index harnesses our previous experience using Speech Reception Thresholds (SRTs) to assess speech-in-noise skills as well as novel algorithms to calculate speech-to-noise ratios (SNR) from LENA recordings in preschoolers'

homes. The SAI combines these two measures to calculate the percentage of home conversations with SNRs above the SRT for each participant as a proxy for access to speech in the real-world. We evaluate the effectiveness of the index by including language experiences that go beyond conventional measures of language exposure (e.g., caregiver language input) to also account for the quality of acoustic input accessible to the child.

Results: We have collected data on ten children (three CDHH). Preliminary results confirmed our premise that caregiver input and access to language are associated with language (both groups of children combined). Thus, we anticipate confirming our hypothesis that both predictors are positively and uniquely associated with language skills while controlling for covariates with the larger data set.

Conclusions: The SAI effectively provides information on children's language experiences that extend beyond measures of caregiver input. Thus, it shows clinical promise as a tool to estimate access to speech in real-world environments for CDHH. This study is clinically significant because 1) the SAI might help identify CDHH at risk for language delays, 2) it supports the effectiveness of home-interventions aimed to optimize language experiences for these children (e.g., assistive listening systems).Work supported by NIH-NIDCD (R21 DC022038) to C.R. Benítez- Barrera

Effects of Age and Hearing Aid Use on Auditory Environments

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Objectives: The primary purpose of this study is to investigate how age, hearing loss, and hearing aid use affect the auditory environments listeners experience in daily life. We hypothesize that older adults with untreated hearing loss are less likely than young adults with normal hearing or older adults who use hearing aids to seek out demanding environments such as speech in noise. Auditory experience may also affect listening ability. We also hypothesize that more time spent in demanding environments like speech in noise may be associated with better speech-in-noise perception. Thus, a secondary purpose of this study is to investigate the relationship between daily-life auditory experience and speech-in-noise perception. We first compare daily auditory environments among young adults with typical hearing, older adults with hearing loss who are non-hearing aid users, and older adult hearing aid users. Then, we examine the relationship between speech-in-noise perception ability and daily-life auditory environments.

Design: Participants wear body-worn devices that record continuous audio from near the head for all waking hours for a week. Ecological momentary assessment (every 2 hours) is used to validate our sound classification method. Participants also complete a speech-in-noise battery in virtual real-world noisy environments. Sound classification is performed using a deep neural network with 521 possible classes. Sound classes are estimated for each 0.5s of audio, for approximately 800,000 classifications during the week. These classifications are reduced to the primary classifications of interest: silence, speech, speech in noise, music, and various noise types. The percent of time each participant spent in each environment class are calculated. Group differences in auditory environments are characterized. Then, whether more time spent in speech-in-noise improves speech perception in noise ability is tested.

Results: Data collection is ongoing. To date, 82 participants have completed the study. Our preliminary results suggest that older adults with hearing loss who do not use hearing aids spend more time (27%) in silence than young adults (17%) or older adults who use hearing aids (17%). Older adults spend more time in speech in quiet than young adults (34% for non-hearing aid users, 39% for hearing aid users, and 23% for young adults). Young adults spend more time (30%) in speech in noise than older adults, but older adult hearing aid users spend more time in speech in noise than non-hearing aid users (21% and 13%, respectively). All participants spend more time in noise and speech in noise than reported previously using other classification methods. There is no evidence for a relationship between the amount of time participants spend in speech in noise and speech-in-noise perception ability.

Conclusions: Our current data supports our hypotheses that auditory environments change with age, such that older adults with hearing loss spend more time in speech in quiet and less time in speech in noise than young adults. Auditory environments of older adults who use hearing aids are more like young adults than older adults who do not use hearing aids. Preliminary results suggest hearing aid use can help older adults maintain active auditory lifestyles.

The Daily Auditory Environment of People with Tinnitus

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Objectives: Tinnitus, the sensation of sound absent an external stimulus, is often linked to a history of excessive noise exposure. Most investigations into tinnitus and noise exposure focus on noise exposure before onset, with little attention to sound exposure patterns and behaviors after the onset of tinnitus. This is surprising given the high comorbidity of tinnitus and hyperacusis, a disorder in loudness perception where ordinary sounds encountered daily are perceived as excessively loud, and sound avoidance is common. The objective of this study was to use body-worn devices to measure environmental sound levels in a tinnitus group relative to controls over a week.

Design: Participants with chronic tinnitus (n=57, 18-80) were recruited from a tinnitus patient database at the UConn Medical Center and compared to age-matched controls (n=50). For a week, participants

wore a personal data-logging noise dosimeter (Etymotic) during all waking activities, including occupational and leisure activities. The dosimeter measured environmental sound levels in 3.75-minute intervals throughout the week. Data were analyzed first using summative metrics of daily sound exposure. Functional data analysis was employed to reveal temporal differences in sound exposure between groups across the week.

Results: The time-weighted average sound pressure levels (dB LAeq, 8-hour equivalent) were lower for people with tinnitus compared to controls for each day the dosimeter was worn. This summative analysis of each day was elaborated upon using functional data analysis, a method for analyzing time series data that is useful for identifying trends within the data. To identify differences in sound exposure between the two groups along the time dimension, point-wise hypothesis tests were performed on denoised curve fits of the time series data, revealing specific times during the day when the groups were significantly different. In addition, simultaneous confidence bands were used to extract the typical (i.e., mean) time-series pattern for the week for the tinnitus and control groups, respectively. These typical patterns were then compared between groups controlling for multiple tests. Both functional data approaches confirmed significant differences in sound exposure between the two groups. The tinnitus group tends to have significantly lower sound exposure than the control group around noon and evenings, with the most significant discrepancies occurring during the weekend.

Conclusions: The tinnitus group was exposed to significantly lower sound levels during the week than controls, especially during time windows where an individual is likely to have more control over their environment (lunchtime, evenings, weekends). Based on the dosimeter data, neither group was at significant ongoing risk of noise-induced hearing loss, as daily average sound levels did not exceed 75 dB LAeq (8-hour equivalent) for either group. If, in our sample, tinnitus was due to a history of noise exposure, it seems that the tinnitus participants have, as a group, discontinued regular (weekly) exposure to noise during daily activities. This could be explained by greater awareness of the dangers of noise exposure in the tinnitus group or decreased tolerance of sound (hyperacusis) due to a compensatory increase in central arising from tinnitus-related changes in auditory physiology.

Effects of Cultural Dynamics on Everyday Acoustic Environments

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Objectives: In September 2022, Xochitl Gonzalez published an article in The Atlantic titled "Why Do Rich People Love Quiet? The Sound of Gentrification is Silence." Gonzalez reflects on her experiences growing up in Brooklyn, describing how her once vibrant, bustling neighborhood transformed into a quieter space due to gentrification and increased wealth. Her observations align with research showing that acoustic environments vary across cultures, influenced in part by social behaviors unique to each cultural group. Gonzalez also underscores a challenge in cultural research: in the U.S., culture and socioeconomic status (SES) are often deeply intertwined, making it difficult to isolate their effects. Acknowledging this, we aimed to investigate whether social behaviors linked to cultural heritage and SES contribute to differences in acoustic environments between college students of Latinx and European heritage. Specifically, we focused on behaviors tied to collectivist values, such as socializing in groups, and

hypothesized that Latinx students would exhibit higher levels of behavioral collectivism. Our research questions were: 1) Is behavioral collectivism associated with nearfield noise levels across groups? 2) Does behavioral collectivism mediate the relationship between cultural heritage and nearfield noise levels? and 3) Does behavioral collectivism mediate the relationship between SES and nearfield noise levels?

Design: College students from the University of Connecticut of Latinx (N = 31) and European heritage (N = 43) were recruited to participate in the study. Students were asked to use digital recorders to capture their daily acoustic environments over two days. We analyzed these recordings to: a) measure nearfield noise levels during social interactions (e.g., interpersonal communication), where "nearfield" is defined as the immediate environment surrounding the listener that falls within "earshot" of the body-worn recorder; and b) quantify the time participants engaged in behaviors reflecting collectivism (i.e., spending time with others, in groups and socializing).

Results: We found that collectivistic behaviors were positively associated with nearfield noise levels and that such behaviors mediated the relationship between cultural heritage and nearfield noise levels. Further, the relationship between SES and behavioral collectivism was not significant. These findings suggest that students of Latinx heritage might experience noisier environments than students of European heritage because, according to their cultural values, they engage in more collectivistic behaviors than their peers during their daily lives.

Conclusions: Our findings shed light on the interplay between culture and acoustic environments. The long-term goal of this line of research is to provide information to guide interventions and policies that promote healthy auditory experiences for everyone, acknowledge that acoustic environments are diverse across cultures, and lead to a greater appreciation for cultural differences in what is considered "noise."

Cultural Differences in Listening Environments for Hispanic Cochlear Implant Users

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Objectives: Cochlear implants (CIs) can restore access to sound for patients with moderate-to-profound hearing loss, increasing communication abilities and quality of life. CI processors can provide "data logging", tracking the number of hours a patient wears their device, as well as information about the time spent in different acoustic environments and the loudness of these environments. Understanding these data is important, as high noise levels and poor signal to noise ratios (SNRs) can decrease speech intelligibility, impairing communication and speech perception outcomes. Louder environments can have a detrimental impact on learning and cognition and have been associated with both socioeconomic disparity and cultural factors. A study showed that among normal hearing college students, Latinx-identifying subjects experienced higher levels of environmental noise and lower SNRs. This finding may be related to greater cultural importance for collectivism and music listening at louder levels. The primary objective of this study is to determine if similar differences in listening preferences exist among CI users. A secondary objective is to examine the relation between data logging variables and speech perception outcomes.

Design: Retrospective chart review of CI patients at a tertiary medical center identified 28 Hispanic and 35 European-American adults (all self-identified) for further review. All subjects had at least six months of CI experience and no significant cognitive impairment. Demographic variables, including race, ethnicity, socio-economic-status (SES)-related variables (e.g., zip code, primary insurance payer, occupation, education) and surgical details related to CI were collected. Outcome measures included speech perception scores (most recent follow up) in the subject's primary language and data logging information extracted from the speech processor (most recent follow up), including hours of total use and time spent in each type of environment.

Results: There was no significant difference detected in the number of total hours the CIs were used, age at CI, or number of females between the Hispanic and European American groups. There was a significant difference in the percentage of time spent in each scene: Hispanic Americans spent more time in "speech in noise", "music", and "noise"; European Americans spent more time in "quiet" and "wind". There was no significant difference detected in the time spent in "speech in quiet" or in speech perception scores between the groups. There were correlations between the percentage of time spent in particular scenes and speech perception scores. Interestingly, the percent of time spent in loud environments (>70 dB) was positively correlated with sentence-in-noise scores for Hispanic subjects, but not for European subjects. Socioeconomic data are currently being analyzed.

Conclusions: Cultural differences appear to exist among CI listener's listening environments, similar to those found in normal hearing listeners, despite similar levels of device usage. Speech outcomes are similar across groups, yet listening preferences do appear to relate to performance in the Hispanic group. Audiologists counseling patients regarding listening environments should be culturally conscious and consider the impact of listening preference on the performance of their patients.

Passive Sensing to Make Sense of Daily-life Listening Experiences

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Objectives: Experience sampling via ecological momentary assessment (EMA) offers valuable insights into hearing-related outcomes in daily life that clinical tests cannot capture. Participants typically respond to questions through mobile interfaces several times a day while using different hearing-aid technologies or listening programs. However, identical listening situations can result in varied perceptual experiences due to differences in noise levels or listening intentions. Therefore, contextual effects, such as the auditory environment, should be accounted for. Here, I will present results from three EMA studies where passive sensing of the auditory environment using participants' own hearing aids helped account for the context of reported listening experiences. The studies aimed to identify hearing-related benefits of hearing aids with different noise management approaches and to learn how well individuals' preferences can be predicted by their listening experiences.

Design: Smartphone-based EMA applications were used by participants (all experienced hearing aid users) to report their listening experiences several times a day. Additionally, the applications logged hearing-aid data, including estimations of the ambient sound pressure level and signal-to-noise ratio every 20 seconds. In one study, 11 participants wore hearing aids fitted with or without a noise management program for 2 weeks in a cross-over manner. In another study using the same design, 40 participants wore two different hearing-aid models differing in their noise management technology

(traditional versus deep-neural-network-based). Besides completing EMAs, participant was asked to select their preferred hearing-aid model at the end of the trial.

Results: We found that hearing-aid noise management significantly increases satisfaction with hearing in "speech in noise" environments and that deep neural network-based noise management systems further improve hearing outcomes by making hearing satisfaction less dependent on ambient noise. In both cases, hearing-related benefits would not have been revealed without passive sensing to contextualize the data. In fact, data about the auditory environment from passive sensing was found to increase the accuracy of predicting individual hearing-aid preference from the self-reported listening experiences by close to 10 percentage points.

Conclusions: Passive sensing of the auditory environment enables detailed insights into hearing-related issues and benefits in daily life, advancing audiological research into real-world settings and increasing the construct validity of the EMA approach.

PODIUM SESSION III: HEARING AID POLICY / HEARING LOSS: EFFORT AND FATIGUE

Medicaid Hearing Aid Policies and Hearing Aid Purchasing among Older Adults

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Objectives: We study the impacts of hearing aid coverage being a required benefit in state Medicaid programs on hearing aid use and activity impairment among older (65 and older) adults dually eligible for Medicare and Medicaid. We hypothesize that required coverage increases hearing aid use and reduces activity impairments.

Design: We use difference-in-differences modelling of observational data to study the effects of four states (Maine, Maryland, Michigan, and Washington) adding hearing aid benefits to their state Medicaid programs. Outcomes include hearing aid use and activity impairments (going out for enjoyment, working for pay, volunteering, attending clubs/groups, visiting friends/family, and attending religious services). For data, we use 10,989 observations of older (65 and older) adults dually eligible for Medicare and Medicaid that were interviewed as part of the National Health and Aging Trends Study from 2012 to 2022.

Results: We estimate that adding hearing aids to Medicaid mandated benefits increased hearing aid use by 5.86 percentage-points, or by 65% ($p<0.001$), among older dual-eligibles. We also find that hearing aid mandated benefits reduced some activity impairments; for example, going out for enjoyment increased by 9.2 percentage points, or 53% ($p<0.001$), working for pay increased by 5.43 percentage points, or 41% decrease ($p<0.05$), and volunteering increased by 7.23 percentage points, or 41.7% ($p<0.01$).

Conclusions: This study is the first to describe the extent to which state-level decisions to make hearing aids a required Medicaid benefit increases hearing aid use and reduces activity limitations for elderly

dual-eligibles. Further work should study the effect of Medicaid hearing aid mandates on working-age Medicaid beneficiaries.

The Impact of Private Insurance Hearing Aid Mandates on Hearing Aid Spending and Utilization

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Objectives: We study the impacts of state hearing aid coverage requirements on hearing aid spending and utilization comparing targeted commercial enrollees in fully insured plans in states that enacted a hearing aid coverage policy to the same age groups in states that did not. We hypothesize that private insurance coverage requirements increase hearing aid spending and utilization.

Design: We use difference-in-differences modelling of observational commercial claims data to study the effects of eight states (CT, GA, IL, MA, ME, NE, TX, WA) that passed or expanded hearing aid mandates requiring private insurers to cover hearing aids for children (7 states) or adults (4 states) between 2012 and 2021. To do so, we utilize commercial claims provided by the Health Care Cost Institute (HCCI) dataset. HCCI covers over 55 million commercial lives per year in all 50 states and the District of Columbia and includes claims from Aetna, Humana, Kaiser Permanente, and Blue Cross Blue Shields. Our analysis incudes individuals in fully insured commercial plans who were subject to a state policy, stratified by age for youth (0-17 years old) and adults (18 to 64 years old). We standardize our hearing aid purchase outcome per 1000 beneficiaries with health insurance to account for differences in sample size across states and collapse the data to the state-year level and log these variables.

Results: Findings indicate that hearing aid purchases increased substantially after a state private insurance mandate was in place by 152% (coefficient=1.552; 95% Confidence interval (CI)= 0.908 - 2.196) and 82% (coefficient=0.823; CI= 0.041 - 1.615) for youth and adults, respectively. Hearing aids also increased total average costs of hearing aid purchases for adults by about 30%.

Conclusions: This study is the first to describe the impact on utilization and spending outcomes of hearing aids for commercially insured individuals after state hearing aid coverage mandates were implemented. Our finding suggest that the mandates increased purchases for adults and youth and reduces out of pocket costs for. Future studies are needed to determine whether increases in hearing aid spending are related to improvements hearing-related and general health and quality-of-life outcomes.

Effects of Individual Differences on Listening Experiences in Daily Life

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Objectives: Individuals with hearing impairment report experiencing higher levels of listening effort and fatigue during daily life than age-matched individuals with normal hearing. Heart rate has been used as an objective marker of listening effort which can be unobtrusively captured in everyday life settings. However, certain listeners may be more susceptible to background noise and challenging listening

situations than others. Additionally, individuals will differ in their willingness to exert effort in various listening conditions. Thus, the objectives of the present study are: To investigate how individual differences in personality traits and cognitive ability influence self-reported listening effort and fatigue measured in everyday life settings. To investigate how individual differences in personality traits and cognitive ability, as well as self-reported listening experiences, influence heart rate measured in various acoustic environments during daily life.

Design: Sixty-seven hearing aid users (mean = 72 years. SD = 10.45) took part in a four-week field trial, during which ambient acoustics were recorded every 20 seconds via the participants' own hearing aids, heart rate was recorded continuously via Empatica Embrace Plus wristbands, and self-reported momentary assessments were provided by the participants via an app throughout the day. The Danish version of the NEO Five-Factor Inventory-3 (NEO-FFI-3) was administered to assesses the five domains of personality: neuroticism, extraversion, openness, agreeableness, and conscientiousness. The sentence completion, verbal analogies, and number series subtests of the Intelligence Structure Test 2000 Revised (IST-2000R) were administered to assess cognitive ability. The data is analyzed using linear mixed effects models with self-reported listening effort, self-reported fatigue, and heart rate as outcomes.

Results: The preliminary results suggest that all personality traits and cognitive ability influence self-reported listening effort in certain listening activities, while neuroticism, extraversion, openness and agreeableness affect self-reported fatigue in certain listening activities. Additionally, extraversion and self-reported importance of a listening activity are associated with heart rate depending on sound pressure level and signal-to-noise ratio level respectively.

Conclusions: The present study is the first to investigate the association of individual differences in personality traits and cognitive ability with self-reported listening experiences as well as objective markers of listening effort measured during daily life. The outcomes of this study are ultimately expected to contribute to identifying individuals who may be at higher risk of social withdrawal or isolation, which may guide hearing aid fitting and contribute to more targeted counselling during audiological rehabilitation.

Why Am I So Tired? Predicting Listening-Related Fatigue in Adults

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Objectives: Adults with hearing loss are more likely to report severe fatigue compared to peers without hearing loss. While it's commonly assumed that their increased fatigue is a consequence of increased listening effort in everyday settings, experimental work testing this hypothesis is limited. In addition, current models of fatigue suggest external (i.e., listening conditions) and internal (i.e., subjective motivation, task importance and control of listening situations) factors play important roles in the development of fatigue. This study uses ecological momentary assessment (EMA) to explore the contribution of such factors towards "right now" fatigue in adults with and without hearing loss.

Design: Twenty-two pairs of adults completed surveys several times a day for one week. Pairs consisted of hearing aid (HA) users (mean age = 65.7 years) and their significant others (mean age = 65.0 years). Significant others had normal/near normal hearing. During each EMA, respondents used Likert scales to

report on their recent listening experiences, including the approximate number and their perceived importance, duration, difficulty, as well as their applied effort, motivation to hear well, and perceived control, in the different listening situations. Finally, respondents rated their fatigue "right now" using a 5-point Likert scale ('not at all worn out' to 'extremely worn out'). Using multinomial regression modelling, we estimated the contribution of different factors to the probability of reporting a specific level of "right now" fatigue.

Results: Participants provided 1096 fatigue ratings. Across both groups and EMA sessions, most participants reported low levels of fatigue, specifically being 'not at all worn out' (~44%) or 'a little worn out' (~32%). Because of the small number of higher fatigue ratings, we collapsed ratings of 'somewhat worn out' (~19%), 'quite a bit worn out' (~5%) and 'extremely worn out' (~1%) into a single category (which reflects higher fatigue), resulting in three categories of fatigue severity for analyses. Preliminary analyses revealed that, for both groups, the probability of reporting higher fatigue increased 1) with the number of active listening situations, 2) as more listening effort was exerted, and 3) as the day progressed. Conversely, for both groups, the probability of reporting higher fatigue decreased 1) as listener motivation increased and 2) interestingly, as the duration of the active listening situation increased. An interaction between group and listening difficulty was also observed. For significant others, the probability of reporting higher fatigue increased with listening difficulties, as expected. In contrast, for HA users, the probability of reporting higher fatigue decreased as listening difficulty increased.

Conclusions: Consistent with current models of fatigue, these data highlight the complex interplay between the listening situation (e.g., number and their duration) and the individual's perception of the listening situation (e.g., motivation, effort, difficulty). HA users and their significant others were affected similarly by some factors (e.g., effort, duration) and differentially by others (i.e., difficulty). Future work is warranted to examine if these relationships are repeatable in a different sample, as well as in those with untreated hearing loss and for those experiencing higher levels of fatigue.

Cochlear Implant Listening Effort Reflects Expectation of Consistent Difficulty
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Objectives: Listening effort is a commonly reported difficulty among those who have hearing loss. The goal of this study was to determine if listening with a cochlear implant affects an individual's ability to be selective about when they deploy their effort. This goal was motivated by previous observations that listeners with cochlear implants (CIs) show little to no reduction in effort when given easier stimuli, suggesting that the reported increase in overall listening effort might actually stem from lack of turning effort off, rather than increasing it beyond what is observed in typical-hearing listeners.

Design: A series of three experiments gave listeners opportunities to voluntarily reduce or increase effort at specific moments based on various factors such as the real or anticipated difficulty of the speech, instructions to attend or ignore parts of sentences, or predictable verbatim repetition of the same stimulus. In all three experiments, pupil dilation and microsaccade rate were used as indices of moment-to-moment changes in listening effort and attentional gain. Participants included 28 listeners with typical hearing and 19 listeners with cochlear implants. Generalized additive mixed-effects models were used to evaluate differences between groups and conditions within groups.

Results: Across all three experiments, TH listeners showed precise selective pupil dilations and microsaccade suppressions linked in time with critical target words that matched the task demands, and rapidly allocated different amounts of effort based on the difficulty of the stimuli. Conversely, CI listeners showed pupil dilation and microsaccade suppressions that did not change even when stimuli could be ignored, or when stimuli were immediately repeated, suggesting inefficient effort. Most notably, in situations where stimuli were tagged in advance as easy or hard, the occasional absence of the tag elicited microsaccade suppressions that matched those observed for the hard stimuli; uncertainty led to consistent preparation for legitimate auditory difficulty.

Conclusions: The results suggest a general pattern of listening effort that goes against the simplistic framework of hearing loss leading to "more effort". Whereas TH listeners employ precise strategic listening effort based on task demands, CI listeners appear to deploy effort indiscriminately without any relief even when the task is modified to be easy. These results support the need to expand the concept of listening effort beyond a "more" or "less" framework, toward a framework of efficiency and strategy that more closely aligns with listening-related stress.

Impact of Cochlear Implant Use on Comprehension and Listening Effort

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Objectives: For many adults with hearing loss, real-world speech communication can be challenging and effortful, leading to fatigue, social withdrawal, and poor quality of life. While subjective reports suggest that listening effort decreases with cochlear implant (CI) use, little is known about changes in objective listening effort for comprehending speech. This study investigates sentence comprehension and listening effort, using a behavioral sentence verification task (SVT), in adult CI recipients over the first six months of CI use. We tested the hypotheses that sentence comprehension and listening effort improve with CI experience and that SVT performance relates to the subjective experience of listening effort and fatigue in everyday life.

Design: Twenty-two post-lingually deafened adult CI users completed the SVT and a battery of self-report questionnaires pre-CI and at 1-, 3-, and 6-months post-activation ("post-CI"). For the SVT, participants classified sentences as true or false as quickly as possible. Accuracy and response times (RTs) were analyzed, representing comprehension accuracy and listening effort, respectively. Participants also completed self-report questionnaires of everyday listening effort (Listening Effort Questionnaire-Cochlear Implant, LEQ-CI; Listening Effort domain of the Cochlear Implant Quality of Life, CIQOL-LE) and listening fatigue (Vanderbilt Fatigue Scale-Adult, VFS-A). SVT performance was evaluated across time points and compared to subjective listening effort and fatigue.

Results: Partially consistent with our first hypothesis, SVT accuracy (comprehension) and RTs (listening effort) significantly improved from pre-CI to 1-month post-CI and from 1- to 3-months post-CI (p's< .017), but not from 3- to 6-months post-CI. Similar improvements were observed in subjective listening

effort (pre-CI to 1-month post-CI; p's< .001) and fatigue (pre-CI to 1-month, 1- to 3-month, 3- to 6-month post-CI; p's<.020). Partially consistent with our second hypothesis, controlling for baseline scores, post-CI SVT RTs (listening effort) were consistently moderately to strongly associated with subjective listening effort and fatigue at 1- and 3-months post-CI: LEQ-CI (r's = -.29 to -.53), CIQOL-LE (r's = .92 to .95), and VFS-A (r's = -54 to -.95). However, these relationships were in the opposite direction than predicted; slower RTs were associated with lower everyday listening effort and fatigue. Higher post-CI SVT accuracy (comprehension) was weakly to moderately associated with higher subjective listening effort (LEQ-CI, r's = .05 to .29; CIQOL-LE, r's = -.08 to -.32), but lower fatigue (VFS-A, r's = -.14 to -.40). SVT 6-month scores were only weakly associated with subjective measures.

Conclusions: These results provide preliminary evidence that behavioral sentence comprehension and listening effort improve with CI use, along with the everyday experience of listening effort and fatigue. Additionally, findings that behavioral listening effort was inversely related to subjective listening effort and fatigue could indicate that CI users who selectively apply effort to comprehend speech may be better at navigating the demands of everyday listening. Future research is needed to better understand the factors impacting task-specific and everyday listening effort and fatigue in adult CI users. Clinically, both subjective and objective measures of listening effort may be useful additions to conventional speech recognition testing for assessing CI outcomes.

PODIUM SESSION IV: HEARING LOSS: EPIDEMIOLOGY AND GENETICS / HEARING AIDS

Polygenic Risk Score-Based Association Analysis of Audiometry and Otoacoustic Emissions

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Objectives: Recent genome-wide association studies (GWAS) identified the genetic architecture underlying common, genetically complex, adult-onset conditions across the health spectrum. GWAS-based polygenic risk scores (PRS) can quantify the genetic risk of complex conditions independent of their trait expression. The objective of the present study was to evaluate the relationship between PRS of complex traits and hearing measures in healthy young adults. This study utilized hearing thresholds (HT) and distortion product otoacoustic emissions (DPOAEs), two widely used clinical measures, for the PRS-based association analysis. We used a linear regression to predict DPOAEs from HTs. A relative metric of ΔDPOAE (i.e., observed DPOAE - predicted DPOAE from HTs) was computed to quantify the relative agreement between HTs with DPOAEs. We reasoned that negative ΔDPOAE indicate poorer DPOAEs than HTs, putatively indicating predominant mechanical dysfunction; while positive ΔDPOAE indicate better DPOAEs than HTs, putatively indicating strial or synaptic/neural dysfunction.

Design: A sample of 227 healthy young adults with self-reported normal hearing was recruited. HTs and DPOAEs were measured from 1000-16000 Hz. A comparison metric of ΔDPOAE was derived using a linear regression, that predicted DPOAEs from observed HTs. Saliva-derived DNA samples were subjected to low-pass whole genome sequencing. A custom PRS calculator was used to obtain PRS of over 3000 complex traits across the health spectrum. A statistical analysis was conducted to identify PRS of HTs, DPOAEs, and ΔDPOAE while statistically controlling the effects of age, sex, self-reported ethnicity, and genetic ethnicity. Enrichment analysis was performed to identify traits categories overrepresenting PRS associated with hearing traits.

Results: 322 PRS predictors revealed significant associations (FDR $p<0.05$) with HTs and were replicated in both ears. 132 PRS predicted showed significant associations with DPOAEs and were replicated in both ears. Endocrine/metabolic traits were significantly enriched for HTs, while DPOAEs revealed no significant enrichment with any trait category. LMM identified 685 PRS predictors showing significant association with ΔDPOAE, among which 79 were replicated in both ears. Among 79 PRS predictors replicated in both ears, 53 showed positive beta values of ΔDPOAE, putatively indicating predominant strial or synaptic/neural dysfunction. Cardiovascular conditions were enriched for positive beta values of ΔDPOAE. 26 PRS revealed negative beta values of ΔDPOAE, putatively indicating mechanical dysfunction to the cochlea.

Conclusions: Genetic comorbidities of acquired hearing loss can significantly impact individual variability in HTs, DPOAEs, and ΔDPOAEs among healthy young adults. Genetic factors might be helpful to differential common cochlear pathologies. Future research is needed to investigate the clinical utility of PRS in the differential diagnosis of common cochlear pathologies in individuals with acquired hearing loss.

Genetic Factors Explain Differences in Otoacoustic Emissions Among Young Adults

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Objectives: Age-related hearing loss (ARHL) is a highly prevalent health condition that has been associated with numerous health comorbidities, including dementia, Alzheimer's disease, cognitive decline, and social isolation. Recent genome-wide association studies (GWAS) have uncovered the genetic architecture underlying ARHL. One known mechanism of ARHL is degeneration of outer hair cells, whose functioning may be observed by measuring distortion product otoacoustic emissions (DPOAEs). We hypothesized that genetic variations associated with ARHL can also explain differences in DPOAEs among healthy young adults with self-reported normal hearing. Early identification of individuals genetically at risk of ARHL before its clinical onset is critical to providing timely interventions to mitigate the negative effects of hearing loss.

Design: We selected 7218 single-nucleotide polymorphisms (SNPs) associated with ARHL in a previous genome-wide association study meta-analysis (meta-GWAS). We performed regression analysis to determine whether these variations could explain differences in DPOAE amplitudes among a sample of 357 healthy young adults with self-reported normal hearing. We employed linear mixed models to identify the SNP effects on DPOAEs. We then used functional annotation to map SNPs to their gene to quantify gene-specific effects on DPOAEs.

Results: 1316 SNPs were significantly associated with DPOAE amplitudes in the young adult cohort. Of these, 426 SNPs demonstrated consistent direction of effect on DPOAE amplitudes compared to what was observed in the meta-GWAS; that is, SNPs that were associated with hearing difficulty in the meta-GWAS were associated with poorer DPOAEs, and vice versa. 83 of the mapped genes were significantly associated with DPOAEs and demonstrated consistent direction of effect on DPOAEs compared to the meta-GWAS.

Conclusions: Individuals with genetic predisposition to ARHL exhibit significantly lower DPOAE amplitudes, potentially decades before clinical onset of ARHL. Genes influencing DPOAEs are likely to have effects on the cochlea itself, and especially outer hair cells. These results emphasize the need for early intervention for high-risk individuals, who may be experiencing a decline in cochlear function well before their age-matched peers. This underscores the necessity of a genotype-first approach, which can identify these individuals before noticeable hearing difficulty emerges and provide clinicians with the chance to perform targeted preventative intervention.

Comorbidity Landscapes of Age-Related Hearing Loss, Tinnitus, and Speech-in-Noise Deficits

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Objectives: Age-related hearing loss (ARHL) is the most prevalent form of permanent hearing loss affecting aging adults. The economic burden of hearing loss exceeds $980 billion/year, with 32% of costs estimated to be driven by comorbidities. Tinnitus, a phantom perception of sound in the ears or head in the absence of any external sound source, and speech perception difficulty in noisy backgrounds, usually referred to as speech-in-noise (SIN) deficits, are common otological comorbidities associated with ARHL. The present study employed a data-driven approach to identify comorbidities across the medical phenome associated with self-reported ARHL, SIN deficits, and tinnitus. We employed artificial intelligence to construct phenotype risk (PheRS) models to quantify the overall risk of ARHL, SIN deficits, and tinnitus.

Design: The UK Biobank database (N>500,000) was used to identify the comorbidities of ARHL, SIN deficits, and tinnitus. Inpatient hospital records were accessed to obtain ICD-10 codes. The records included 19,190 distinct diagnostic entities. ICD-10 codes were converted into phecodes using the phecodeX map to reflect modern disease classification while removing internal redundancies of the ICD-10 scheme. Phecodes are categorized into 18 groups: congenital, genetic, sense organs, musculoskeletal, neurological, neoplasm, gastrointestinal, cardiovascular, genitourinary, endocrine/metabolic, neonatal, infections, respiratory, dermatological, pregnancy, mental health, symptoms, blood/immune. Logistic regression was conducted to identify phecodes associated with ARHD, SIN deficits, tinnitus, and tinnitus severity while statistically controlling for age, sex, self-reported ethnicity, and genomic ethnicity with the first 10 genomic principal components (PCs). The genomic PCs were obtained from the UK Biobank to control for potential population stratification. Artificial neural network (ANN), XGBoost, and L1 and L2 regularization methods were evaluated to construct PheRS models. Enrichment analysis was conducted to identify trait categories showing overrepresentation of phecodes associated with each trait.

Results: The association analysis identified 383, 449, 283, and 216 medical conditions associated (adjusted $p<0.05$) with ARHD, SIN deficits, tinnitus, and tinnitus severity, respectively. Gastrointestinal conditions revealed significant enrichment with all traits. Respiratory, genitourinary, and sense organs showed significant enrichment with ARHD, SIN deficits, and tinnitus. SIN deficits and tinnitus severity showed significant enrichment with mental health and neurological conditions. Among the mental health conditions, major depressive disorder, anxiety disorder, and bipolar disorder showed the strongest associations with auditory traits. Elevated PheRS significantly increased the risk of their respective phenotype expression.

Conclusions: The study revealed the comorbidity landscape of ARHD, SIN deficits, tinnitus, and tinnitus severity. The robust enrichment of gastrointestinal traits with auditory conditions suggests a potential

link to gut dysbiosis. The strong associations between mental health conditions, particularly with SIN deficits and tinnitus severity, underscore the complex interplay between auditory and mental health. PheRS provides a quantifiable measure of risk, that may be useful for clinicians in predicting and managing these conditions. Further research should focus investigating the biological mechanisms underlying these associations.

Longitudinal Association Between Sleep Disturbances and Hearing Loss

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Objectives: Sleep disturbances are potential novel risk factors for hearing loss, through mechanisms including cardiovascular factors impacting the cochlea's blood supply, oxidative stress, and chronic inflammation. Although cross-sectional studies in clinical samples and population-based surveys have reported associations between sleep disturbances and hearing loss, longitudinal evidence remains limited, precluding examination of the direction of potential causal associations between sleep disturbances and hearing. However, it is also possible that hearing loss leads to sleep disturbances through fatigue, depression, and social isolation. We aimed to examine the longitudinal association between sleep disturbances and hearing loss trajectory over a maximum follow-up of 10 years, with a secondary aim to understand the direction of the sleep-hearing association.

Design: This study included 782 dementia-free participants aged ≥50 years from the Baltimore Longitudinal Study of Aging from 2012-2023, with ≥1 visit with both hearing and sleep assessments. Hearing ability was assessed by pure-tone audiometry and better-ear four-frequency (0.5, 1, 2, 4 kHz) pure-tone average (PTA) in dB HL (higher=worse) was calculated. Sleep measures included: (1) self-reported sleep duration collected categorically and analyzed as ≤6, 6-7, >7 hours and (2) sleep symptoms and quality as assessed by the modified five-item Women's Health Initiative Insomnia Rating Scale (range 0-20, higher=worse). We used linear mixed effects models to examine the longitudinal association between sleep and trajectory of hearing, adjusting for age, sex, race, education, smoking, alcohol use, noise exposure, body mass index, hypertension, diabetes, and stroke. To understand the temporal sequence of hearing loss and sleep disturbances, we fit sequential bivariate latent change score models assuming: (1) no association; (2) sleep drives subsequent change in hearing; (3) hearing drives

subsequent change in sleep; and (4) a bidirectional association. The likelihood ratio test was used to select the best-fitting model.

Results: 782 participants had a mean age of 71 years, 45% were males, and 27% self-identified as Black. Compared to participants with ≤6 hours of sleep, participants with >7 hours of sleep had a faster annual rate of decline in PTA (0.20 dB HL, 95% CI: -0.01, 0.41) over a mean follow-up of 4 years. This was not observed among participants with 6-7 hours of sleep. No association was observed between sleep quality and rate of hearing change. In secondary analysis evaluating the temporal sequence of the sleep-hearing association, sleep duration and sleep quality appeared to drive subsequent decline in PTA, but there was no evidence that PTA affected subsequent sleep.

Conclusions: Our findings provide novel longitudinal evidence suggesting sleep disturbances might be risk factors for hearing loss. Future longitudinal research with repeated polysomnography or actigraphy is needed to better characterize different aspects of sleep and clarify the sleep-hearing association to evaluate whether sleep disturbances might be promising targets for hearing loss prevention.

Genetic Risk Modeling of Acquired Hearing Loss Using Artificial Intelligence

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Objectives: Recent genome-wide association studies (GWAS) identified genetic architecture underlying acquired hearing loss. Polygenic risk scores (PRS) can summarize the genetic risk of a complex trait into a single score. PRS consider only linear additive effects of genetic variants, ignoring the complex interplay between genetic, environmental, and lifestyle factors. This study aimed to improve the performance of the genetic risk model by utilizing the artificial intelligence (AI) framework predicting acquired hearing loss from genetic, environment, and lifestyle profiles. We hypothesized that genetic variants and their interactions with environment and lifestyle can significantly predict the risk of acquired hearing loss.

Design: The study utilized a UK Biobank cohort (N=427,316) for designing the AI model for predicting the risk of acquired hearing loss using genetic, environment, and lifestyle profiles. A cohort of 227 healthy young adults was used to validate the results of the AI model. Age, sex, self-reported ethnicity, the first 10 genomic principal components, candidate genetic variants showing association with acquired hearing loss, PRS of acquired hearing loss and related comorbidities, noise exposure, music exposure, and smoking were used as predictors for the statistical models predicting self-reported hearing difficulty. Logistic regression, XGBoost, Random Forest, Naïve Bayes, and artificial neural network (ANN) were used to predict self-reported hearing difficulty. We used Shapley Additive Explanations (SHAP) to identify the specific features that uniquely contributed to improving model performance. Area Under Receiver Operating Curve (AUROC) and F1 statistics were compared across the models to identify the best model.

Results: ANN (AUROC=0.81) and XGBoost (AUROC=0.80) achieved the best performance. ANN achieved better F1 statistics (F1cases=0.60, F1control=0.82). The explainable AI-based analysis of ANN revealed that two PRS models of acquired hearing loss (PGS000762 and PGS002104) showed the highest feature importance, followed by age and sex. PRS of hearing aid use, respiratory and ear, nose, and throat diseases, neuroticism, CX3CL1 serum levels, asthma, headache, neuroticism, suicidal thoughts, vitamin B12, and tinnitus revealed high feature importance. Young adults with high ANN predicted risk of acquired hearing loss showed significantly elevated hearing thresholds.

Conclusions: The AI-powered risk models can accurately quantify the risk of acquired hearing loss. The explainable AI can be used to interactively project the risk of acquired hearing loss across the lifespan. The results indicate that the polygenic risk of acquired hearing loss, as well as the related comorbidities, explain the phenotypic expression of acquired hearing loss. We posit that effective communication about genetic risk and adherence to healthy auditory lifestyle at younger ages can prevent or delay the clinical onset of acquired hearing loss at older ages.

Clinical Trial Results on One vs Two Hearing Aids

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Objectives: The primary study goal was to determine the benefit of unilateral or bilateral hearing aid fittings for the treatment of mild-to-moderate age-related hearing loss in individuals 50+ years of age. Our primary hypothesis was that patients with mild-to-moderate hearing loss fitted with bilateral hearing aids will report more self-perceived benefit than those fitted with a unilateral hearing aid.

Design: A multi-site, randomized-controlled clinical trial (RCT) was conducted with two treatment arms including a unilateral fitting arm and a bilateral fitting arm. A total of 275 participants were randomized to a treatment group (n = 136 unilateral, n = 139 bilateral). None of the participants had prior hearing aid use and all participants obtained hearing aid(s) through common clinical processes including payment consistent with obtaining one or two devices. Participants in both arms had a 3-month trial of their assigned treatment. The primary study outcome was the Abbreviated Profile of Hearing Aid Benefit (APHAB). After the primary 3-month trial, participants returned to the clinic for outcomes assessment (behavioral and self-report) and chose whether or not to continue with their current configuration (1 or 2 hearing aids) or change to a different configuration (0, 1, or 2 hearing aids). The primary study outcome was change in Global APHAB score (from baseline to 3 months). A linear regression model was fit for "completers" (those who had baseline and 3-month scores) with randomized assignment and clinical site as covariates.

Results: The results showed that bilateral hearing aid use resulted in greater reduction in global APHAB score benefit than unilateral hearing aid use. On average, bilateral users had 5 percentage points more benefit than unilateral users. The average APHAB change score for patients assigned to unilateral group was 14.41 (SD: 13.02), and the average APHAB change score for patients assigned to the bilateral group was 19.74 (SD: 15.18) in bilateral patients for an average difference of 5.29 percentage points between the groups (95% CI: (1.80, 8.79), p=0.003). A key secondary endpoint was the percentage of patients achieving a 15-point reduction in APHAB score from baseline to 3 months. Again, the bilateral group

showed an increase in response over the unilateral group (57.8% vs 41.6%, p=.005). At the conclusion of the primary trial, 66.9% chose the bilateral configuration and 26.9% chose a unilateral configuration.

Conclusions: Adults with mild-to-moderate age-related hearing loss find benefit from unilateral or bilateral amplification, and more benefit on average from bilateral hearing aids than from unilateral hearing aids. This RCT is the first study we are aware of demonstrating that self-perceived bilateral benefit in the presence of realistic cost differences (i.e. all participants paid for hearing aid related services and realistically, paid more for two hearing aids than one). These results support that adults with mild-to-moderate age-related hearing loss should be recommended bilateral hearing aids, and more research is needed to understand the factors that influence the choice for unilateral or bilateral fittings in this population.

An Accessible Image-Based Questionnaire for Assessing Hearing and Hearing-Aid Outcomes

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Objectives: To develop and validate a language-independent 'Image-based questionnaire' (IBQ) based on the Common Sound Scenarios Framework (CoSS) in which standard written descriptions of the 14 CoSS listening situations are replaced with photographs. This will largely remove language and literacy barriers, allow for better-controlled comparisons across populations, and decrease variability in interpretation of each questionnaire item.

Design: IBQ development and validation took place over a patient-public involvement (PPI) session and four experiments. The PPI session attended by seven individuals was used to assess desirability of an IBQ and to discuss 'meta-content' (age, ethnicity, gender, emotional valence) of potential images. This information was used when selecting six images for each CoSS (84 total) for use in experiment 1. In Experiment 1, 71 participants (median age 56 yr., 30% poor hearing) rated how well they thought they would hear in each scenario, and indicated which photograph(s) best represented each specified scenario. From this the two photographs most often selected for each CoSS were used in Experiment 2. In Experiment 2, 42 participants (age 33-86 yr., 48% poor hearing) used open-text to describe what they thought they 'would be listening to/trying to hear' if they were in the scenario shown in each photograph. For each CoSS, the image most often selected and best described was chosen for the final 14-item IBQ. In Experiment 3, 55 participants (median age = 39 yr., 51% hearing loss) completed the 14-item IBQ, a text-based version of the IBQ (TBQ), the Glasgow Hearing Aid Benefit Profile (GHABP), and the digits-in-noise test (DiN). They also reported their opinions about the IBQ versus TBQ. Up to 120 participants will take part in Experiment 4 (ongoing). Test-retest data on the IBQ are being collected, as is audiometric data, to examine the association between questionnaire scores and hearing sensitivity.

Results: PPI indicated favourable opinions towards an IBQ, preference for use of an image-based response scale, and that age, ethnicity, etc. of people in each photograph was unimportant as long as they

varied across the questionnaire as a whole.Ratings and open-text responses from Experiments 1 and 2 allowed us to select a single photograph that accurately represents each CoSS, i.e. each was 'correctly' described (e.g. singular nouns used to describe one-on-one scenarios, plural nouns used for groups, etc.). In Experiment 3, significantly more participants preferred, found easier and were more confident completing the IBQ than the TBQ ($p<0.001$). There were stronger correlations between the IBQ and DiN ($r=-0.448$), than between the GHABP and DiN ($r=-0.295$), IBQ ratings were significantly lower (hearing less well) in photographs depicting noisy scenarios than quiet scenarios, and for participants with poorer relative to better self-rated hearing. Data collection for Experiment 4 is ongoing.

Conclusions: The findings indicate that the photographs selected for the IBQ reflect the intended listening scenarios, the IBQ has face-validity, and participants prefer completing an image-based questionnaire over a text-based questionnaire. The IBQ is an accessible alternative to standard clinical self-report outcome measures.

Factors Influencing Hearing Aid Adoption, Usage, and Retention

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Objectives: Hearing aids (HAs) are the most commonly recommended intervention for those with hearing loss, yet many individuals either discontinue use or return them during trial periods. Reasons for this include the severity of hearing loss, perceived listening challenges, costs, and social stigma. A prevalent issue is difficulty understanding speech in noisy settings, often leading to dissatisfaction with HAs. However, the connection between clinical speech perception scores (in quiet and noise) and HA usage remains unclear. This study addresses this gap by examining how speech perception in quiet and noise, hearing loss severity, and insurance status influence HA adoption and retention using a large dataset from an academic medical center.

Design: This preliminary study draws from audiological and hearing aid records collected at the Stanford Ear Institute since 2006. The study includes adults (≥18 years, N = 26,816) and excludes individuals with normal hearing (HFPTA ≤25 dBHL at 1000, 2000, and 4000 Hz), those with conductive hearing loss, and users of cochlear implants (CI), CROS, or bimodal devices. The key variables influencing HA procurement, use, and retention considered here were degree of hearing loss, speech perception in quiet (Word Recognition in Quiet - WRQ) and noise (QuickSIN), and billing type: (1) private insurance, (2) Medi-Cal (California's healthcare program covering HAs), and (3) self-pay.

Results: "Chi-square analysis ($\chi^2 = 643.71$, df = 8, $p< 2.2e-16$) showed that billing type significantly impacted hearing aid (HA) acquisition, with Medi-Cal users having the highest adoption rates. A Generalized Linear Model (GLM) further revealed that speech perception scores in quiet and noise did not significantly influence HA acquisition or usage, regardless of hearing loss severity ($p > 0.01$). Medi-Cal users also demonstrated the highest device retention. To explore factors affecting retention, we examined return and exchange patterns, finding that a group of “device cyclers

Conclusions: who financed or insured their HAs, contributed to higher return rates. No significant trends in HA usage emerged across hearing loss or speech perception scores, although individuals with moderately severe hearing loss and better speech perception in noise tended to use their HAs longer.

PODIUM SESSION V: AUDIOLOGY AND OTOLOGY: DIAGNOSIS AND INTERVENTION

Ear Canal Geometry from Infancy Through Old Age

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Objectives: Ear-canal geometry impacts a range of audiological practices, from earmold replacement schedules in young hearing aid users to volume norms in tympanometry and to assumptions in wideband acoustic immittance (WAI) measurements. This study offers the first comprehensive characterization of ear-canal geometry and its development.

Design: One ear from each of 221 de-identified high-resolution CT scans (ages 0.5-91 years) was analyzed using OsiriX MD V.12.01 software with a multiplanar reconstruction technique. Non-syndromic ears with no history of external ear disease or surgery were included. Cross-sectional areas were measured along the central axis at 1-2 mm intervals, with objective definitions applied to identify key locations, including the tympanic annulus, first bend, and entrance. Bone-to-cartilage transition points were measured at four canal surfaces (superior, anterior, inferior, and posterior). We assessed whether measures varied by age cohorts (12 groups) and sex assigned at birth. The CT scans were obtained retrospectively from UMass Chan Medical School, with IRB exemptions for Smith College and UMass.

Results: Ears assigned male at birth tend to have slightly greater lengths and areas than those assigned female, although sex differences are minimal compared to intersubject variability and age-related differences. The area within the tympanic annulus shows no statistically discernible age-related differences (mean ± SE: 63.1 ± 0.4 mm¬≤), suggesting it is mature at birth. All other area and length measurements vary significantly across age groups up to 10 or 15 years, with fewer differences observed above 15 years. For example, the canal entrance area increases from 52.7 ± 5.8 mm¬≤ in the youngest group (0-2 years) to 115.4 ± 5.2 mm¬≤ in the oldest group (80-91 years), with corresponding canal lengths of 21.2 ± 0.4 mm and 31.7 ± 0.6 mm. Across these same age groups, the first bend area ranges from 25.5 ± 3.3 mm¬≤ to 80.1 ± 5.4 mm¬≤, and the distance from the annulus to the first bend varies from 16.4 ± 0.4 mm to 26.6 ± 0.5 mm. The bone-to-cartilage transition does not shift above age 10; in mature ears, it occurs progressively from the superior-to-anterior-to-inferior-to-posterior canal surfaces at 10.9, 12.4, 14.7, and 15.6 mm from the annulus. In younger ears, this transition occurs closer to the annulus and varies with age.

Conclusions: This study characterizes ear canal geometry and maturation, showing that (1) the area within the tympanic annulus remains stable after birth, (2) canal areas and distances increase significantly in the first 10 years, with some minor increases continuing across ages but with high population variability, and (3) the bone-to-cartilage transition matures in the first 10 years by extending

the bony section from the annulus to the canal's second bend, while the length of the cartilaginous section remains unchanged after birth. These findings enhance understanding of the canal geometry's influence on acoustic properties, particularly in calculating absorbance, which relies on canal area at the measurement probe.

Audiometric Thresholds and Computed Tomography in Children with Down Syndrome

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Objectives: It is estimated that 75% of children with Down syndrome have hearing loss (HL). Many cases are conductive (CHL) in nature; however, high rates of mixed and sensorineural hearing loss are also observed. The anatomic and physiologic characteristics of individuals with Down syndrome predict risk for CHL, including frequent Eustachian tube dysfunction, immune deficiencies, and otitis media with effusion. Although imaging findings in individuals with Down syndrome have shown a high rate of outer and inner ear anomalies (e.g., hypoplastic external and internal auditory canal, respectively) the role of temporal bone anatomy in hearing sensitivity remains undefined. The purpose of the current study was to review audiometric thresholds, and characterize temporal bone computed tomography (CT) findings in individuals with Down syndrome.

Design: A retrospective chart review was completed at a large tertiary care pediatric hospital. Medical records of patients with Down syndrome who were seen for behavioral audiometric testing from 8/2023-8/2024 and who had undergone imaging via CT within 6 months of available audiometry were included. Post-surgical ears (except for pressure equalization tube placement), ears with active middle ear disease, and ears without both air and bone conduction thresholds were excluded. Demographic, radiographic, and audiometric data were analyzed.

Results: 584 unique patients with Down syndrome were seen in the audiology clinic over the study period, and 45 patients (90 ears) had temporal bone CT. Of those, 44 ears were excluded based on the criteria above, and 46 ears were included in the analysis. All 46 ears demonstrated HL: 31 ears had CHL and 15 had mixed HL. Median bone conduction thresholds (15 dB) were in the normal range, and median air conduction thresholds (35 dB) were in the mild to moderate HL range. 38 ears had tympanometry results available. Of those, 28 (74%) ears had normal tympanometry (n=10 ears) or patent tubes, (n=18 ears), suggesting a high presence of grossly normal middle-ear function despite all ears having a conductive component to their HL.CT findings showed 13 ears (28%) had normal outer ears, 11 (24%) had normal middle ears, and 2 (4%) had normal inner ears. Outer ear anomalies included narrowed external auditory canal (39%) and thickened tympanic membrane (37%). Middle ear anomalies included under-pneumatization of the mastoid (46%), ossicular malformation (37%), and hypoplastic middle ear cavity (11%). Inner ear anomalies included small bony island of the lateral semicircular canal (67%), cochlear hypoplasia (22%) and enlarged vestibular aqueduct (8%).

Conclusions: High rates of anatomic ear anomalies (as determined by temporal bone CT) were observed in this sample of children with Down syndrome. Air-bone-gaps were detected for all ears despite normal

middle ear function as described by tympanometry in 74% of cases. These findings underscore the need for further investigation of the mechanisms of hearing loss for individuals with Down syndrome.

Broadband and 8kHz chirp ABRs in Fullterm and Preterm Infants

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Objectives: Approximately 10% of preterm infants have permanent hearing loss or are at risk for delayed or progressive hearing loss. Furthermore, many infants receive aminoglycoside antibiotics increasing their risk for high-frequency hearing loss. The auditory brainstem response (ABR) measured with traditional click and tonebursts have several limitations (smaller amplitudes, less accurate estimation of hearing levels, longer test times). Innovative "chirp stimuli" overcome these limitations with increased neural synchronization, leading to improved waveform detection and shorter test times. However, the infant chirp ABR literature is sparse, limited normative broadband chirp data is available and narrowband chirps are constrained to frequencies ≤ 4 kHz, limiting clinical implementation. The purpose of this study is to evaluate chirp ABRs in preterm and fullterm infants to improve detection of abnormal neurologic function and high-frequency hearing loss.

Design: In this analysis, 58 fullterm healthy infants (mean=2.8 mos; range=1-5; male=31) and 133 preterm infants (mean=2.5 mos; range=1-5; male=72) born between 24-32 weeks gestational age were tested. Procedures included hearing and medical history, otoscopy, 1 kHz tympanometry, distortion product otoacoustic emissions (DPOAE; Titan, Interacoustics), and ABR using broadband chirps (70 nHL) and level-specific CE-Chirps (air conduction: 1 and 8 kHz; bone conduction: 1 kHz; Eclipse, Interacoustics). Bayesian weighting, stopping rules, and interpretation criteria were employed: response confidence (FMP), amplitude, signal-to-noise ratio, and residual noise.

Results: All fullterm infants had a present broadband chirp response and normal hearing (NH). Within the preterm cohort, 100% had a present broadband response and 33% had hearing loss (20% conductive [CHL], 11% sensorineural [SNHL], 2% undetermined) that ranged from slight to moderately-severe. RMANOVAs were used to examine amplitude and latency differences between subgroups. For the broadband chirps, preterm infants with NH or SNHL showed no significant differences in wave I, III and V latencies compared to the fullterm group. However, preterm infants with CHL showed wave I, III, and V latency delays ($p<0.001$) compared to fullterm NH, preterm NH, and preterm SNHL subgroups. Wave III amplitude was reduced for CHL ($p<0.001$) and SNHL subgroups ($p=0.027$) and wave V amplitude was reduced for SNHL compared to NH groups ($p=0.046$). For 1 and 8 kHz narrowband chirps, preterm CHL and SNHL subgroups had elevated thresholds compared to NH fullterm and preterm groups. Greater days of aminoglycoside antibiotic exposure in preterm infants were related to poorer 1 and 8 kHz chirp thresholds ($p<0.001$).

Conclusions: Results are novel and clinically relevant as it is the first report of 8 kHz chirp thresholds and the largest sample of level-specific CE-Chirp ABR responses in fullterm and high-risk preterm infants. Normative broadband chirp data support use over traditional clicks in clinical practice. Current newborn hearing screening is insensitive to the slight-mild and high-frequency hearing loss detected in this cohort. The significant relationship between chirp thresholds and aminoglycoside exposure provide evidence for use in monitoring infants at risk for progressive loss after NICU discharge. Future analysis includes full

development of level-specific chirp norms with additional recruitment of fullterm infants and further evaluation of relationships between chirp ABRs, medical factors, and hearing loss risk factors.

Data-Driven Audiometric Classifications and Speech Perception Measures

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Objectives: The pure-tone audiogram is the current gold standard for hearing assessment, and generally includes thresholds from 250 to 8000 Hz. Large numbers of audiograms are routinely summarized by a pure-tone average (PTA), which averages 3-4 audiometric frequencies. While useful, the PTA does not consider audiometric configuration, and does not consider some frequencies. Moreover, PTA only partially predicts suprathreshold deficits in speech understanding. New advances in data-driven profiling, however, offer the opportunity to refine hearing loss classifications, and to better capture natural variability in hearing thresholds to advance precision audiology. Here, we employ a data-driven approach to mathematically identify the most common audiometric clusters. We then expand this approach by identifying clusters associated with specific auditory pathologies, such as Meniere's disease, vestibular schwannoma, and sudden hearing loss. Finally, we then characterize suprathreshold speech recognition abilities in quiet and noise for each of these clusters and pathologies.

Design: Here we identified 66956 audiograms from individual patients from our database, excluding individuals with conductive or mixed hearing loss (air-bone gap ≥10 dB HL). We then applied K-Means clustering measured at 8 frequencies (250 - 8000 Hz) to identify 10 distinct clusters using the scikit-learn package in Python. We then examined suprathreshold function by examining speech perception measures in quiet (Word Recognition in Quiet, WRQ) and noise (QuickSIN). Finally, we applied the same analysis pipeline to patients with Meniere's disease (N = 4,669), vestibular schwannoma (N = 4,335), and sudden hearing loss, generating unique models of 10 clusters for each pathology.

Results: While preliminary, our results reveal unique audiometric configurations across the dataset. WRQ scores were excellent with most audiometric configurations. In contrast, deficits with QuickSIN were observed with even small amounts of hearing loss, with greater variability between patients than with WRQ. In Meniere's disease, younger individuals often showed a rising audiometric configuration, possibly linked to recent diagnosis, while older individuals generally had flat or sloping configurations. Individuals with vestibular schwannoma tend to have varying degrees of hearing loss with sloping configuration, except for ~ 18% who had normal hearing sensitivity with a flat configuration. Both WRQ and QuickSIN SNR losses in these pathologies tended to be worse than in those individuals with sensorineural loss alone.

Conclusions: Here we identified distinct, data-driven audiometric clusters in patients with sensorineural hearing loss, and with common auditory pathologies. Across most pathologies and clusters, WRQ scores were excellent, consistent with previous research indicating that WRQ scores are generally only poor in the presence of significant hearing loss. In contrast, deficits on the QuickSIN were routinely observed across all audiometric configurations, with worse performance observed with increasing hearing loss.

More importantly, the distinct audiometric clusters observed across different age groups and auditory pathologies may offer insights into the progression and impact of each disorder on hearing profiles, and rehabilitation strategies. Taken together, this approach sets the stage for new advances in precision audiology by allowing for greater characterization of performance than traditional PTA measures, particularly for handling large audiologic datasets.

Why the NoSπ Threshold Should be Measured in Audiometric Evaluations

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Objectives: Current clinical procedures for conducting routine audiometric evaluations require the measurement of air and bone conduction thresholds as well as an objective evaluation in each ear of word recognition in quiet. Patient-reported hearing difficulty is sometimes captured by standardized questionnaires (e.g., THS, SSQ, HHIA) and speech-in-noise scores are sometimes captured with standardized tests (e.g. QuickSIN, WIN). With the exception of the speech-in-noise tests, all listening tests in a routine audiometric evaluation are administered monaurally, and tests of binaural function, such as the Masking Level Difference (MLD) test, are usually limited to a small percentage of patients who are being evaluated for auditory processing disorders. Recent findings from our laboratory suggest that binaural assessments, particularly the antiphasic NoSπ threshold from the MLD test, can be a valuable tool for objectively measuring hearing damage in noise-exposed individuals, even when traditional audiometry and speech-in-noise testing appear normal.

Design: Results were taken from a number of large scale studies that have measured hearing thresholds, hearing complaints, speech-in-noise performance and noise and blast history in US Service Members. Correlations and multivariate models were used to determine the extent to which NoSo and NoSπ thresholds are correlated with noise and blast history and how well they can predict speech-in-noise performance and hearing complaints both in isolation and in combination with hearing threshold data.

Results: The results show that the NoSπ threshold is consistently correlated with noise and blast exposure, and that it is a significant predictor of hearing complaints and hearing performance both alone and in combination with audiometric threshold data. The NoSπ threshold appears to be particularly useful for identifying and tracking hearing deficits in individuals with hearing complaints but normal audiometric thresholds. It is notable that NoSπ appears to be a much greater predictor of hearing difficulties in this population than the NoSo threshold or the MLD (The NoSo threshold minus the NoSπ threshold), which is frequently the only measure reported when the MLD test is administered as a measure of auditory processing disorder.

Conclusions: The NoSπ threshold has not traditionally been used as a clinical measure of hearing performance, in part because of the assumption that both NoSo and NoSπ thresholds increase proportionally with hearing loss, making the MLD-calculated as the difference between these two thresholds-the preferred measure of binaural processing. However, there is substantial evidence that the NoSπ threshold varies in ways that reflect overall auditory function independently of pure-tone thresholds, while the NoSo threshold is less reliably correlated with these functional changes. The greater variability in the NoSo threshold introduces measurement noise, limiting the clinical value of the MLD

primarily to the diagnosis of individuals with severe binaural impairment. We believe the NoSπ threshold alone is a more consistent and meaningful measure of overall hearing performance than the MLD and that audiologists should consider measuring and tracking it in noise-exposed individuals.

Effects of Audiometric Threshold on N0Sπ Detection

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Objectives: Binaural interaction is one of the domains used for the audiological evaluation of central auditory processing disorder. US Service Members (SMs) that have been blast exposed also show decreased binaural processing. Clinically, a 33-trial test of the binaural masking level difference (BMLD) can be used for identifying abnormal binaural processing. The homophasic noise with an antiphasic signal (N0Sπ) component of the BMLD test is the most sensitive for detecting the binaural processing deficits of blast-exposed SMs. We are developing an 18-trial procedure that provides a more precise estimate of N0Sπ performance while taking less time to administer than the 33-trial BMLD test. A critical step towards the development of this 18-trial N0Sπ procedure is defining a cutoff threshold that differentiates between normal and abnormal binaural processing. The objective of this study was to determine if N0Sπ detection of a 500-Hz signal depends on the audiometric threshold at and above 500 Hz.

Design: Data were collected at hearing conservation clinics during routine monitoring of SMs. Each SM completed the 18-trial N0Sπ detection procedure, an audiogram, and a questionnaire regarding previous blast exposures. This study includes 8,502 SMs who reported no history of blast exposure. The dependence of the 500-Hz N0Sπ detection threshold on audiometric threshold was quantified with a quantile regression model that included the 500-Hz worse-ear audiometric threshold, the 500-Hz interaural asymmetry, and the presence/absence of normal hearing thresholds (20 dB HL or better) above 500 Hz.

Results: The slope of the regression line between the N0Sπ detection threshold and the 500-Hz worse-ear audiometric threshold depended on both the quantile level at which the regression was performed and the presence of normal hearing thresholds above 500 Hz. For above average performers (75th percentile and above), the 500-Hz worse-ear audiometric threshold did not affect N0Sπ detection. For below average performers (25th percentile and below), the N0Sπ detection threshold degraded by 1 dB for every 10 dB increase in the 500-Hz worse-ear audiometric threshold with normal hearing thresholds above 500 Hz and by 2 dB with elevated hearing thresholds above 500 Hz. The 500-Hz interaural asymmetry did not affect the N0Sπ detection threshold.

Conclusions: Other studies conducted in our laboratory indicate that the N0Sπ detection threshold tends to be elevated in individuals who have a history of blast exposure. This degradation in binaural processing tends to increase with increasing hearing thresholds even when those thresholds would be considered "normal". The data presented here show that binaural processing also degrades with increasing thresholds for individuals who perform poorly at NoSπ detection even when they do not report a history of blast exposure. Further study is needed to understand why some normal-hearing listeners have degraded binaural processing and why their performance degrades more rapidly with

increasing worse-ear audiometric thresholds than it does for listeners who have relatively good binaural processing.[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.]

Use of Artificial Intelligence Hearing Aids for Identifying Fall Risk

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Objectives: Falls remain one of the primary causes of injury and death among older adults, underscoring the critical need for effective fall-risk identification methods. The CDC developed the STEADI (Stopping Elderly Accidents, Deaths, and Injuries) protocol, which combines validated functional mobility assessments to predict fall risk with reasonable accuracy. Enabling patients to self-administer these assessments could remove several common barriers to implementing STEADI in clinical settings, such as limited resources, extended appointment durations, and specialized training requirements. This shift could also make care plans, which have been shown to reduce falls by up to 40%, more accessible to patients. We aim to assess whether self-administered fall-risk assessments using hearing aids with built-in inertial measurement units (IMU-HAs) can serve as a reliable alternative to clinician-administered assessments. This study's objectives are to (1) evaluate the feasibility of IMU-HAs for independent fall-risk assessments as guided by the STEADI protocol, (2) identify barriers that participants may face in completing the protocol independently, particularly through the hearing aid (HA) app, (3) optimize the app's usability to improve accessibility for users with varying levels of comfort with technology, and (4) assess the accuracy and reliability of the IMU-HA scoring algorithm. With this system, participants use the IMU-HA while completing the STEADI protocol, which is then scored via a phone app. During in-person testing, scores closely matched those from a trained observer, indicating that this method may be suitable for fall-risk monitoring. In follow-up studies, some participants were able to complete the protocol at home without direct supervision, although over 20% encountered challenges. To better understand and address these difficulties, we repeated the protocol in a controlled lab setting where participants were monitored remotely by a clinician.

Design: Our study included 50 participants aged 55 to 100 years who self-reported a fall risk. Each participant was fitted with bilateral IMU-HAs and independently completed the CDC STEADI assessments, which include the Timed Up and Go, 4-Stage Balance Test, and Chair Stand Test. While all testing took place in a lab, participants followed the protocol independently, guided by the HA app, with remote observation from a clinician in a separate room via a telehealth portal. The clinician simultaneously scored the protocol and noted any challenges participants faced when completing the process independently using the HA application.

Results: Initial results indicate a strong agreement between the HA app scores and those from a trained observer across all STEADI assessments. Errors were less frequent in the TUG and chair-stand tests compared to previous results, suggesting that the revised algorithm is more reliable. Nevertheless, some

participants still faced difficulties using the app for independent completion of the protocol, with the most common issue being "confusion with the app."

Conclusions: Overall, these findings continue to support the potential of IMU-HA technology for identifying individuals at risk of falling according to the STEADI protocol. However, for equitable access, the app's usability must be enhanced, particularly for users less comfortable with technology. Attention to the app's reading level is also essential to ensure widespread accessibility.

Preliminary Study of Remote Counseling and Sound Therapy for Hyperacusis

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Objectives: For many patients with hyperacusis, receiving treatment is limited by issues of accessibility and affordability. Remote counseling has the potential to provide better solutions for hyperacusis management and evidence-based clinical guidelines that are currently lacking. In this study, we developed a novel, remotely delivered counseling program and conducted a sound trial for patients with hyperacusis. We aimed to evaluate feasibility of the remote counseling program to reduce reactions to hyperacusis and to determine the effectiveness of sound therapy for relieving hyperacusis.

Design: We created a four-week remote counseling program, Hyperacusis Activities Treatment-Online (HAT-Online), that included asynchronous videos, hands-on activities and quizzes, handouts and resources for teaching coping skills and keeping patients engaged, and synchronous discussions for coaching. Weekly content was derived from in-person therapy using Hyperacusis Activities Treatment (HAT) and focused on five relevant topics that included: 1) an overview of hyperacusis, tinnitus, hearing and hearing loss; 2) reactions to hyperacusis and strategies to reduce negative reactions to sounds; 3) thought analysis and restructuring; 4) relaxation techniques and mindfulness; and 5) gradual sound exposure and proper use of hearing protection. Following counseling, we compared two sound therapy approaches over four weeks. Participants were randomly assigned into one of two groups: 1) Group 1: listen to everyday sounds that trigger hyperacusis and 2) Group 2: listen to low-level, continuous background noise (i.e., white noise) from sound generators. Participants used successive approximations to increase the level and duration of the sound, and coaching was provided. We tracked sound usage and reactions to sound using daily logs. Hyperacusis and reactions to hyperacusis were measured using the Inventory of Hyperacusis Symptoms and a psychoacoustic sound test. The questionnaire and sound test were administered online at intervals before, during, and after the counseling and sound therapy interventions. We enrolled participants in the study in cohorts of 6-10 to facilitate discussion and connection during the study. In this preliminary study, we enrolled 24 participants, of which 20 participants finished the study.

Results: The completion rate of the IHS questionnaire was 85% and 89% for the sound test. A repeated-measures ANOVA showed that IHS questionnaire ratings of hyperacusis symptoms declined over the course of the four time points, ($F(3) = 4.05$, $p = .01$. Comparing sound therapy groups, the rate of decline in hyperacusis symptoms did not differ, ($F(3) = 0.73$, $p = .54$). On the psychoacoustic sound test, we did not find a significant improvement over time, ($F(3) = 2.55$, $p = .07$). Overall, 57% of participants have reported a moderate to large decrease in their hyperacusis symptoms.

Conclusions: Our remote counseling program, HAT-Online, provides holistic education about hyperacusis, coping strategies to lessen reactions to everyday sounds, and management options. The preliminary data from 20 participants indicated a significant improvement in their hyperacusis symptoms after receiving remote counseling. More participants are working through the program and we continue to gather evidence to assess its effectiveness.

PODIUM SESSION VI: COCHLEAR IMPLANTS / SPEECH PERCEPTION

Pre-operative Predictors of Early Cochlear Implant Outcomes in Adults

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Objectives: Adults with postlingual hearing loss who receive cochlear implants (CIs) display enormous unexplained variability in speech recognition outcomes. Prior work has demonstrated that a combination of demographic, auditory, surgical, neurocognitive, and linguistic measures can help explain long-term CI outcomes, but it is unclear how well pre-operative measures can predict early or long-term CI outcomes. Our limited ability to reliably predict speech recognition outcomes for patients considering CIs creates a barrier to effectively counseling patients pre-operatively or identifying patients who are at risk for a poor CI outcome. The objective of this study was to use a pre-operative test battery of auditory, neurocognitive, and linguistic measures to predict early (1-month post-CI activation) speech recognition outcomes. The central hypothesis was that greater predictive power can be established by using neurocognitive and linguistic measures in addition to standard clinical demographic and hearing-related measures to predict early CI outcomes.

Design: A prospective, longitudinal study was performed in 25 adults undergoing CI surgery for bilateral moderate-to-profound sensorineural hearing loss. A battery of predictor measures was collected prior to surgery, including traditional demographic and hearing-related measures, but also assessments of spectrotemporal processing (using the Spectral-temporally Modulated Ripple Test, SMRT), non-auditory neurocognitive functioning (e.g., working memory capacity, fluid intelligence), and linguistic skills (e.g., rapid word processing, rapid phonological processing, rhyme judgement). One month after CI activation, a variety of word and sentence recognition measures of varying complexity (monosyllabic words, meaningful and nonsensical sentences spoken by a single talker, and high talker variability sentences) were assessed. Correlations and multivariable linear regression analyses were performed for each speech recognition task to assess the contributions of pre-operative demographic, hearing-related, auditory, neurocognitive, and linguistic measures to early speech recognition outcomes.

Results: Broadly, pre-operative auditory, neurocognitive, and linguistic measures were related to speech recognition performance, although the strength of the relations varied by task. Pre-operative fluid intelligence ($r = .51$ to $.62$) and a measure of non-word repetition ($r = .52$ to $.79$) correlated significantly with early speech recognition accuracy. Pre-operative aided spectrotemporal processing predicted early vowel recognition ($r = .51$) and high variability sentence recognition ($r = .62$). Consistent with our hypothesis, preliminary results demonstrate that pre-operative fluid intelligence, non-word repetition, and spectrotemporal processing together could predict approximately 70% of the variance in sentence

recognition, outperforming models including only traditional demographic and hearing-related measures.

Conclusions: Early post-CI speech recognition performance can be predicted reasonably well using a pre-operative battery of auditory, neurocognitive, and linguistic measures. In theory, a similar pre-operative test battery could be used clinically to identify individuals at risk for a poor CI outcome, and to assist in pre-operative counseling to set realistic patient expectations.

Mapping Considerations for Cochlear Implant Users with Unilateral Hearing Loss

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Objectives: Adult cochlear implant users with unilateral moderate-to-profound sensorineural hearing loss typically experience better speech recognition and sound source localization post-activation than pre-operatively, though individual outcomes vary. One potential source of the variability in outcomes are differences in frequency-to-place mismatch. Default mapping procedures assign the bandpass filters without consideration of the placement of the individual's electrode array relative to cochlear place, resulting in tonotopic mismatches for the majority of cochlear implant users. Place-based mapping procedures assign the bandpass filters to match the cochlear place frequency for specific electrode contacts, eliminating tonotopic mismatches. The present study investigated the influence of mapping procedure, magnitudes of tonotopic mismatches, and demographic variables (e.g., age, cognition, and biological sex) on the outcomes of cochlear implant users with unilateral hearing loss.

Design: 15 adults participated in a repeated-measures, double-blinded, prospective investigation of outcomes with two mapping procedures (default versus place-based). The acoustic ear had a pure tone average (.5, 1, 2, & 4 kHz) of ≤30 dB HL. Participants were randomized at device activation to receive a default (n=7) or place-based (n=8) map. Participants were evaluated at 1, 3, 6, and 12 months post-activation. Vowel and word recognition were assessed with the CI alone. Sound source localization was assessed in the combined condition (CI plus acoustic ear) with two speech-shaped noise stimuli: broadband noise (BBN; 126-6,000 Hz) and low-pass filtered noise (LP; 126-500 Hz). Performance on the Flanker Inhibitory Control and Attention Test was used as to characterize cognition.

Results: Significantly better vowel recognition and sound source localization (BBN and LP stimuli) was experienced by the place-based group as compared to the default group out to 12-months post-activation. For participants with default maps, larger magnitudes of tonotopic mismatch resulted in significantly poorer vowel recognition, word recognition, and sound source localization (LP stimulus). Participants with better inhibition control and attention had significantly better word recognition, and males had significantly better sound source localization than females.

Conclusions: Tonotopic mismatches significantly influenced the 1- to 12-month post-activation outcomes for adult cochlear implant users with unilateral hearing loss. These data support the idea that better speech recognition and sound source localization may be experienced by this patient population when

listening with image-guided, place-based maps that eliminate tonotopic mismatches than with default maps that do not account for the variability in electrode array placement.

Spatial Cues in Speech-in-Noise: Orienting Responses in Pediatric Implant Users

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Objectives: Children with unilateral conductive hearing loss struggle in noisy environments due to impaired binaural hearing, affecting sound localization, speech segregation, and spatial cue use. Bçare increasingly used to manage unilateral conductive hearing loss by providing sound to the impaired ear, though their impact on binaural hearing and spatial listening remains underexplored. In noisy settings, listeners may use head positioning to enhance speech perception, leveraging cues like the acoustic head shadow and pinna filtering for better-ear effect. This study aims to evaluate orienting behaviors in children with unilateral conductive hearing loss during a dynamic speech-in-noise task to assess bone conduction implant effectiveness in improving spatial cue use and speech understanding. We hypothesize that children with unilateral conductive hearing loss will use head rotation to detect target speech and, even with bone conduction implants, may continue to rely on better-ear strategies due to remaining asymmetries.

Design: Head movement was tracked to study listener behavior for optimizing SNR under binaural and monaural conditions. A within-subject design tested 5 normal-hearing children in binaural and monauralized (plug+muff), and 5 children with unilateral conductive hearing loss in unaided and bone conduction implant-aided conditions. Target sentences were presented randomly at 0° and ±60° azimuth with diffuse babble noise. Children repeated the target sentences at decreasing SNRs while freely moving their heads. Speech reception thresholds and head movement velocity were recorded to assess response variability and promptness.

Results: Speech presented from the front (0°) and to the better-ear led to lower speech reception thresholds, and was easier for participants compared to when presented to the impaired ear. There was greater overall number of corrective head movements and increase in errors for signals presented to the impaired ear compared to the better-ear ($p< 0.05$). A reduction in errors was observed under the aided condition, although did not reach that of the better-ear or binaural hearing condition ($p< 0.05$). Response promptness is improved under binaural hearing and when aided compared to the monauralized listening condition.

Conclusions: When binaural hearing is disrupted, children with unilateral conductive hearing loss show high error rates and more corrective head-orienting responses. Bone-conduction implants reduce errors and inefficiencies in orienting behavior compared to unaided listening, though performance does not reach that of normal hearing children. These findings highlight the critical role of binaural cues in accurate sound localization and task performance in complex acoustic environments, with bone conduction implants providing partial but impactful benefits in pediatric unilateral conductive hearing loss.

Distorted Tonotopy in Sensorineural Hearing Loss: A Cross-Species Study

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Objectives: Patients with similar audiograms often experience varying levels of difficulty in understanding speech in noisy environments, despite using state-of-the-art hearing aids. With audibility largely restored by amplification, these divergent suprathreshold outcomes are often attributed to reduced frequency selectivity (i.e., broadening of the so-called "tip" of cochlear frequency tuning curves) associated with sensorineural hearing loss (SNHL), and to non-peripheral factors such as attention, working memory, and executive function. However, our ongoing cross-species studies on neural coding in SNHL suggest that distorted tonotopy-a phenomenon where hypersensitive tails of cochlear tuning curves commandeer the response of the basal half of the cochlea-can significantly contribute to the degraded neural coding of sounds.

Design: Auditory-nerve single-unit measurements were performed in a chinchilla model of SNHL with noise-induced permanent threshold shifts. In parallel human studies of individuals with mild or moderate SNHL, we utilized behavioral measures, otoacoustic emissions, and electroencephalography (EEG) to characterize distorted tonotopy.

Results: Data from auditory nerve recordings in the chinchilla revealed that hypersensitive tuning-curve tails were the primary contributor to the severe degradation of speech-envelope coding through the masking effects of low-frequency energy on basal responses, manifesting both as impaired representation of higher vowel formants and near erasure of transient responses to high-frequency consonants. This effect is particularly pronounced with naturalistic stimuli, such as speech, which contain intense low-frequency components alongside softer but highly informative high-frequency content. Going from bad to worse, this effect is further exacerbated in noisy backgrounds with "pink" spectral characteristics (e.g., background talkers, environmental noises). Our human experiment revealed that humans with SNHL also exhibit hypersensitive tuning-curve tails, even with mild-moderate SNHL. Furthermore, EEG measurements in human listeners with SNHL revealed that these hypersensitive tails are linked to impaired tracking of speech envelopes. Importantly, variations in the estimated degree of distorted tonotopy were also predictive of the large individual differences in speech-in-noise outcomes that persist despite prescriptive amplification.

Conclusions: Taken together, our results suggest that distorted tonotopy is a prominent contributor to suprathreshold deficits in SNHL in both laboratory animals and in human listeners. Additionally, in both species, non-invasive assays offer promise towards providing useful indices of distorted tonotopy that may, in the long run, be developed and leveraged for clinical use.

Bayesian-Guided Estimation of Speech Reception Thresholds in Background Noise

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Objectives: Speech-in-noise (SiN) tests provide valuable information about listeners' hearing difficulties. The scope of SiN testing has grown to consider the effort expended by listeners to achieve different levels of SiN performance. Typical SiN tests provide guidance on classifying performance as "normal" or "abnormal" in the form of normative references which describe the distribution of expected performance in normal hearing (NH) listeners under certain acoustic conditions. However, the difficulty experienced by different groups of listeners may vary considerably at the same signal-to-noise ratios (SNRs), complicating judgement of effort ratings against "acoustic-based" norms. Although adaptive staircase methods exist to target specific SiN performance levels, they are often limited to single-level speech reception thresholds (e.g., SRT-50%) and become increasingly inefficient for higher performance criterion (e.g., > 75%) more supportive of real-life conversation. Here, we describe the development and validation of a Bayesian-guided approach to estimating a listener's complete psychometric function for SiN using speech materials previously developed for the Repeat-Recall Test (RRT).

Design: Twenty older adult listeners with NH and 20 with HI were recruited to perform the Bayesian-guided SiN test. Target RRT sentences were presented at a fixed level of 68 dBA SPL from a single loudspeaker positioned at 1 m directly in front. Psychometric functions were estimated over 32 sentence presentations with co-located background maskers, either speech-shaped noise or two-talker babble noise, presented at varying levels corresponding to SNRs selected by the test algorithm. Listener SiN performance was scored for correct repetition of each of 3-4 pre-identified target words per sentence. Test-retest reliability was assessed both within- and between-session for each of the masker types as well as for RRT materials that were either high or low in their availability of semantic context. All listeners were then tested with 32 sentences at fixed SNRs corresponding to their individualized SRTs for 50, 75, and 90% performance at each combination of masker type and context availability. Listening effort outcomes were surveyed after each sentence block in the fixed SNR conditions.

Results: Preliminary analysis of 8 listeners with NH and 14 listeners with HI suggests good within-session test-retest reliability for each of the three SRT performance levels across all test conditions, with a minimum intraclass correlation coefficient (ICC) of 0.75 and a maximum ICC of 0.95 (median ICC = 0.87). Preliminary assessment of SRT accuracy in 6 listeners with NH and 6 with HI showed mean deviations of +12% (±11 SD), +7% (±6 SD), and +1% (±5 SD) for criteria of 50, 75, and 90% correct, respectively. Listening effort ratings also decreased as expected as performance criteria increased. Comparison of listening effort ratings from listeners with HI against NH norms await data collection from all remaining participants.

Conclusions: Early data support a Bayesian-guided approach to SRT estimation for both high and low context RRT sentences in two different noise types. Additional data will be used to assess whether judging listening effort against norms at different SRTs may help profile listeners into those who generally find following SiN to be easy or difficult.

Spectral Weighting and Aided Speech Recognition in Noise Among Older Adults with Age-Related Hearing Loss

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Objectives: Older adults with a similar degree of age-related hearing loss may nonetheless exhibit differences in how they utilize speech cues across frequencies when performing a speech recognition task in background noise. The current study investigates whether the relative weights that individual listeners give to various frequency regions, i.e., their band importance functions, are predictive of aided speech recognition performance in noise.

Design: Individual band importance functions were assessed from 44 older adults with various degrees of age-related hearing loss. The quick-Band-Importance-Function (qBIF) procedure was used for efficient estimation of the band importance functions. During the procedure, the participant was presented with sentence-in-noise stimuli that were spectrally filtered and was instructed to repeat the presented speech. The spectral weights for five octave-frequency bands (centered at 250, 500, 1000, 2000, and 4000 Hz), which formed the band importance function, were estimated from performing a correlational analysis between the spectral variations applied to the five bands and speech recognition accuracy. The test stimuli were amplified so that lower estimated weights would not trivially reflect a lack of audibility. The qBIF procedure took 80 sentences, approximately 10 minutes to complete. The participants were then fitted with either a commercially available hearing aid (23 participants) or an open-source hearing-aid simulator (21 participants). The hearing aid or hearing-aid simulators were fitted using a standard prescription formula (NAL-NL2) and clinical best practice. Aided speech recognition was measured using AzBio sentences presented at 60 dBA in multi-talk babble background at signal-to-noise ratios at 5 dB. For participants receiving commercial hearing aids, the speech recognition test was repeated using additional programs where high-frequency amplification (above 2 kHz) was either over-fitted (10 dB above target) or under-fitted (10 dB below target).

Results: The average band importance function estimated from the older-adult participants exhibited the highest spectral weight at 2 kHz and lower weights for lower or higher frequency bands, which resembled that of typical-hearing young adults. More importantly, large individual differences in spectral weighting were observed. Results showed that a higher spectral weight at 2 kHz was associated with better aided speech understanding in noise. The same association between the 2-kHz weight and the aided speech recognition score was also observed for the over-fitted condition, but not for the under-fitted condition.

Conclusions: The individually estimated band importance functions are predictive of the aided speech recognition performance in noise. The individual spectral weighting patterns may reflect diverse strategies in coping with a challenging speech recognition task.

Factors Influencing Audiovisual Speech Benefit in Children: Acoustic-Phonetic Redundancy

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Objectives: Previous research demonstrates greater audiovisual benefit to speech-in-noise recognition for children who are hard of hearing (HH) than for children with typical hearing (TH). This study

examines the source of hearing-related differences in children's audiovisual benefit. We test the hypotheses that (1) children's audiovisual benefit is governed by acoustic-phonetic access and (2) experience with reduced auditory access leads children to be more proficient at using visual speech in conjunction with acoustic cues.

Design: Children who are HH and their peers with TH (age 7-12 years) completed two experiments requiring them to repeat consonant-vowel-consonant words. Thirty TH children participated in each experiment. To date, 21 HH children have participated in experiments 1, and 17 HH children have participated in experiment 2. Data collection is ongoing. In experiment 1, auditory-only and audiovisual frequency importance weight functions were measured using words filtered into 6 one-octave bands centered at 0.25, 0.5., 1, 2, 4, and 8 kHz. On each trial, acoustic speech was filtered to contain three pseudo-randomly chosen bands. Generalized linear mixed models were used to fit accuracy data from each modality given the presence or absence of each band. In the second experiment, auditory-only, visual-only, and audiovisual word -in-noise recognition were measured at individually set signal-to-noise ratios. Responses were phonetically transcribed to examine transmission of consonant voicing, manner of articulation, and place of articulation. To assess the role of acoustic-phonetic access in determining audiovisual benefit in both experiments, we calculated the proportion of target and response consonant pairs that are discriminable using only visual speech and compared them across hearing groups and modalities.

Results: The auditory-only and audiovisual frequency importance weighting functions both showed a peak at 2 kHz with declining weights for bands farther from 2 kHz. Weights in the audiovisual condition were higher than in the auditory-only condition for the 0.25 kHz band and lower than in the auditory-only condition for all higher frequency bands. Modality effects did not differ significantly across hearing groups, suggesting a similar impact of visual cues on frequency importance weights in TH and HH children. In both experiments, TH and HH children were equally likely to substitute an auditory consonant for a visually distinct consonant, meaning the two groups had similar opportunity to use visual speech to supplement missing auditory information. However, in both experiments, HH children demonstrated greater AV benefit than TH children. Visual-only consonant feature transmission accuracy was also greater in HH children than TH children.

Conclusions: Results thus far suggest that differences in acoustic-phonetic access may not be the primary factor underlying hearing-related differences in audiovisual benefit among children. Instead, it seems experience with reduced auditory access may lead HH children to be more proficient at using visual speech in conjunction with acoustic cues. The impact of high-frequency and low-frequency aided audibility on individual differences in auditory-visual phonetic redundancy and audiovisual benefit will be discussed. [Funded by NIDCD R21DC020544.]

Social Influence on Eye Gaze Behavior During Audiovisual Speech Perception

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Objectives: Although listeners with hearing loss have been found to gaze more at the mouth during audiovisual listening, studies have continually used pre-recorded video stimuli that lack the real-life social pressure of maintaining eye contact. Additionally, the dominant approach in these studies is to have participants respond as a third-party observer (e.g., by repeating the word/sentence or answering a

comprehension question). Such non-interactive paradigms do not capture social and communicative factors that are likely to influence the way participants use visual speech cues during actual conversation, which could limit the generalizability of these studies to everyday scenarios. The current study tested whether social interaction would shift patterns of eye gaze behavior as listeners with typical hearing perceived audiovisual speech. In particular, we hypothesized that participating in live conversation would limit the amount of time listeners spend looking at the talker's mouth - especially when both interlocutors were present in the same room and could perceive shared eye contact.

Design: Typical-hearing participants' eye gaze was tracked continuously using a head-mounted eye tracker as they perceived audiovisual speech in three contexts: 1) watching prerecorded speech videos, 2) participating in a one-on-one video call, and 3) engaging in face-to-face conversation. Conditions 2 and 3 allowed us to dissociate effects of participating in live conversation from effects of joint awareness of eye contact. A front-facing camera captured the conversation partner's face in the same coordinate frame as the gaze data. Computer vision techniques were used to track the talker's facial features over time, allowing us to examine the proportion of time participants fixated on the eyes or mouth without constraining natural head movements. An additional analysis compared eye gaze behavior between when the participant was listening vs. talking - a distinction that has been largely ignored in previous studies of audiovisual speech perception.

Results: When engaged in interactive conversation, participants spent more time looking at the eyes relative to the mouth compared to what has been found with video stimuli, verifying the impact of social context on gaze strategy. Additionally, participants spent more time looking at their conversation partner's eyes (and less time looking at their mouth) in the face-to-face condition as compared to the video call condition. Fixations to both facial landmarks were substantially reduced when the participant was talking, with a marked uptick in fixations to other points in the room away from their conversation partners' face.

Conclusions: Gaze strategies during audiovisual speech perception depend on social and communicative factors that are not captured by traditional lab-based studies using pre-recorded speech materials. Understanding these differences is critical to translating what we know about audiovisual speech benefits into real-world communicative contexts. Eye gaze behavior also changes substantially between talking and listening phases of conversation, which has implications for frameworks that assume the listener maintains fixation on a listening target, including the development of gaze-directed hearing aids. This study with typical-hearing listeners lays the groundwork for future studies examining the strategies used by listeners with hearing loss to integrate visual cues during live conversation.