

American Auditory Society Scientific and Technology Meeting March 6-8, 2014

PODIUM PRESENTATIONS: Thursday, March 6, 2014

PODIUM SESSION I: SPEECH PERCEPTION

Podium Paper I.A.

Evolutionary Triumph: Speech and Hearing Equilibrium – Tribute to Dr. Dirk’s Work on Speech Intelligibility

Chas Pavlovic, PhD, Sound ID, Palo Alto, CA

In the mid eighties three hearing laboratories engaged in what became a 15 year long work of examining how the speech intelligibility is distributed over the audible frequency range. These were Donald Dirks’ lab at UCLA, Gerald Studebaker’s lab at Memphis Speech and Hearing Center, and Chas Pavlovic’s lab at University of Mississippi (later University of Iowa). This work fundamentally changed the view of what the most important speech frequencies were and documented the “importance functions” for different speech material. It has also resulted in the Speech Intelligibility Index (SII) model. In this talk, in addition to reviewing this corroborative inter-laboratory work and its conclusions, a hypothesis will be postulated and discussed that speech productions mechanism and the auditory mechanism have evolved in parallel to result in a maximum transfer rate for speech information. To this goal, the speech energy has evolved to be flat across auditory filters and the auditory filters have evolved to have equal channel capacity to each other.

Podium Paper I.B.

Neural Encoding of Speech in Healthy and Impaired Auditory Systems

Saradha Ananthakrishnan, PhD, Towson University, Towson, MD

Ananthanarayan Krishnan, PhD, Purdue University, West Lafayette, IN

Our current knowledge of deficits in speech perception and encoding consequent to sensorineural hearing loss (SNHL) is restricted to behavioral studies in humans and single-unit experiments in animals. Results from these studies indicate a differential effect of SNHL on encoding of acoustic features important for pitch and speech perception, namely envelope (F0) and temporal fine structure (TFS) (formant structure) cues. The objective of the present set of experiments is to provide a systematic evaluation of sub-cortical neural correlates of these perceptual deficits using an objective, electrophysiological, non-invasive neural index, namely the frequency following response (FFR). In order to capture the neurobiological signature of hearing loss in various real-world situations, FFRs were studied in response to complex signals presented in several different listening situations (quiet, background noise, reverberation). Evidence from the FFR suggests that neural phase locking of both envelope and TFS cues is degraded in hearing impairment, reflecting a complex interplay of attenuation and distortion effects subsequent to SNHL. Under adverse listening conditions, these neural representations also dependent on stimulus, level and type of stimulus degradation. Finally, these results establish the FFR as a viable technique to measure brainstem speech encoding in hearing impaired listeners.

Podium Paper I.C.

Competition Between Listening and Learning Strategies in Children with Hearing Loss

Andrea Pittman, PhD, Arizona State University, Tempe, AZ

This presentation will review recent and ongoing studies regarding the effects of hearing loss on children's ability to learn new words. In the first study, children counted the number of nonsense words embedded into short sentences. The results revealed that their ability to detect unknown words was related to the quality of the acoustic signal and that children with hearing loss detected fewer nonsense words than children with normal hearing. In the second study, the same non-word detection task revealed that adults with similar configurations of hearing loss were able to detect more nonsense words than children with hearing loss. In the third study, children indicated whether individual words were real or not real. The results revealed that children with hearing loss repaired nonsense words to be real words more often than children with normal hearing. Overall, these results suggest that children with hearing loss are unable to detect new words as well as their age-matched and hearing-matched peers because they tend to repair words that they don't know. These repair strategies may optimize their perception of familiar speech, particularly in adverse listening environments, but they may also cause them to miss opportunities to learn new information.

Podium Paper I.D.

Effects of Working Memory and Language on Children's Speech Perception

Meredith Spratford, AuD; Ryan Mccreery, PhD, Boys Town National Research Hospital, Omaha, NE

Ellen Hatala, University of Iowa, Iowa City, IA

Children require more audibility to achieve similar performance to adults for speech perception tasks, even after controlling for developmental language knowledge. Working memory (WM) could help explain age-related variability in performance. WM develops into adolescence and supports language development, academic achievement, and complex cognitive tasks. Thus, it could be expected that older children will have better WM skills that lead to improved performance on linguistically-complex speech perception tasks in noise.

Our research team assessed 100 NH children ages 5-12 years old in the domains of WM, language, and speech perception. The Automated Working Memory Assessment (AWMA) was administered to assess visuo-spatial and verbal storage and processing. Receptive vocabulary and grammar were evaluated with the Peabody Picture Vocabulary Test (PPVT-4) and Test of Reception of Grammar (TROG-2). An adaptive tracking procedure was used to measure speech perception in noise for monosyllabic words and low- and high-predictability sentences. Parents completed the Behavioral Rating Inventory of Executive Function (BRIEF).

Results will be shared regarding the influence of language and WM on speech perception tasks controlling for age as well as how behavioral WM measures relate to parent report on the BRIEF. The impact on intervention strategies will be discussed.

Podium Paper I.E.

Psychometric Functions Using a Small Number of Masked Sentences

Lauren Calandruccio, PhD; Emily Buss, PhD, The University of North Carolina at Chapel Hill, Chapel Hill, NC

Open-set masked speech perception is commonly assessed using one of two measures: an adaptive threshold or percent correct at one or more fixed signal-to-noise ratios (SNRs). Whereas adaptive thresholds can be estimated with a relatively small number of stimuli and little prior knowledge of the listener's sensitivity, measuring percent correct at multiple SNRs provides a fuller characterization of the psychometric function. The present study evaluates a hybrid approach, wherein sentence recognition is assessed at a range of ascending SNRs for each stimulus token. The target stimuli were ten lists of AZBio sentences, presented in steady speech-shaped noise, amplitude-modulated speech-shaped noise, or two-talker speech. A group of 12 normal-hearing adults was tested in each of the three maskers. Five lists were presented in traditional fixed-SNR paradigm, where each sentence was presented only once. The other five lists were presented using the ascending method, with each sentence presented multiple times, each time increasing the SNR until the entire sentence was reported correctly. A different set of five SNRs was used for each masker, and the list-to-condition assignment was counterbalanced across listeners. Psychometric functions were fitted to the results and compared to characterize the efficiency and accuracy of the two methods.

Podium Paper I.F.

A Unified Approach for Measuring Audiovisual Speech Integration Skills

Nicholas Altieri, PhD, Idaho State University, Pocatello, ID

Most assessments of audiovisual integration skills rely entirely on accuracy scores (e.g., Grant, 2002). This study implemented a unified capacity measure of audiovisual speech recognition that incorporated both reaction times (RT) and accuracy (Altieri, Townsend, & Wenger, 2013). Capacity constitutes a novel tool for assessing speech integration skills, and determining the locus of a listener's integration (in)ability (speed accuracy, or both?). The specific goals of this study involved utilizing this approach to comprehensively assess the extent to which normal-hearing and hearing-impaired listeners benefit from visual speech cues. Normal-hearing listeners and those with hearing-impairment participated in a study examining open-set sentence recognition (AV, and A-only and V-only), and forced-choice speeded word recognition (where capacity was measured). To summarize, the data confirmed previous research showing that normal-hearing and hearing-impaired listeners benefit from visual speech information in the accuracy domain. However, hearing-impaired listeners demonstrated greater audiovisual benefit in both tasks. The capacity measure in particular revealed systematic differences in processing speed, accuracy, and hence integration ability in normal-hearing versus hearing-impaired listeners. Capacity should therefore prove useful for diagnosing/identifying potential face-to-face communication deficits across older listeners and those with different hearing abilities.

Podium Paper I.G.

Hearing Loss, Mental Effort and Fatigue: Not a Simple Relationship

Benjamin Hornsby, PhD; Zoe E. Doss, BS, Vanderbilt University, Nashville, TN

Recent work suggests fatigue and vigor deficits may be significant for adults and children with hearing loss (HL). It is commonly assumed that the increased mental effort required by persons with HL to detect and process auditory stimuli, over time, leads to the subjective experience of fatigue. This study empirically examines this assumption. Subjective measures of effort and fatigue were obtained following a cognitively demanding speech task. Coordinate Response Measure (Bolia et al., 2000) messages were presented in noise. Participants listened for target numbers while ignoring other numbers and pressed a button when targets occurred, providing a measure of attention and processing speed, and then recalled the Call sign and Color associated with the target number. Task difficulty/effort was varied for normal hearing participants (n=12) by changing SNR (-2, -4, and -6 dB). For participants with HL (n=12) task difficulty was varied by completing the task with and without hearing aids (-4 dB SNR only). Results suggest relationships between subjective effort and fatigue differ in persons with and without HL. Mental effort systematically varied with task difficulty for both groups. However, fatigue effects varied with task difficulty only for persons with HL with aided listening reducing the percept of fatigue.

PODIUM SESSION II: HEARING TECHNOLOGY; REHABILITATION

Podium Paper II.A.

User Self-Adjustment of a Simulated Hearing Aid Using a Mobile Device

*Dianne Van Tasell, PhD, University of Minnesota, Ear Machine LLC, Tucson, AZ
Andrew Sabin, PhD, Ear Machine LLC, Chicago, IL*

Finding the signal processing parameter values that are most appropriate for an individual user in the environments of his/her daily life is one of the essential components of hearing aid fitting. The work reported here investigated users' abilities to adjust hearing aid signal processing parameters themselves in a variety of sound environments. A simple controller interface was implemented on an iPod Touch running a real-time signal processing simulation of a 9-channel WDRC hearing aid. The user manipulated two wheels: one wheel adjusted gain, compression, and MPO in all 9 channels simultaneously according to an algorithm based on demographic hearing loss data; the other wheel adjusted frequency response according to an algorithm based on analysis of common fine-tuning adjustments. Forty-eight subjects with sensorineural hearing loss, aged 27 - 94, adjusted the controllers for each of six speech passages (in quiet or noise) and three music passages. Results showed that: 1) subjects were consistent in their adjustments (mean test-retest < 4dB); 2) on average they adjusted to slightly less than NAL prescribed gain; 3) most preferred their own settings over NAL settings in blind A/B comparisons; and 4) after some practice, average adjustment time was about 20 seconds. [Work supported by NIDCD grant R44 DC013093]

Podium Paper II.B.

The Retina: A New Pathway for Hearing

Peter Poulsen, Temeku Technologies Inc, Herndon, VA

A technology has been developed that allows investigation of the visual processing system to exploit neural/synaptic plasticity such that the wearer of a new type of eyeglasses could have his or her hearing restored, or even provided for the first time by translating sound information to unfocussed visual information. Characteristics of such a hearing device would include: no surgery, no drugs, no special training, no interference with eyesight, and very low cost.

Podium Paper II.C.

Using GPS Location Data of Smartphones to Predict Listening Demand

Yu-Hsiang Wu, PhD; Shabih Hasan, MA; Octav Chipara, PhD; Elizabeth Stangl, AuD,
University of Iowa, Iowa City, IA

Listening demand, or auditory lifestyle, is an important factor that needs to be considered when selecting a hearing aid and specific amplification features. Our previous work (Wu and Bentler, 2012) demonstrated that listening demand can be estimated by self-reported social lifestyle. The purpose of this study was to investigate if social lifestyle, which was objectively quantified by location information collected using the global positioning system (GPS) of smartphones, could predict listening demand for older adults with hearing impairment. Nineteen participants carried smartphones throughout their daily activities for one week. Each day the smartphone prompted participants to conduct surveys at random time intervals. When conducting the survey, the phone registered the location information and recorded ambient sounds. The distribution of the location across the week was analyzed using cluster analyses. Listening demand was objectively quantified using the sound level of the audio recordings made by phones. The results indicated that the convergence pattern of location was related to listening demand: listeners who had a more scattered pattern of location tended to encounter more noisy environments. The location pattern predicted listening demand better than a social lifestyle questionnaire. (Work supported by NIH/NIDCD grants R03 DC012551.)

Podium Paper II.D.

Stages of Change in Adults who have failed an Online Hearing Screening

Ariane Laplante-Lévesque^{1,2}; K. Jonas Brännström^{1,3}; Elisabeth Ingo¹; Gerhard Andersson^{1,4};
Thomas Lunner^{1,2}

¹ Department of Behavioural Sciences and Learning, Swedish Institute for Disability Research, Linköping University, Sweden; ² Eriksholm Research Centre, Oticon A/S, Denmark; ³ Department of Logopedics, Phoniatrics and Audiology, Lund University, Sweden; ⁴ Department of Clinical Neuroscience, Karolinska Institute, Sweden

This study collected information on the transtheoretical (stages-of-change) model in adults who had failed an online hearing screening. The psychometric properties of the University of Rhode Island Change Assessment (URICA) were investigated. This article describes the stages-of-change scores of 224 participants. It also describes concurrent validity: associations between URICA scores and speech-in-noise recognition scores, self-reported degree, and duration of hearing disability. Most of the participants were in the contemplation or preparation stages. A significant association between stages of change and self-reported degree of hearing impairment, but not speech-in-noise recognition scores or self-reported duration of hearing disability, was found.

Podium Paper II.E.

Benefit of Integrative Therapy for Treatment of Severe Tinnitus

Rebecca Price, AuD; Ruth Wolever, PhD; Debara Tucci, MD, Duke University Medical Center, Durham, NC

Tinnitus is a common and disabling problem for many people. Sound based and educational therapies (SBE) have been a popular choice for treatment. While sound enrichment programs are effective, approximately 1.2 million sufferers do not benefit due to degree of hearing loss and prominent non-auditory symptoms. Alternative therapies, in an integrated program, including cognitive behavioral therapy (CBT), meditation, acupuncture and integrative health coaching (IHC) were hypothesized to benefit tinnitus sufferers more than SBE alone. Thirty six patients with debilitating tinnitus (average of 62 on Tinnitus Handicap Inventory (THI)) were enrolled in this NIDCD-funded, randomized pilot study (R21 DC011643 to D. Tucci and R. Wolever). Patients in the control group received two SBE sessions including tinnitus assessment and sound based strategies for reducing tinnitus awareness/disturbance. Patients in the experimental group, in addition to SBE, received acupuncture, CBT, meditation and IHC. All patients received medical evaluation including temporomandibular joint (TMJ) assessment. Outcomes were measured pre, post-treatment, and 3 months post treatment. Primary outcome measure was THI; secondary measures included psychophysical measures as well as quality life assessments and non-auditory functions. Findings will be discussed in detail. The primary assessment (THI) showed significantly steeper improvement in the experimental than the control group ($p < .05$).

Podium Paper II.F.

Interactive Multimedia Videos Promote Success in First-Time Hearing Aid Users

Melanie Ferguson, PhD; Marian Brandreth, MS, Nihl Nottingham Hearing Biomedical Research Unit, Nottingham, UK

William Brassington, MS, Nottingham University Hospitals NHS Trust

Paul Leighton, PhD; Heather Wharrad, PhD, Nottingham University, Nottingham, UK

Hearing aid (HA) fitting alone is not the optimal intervention for people with hearing loss. Adopting additional rehabilitation strategies, such as interactive videos to improve patient education, could improve patient success with HAs.

Eight interactive, multimedia video tutorials (or reusable learning objects, RLOs) were evaluated in an RCT of 167 first-time HA users; half received the RLOs (RLO+) and half formed a waitlist group (RLO-). RLOs were effective in almost every domain examined. RLO uptake and compliance was high (78% and 94% respectively). 50% watched the RLOs 2+ times suggesting the RLOs were used to self-manage users' hearing loss and HAs.

The RLO+ group had better retention of information, and better practical HA skills than the RLO- group ($p < .001$). HA use was higher for challenging listening situations in the RLO+ group, and in suboptimal users in the RLO+ group ($p < .05$). RLOs were rated as highly useful (mean=9/10).

Post-evaluation focus groups reported improved awareness and confidence, involvement of family members and sharing RLOs with others. Health economic analysis showed the RLOs were a very cost-effective healthcare intervention.

With a gap in audiology habilitation for an effective multi-media intervention, the RLOs will be market-ready for wider UK distribution in Spring 2014.

PODIUM SESSION III: MIDDLE EAR; PSYCHOLOGICAL ACOUSTICS

Podium Paper III.A.

Estimating Ear Canal Volume and Eardrum Compliance from Wideband Reflectance

*Sarah Robinson, MS; Jont Allen, PhD, University Of Illinois, Urbana-Champaign, Urbana, IL
Suzanne Thompson, PhD, St. John's University, Queens, NY*

Tympanometry is the industry standard for clinical middle ear (ME) assessment. The acoustic admittance at the ear canal entrance is measured for varying static pressures, typically at a single frequency (226 Hz). Two quantities routinely estimated from this measurement are the residual ear canal volume (between the probe and eardrum), and the eardrum compliance. It has been shown that wideband acoustic reflectance may also be used for ME diagnosis. Reflectance is measured by a probe sealed in the ear canal at ambient pressure, over a wide frequency range (0.2-6.0 kHz); acoustic admittance may be derived from reflectance.

Previously, the authors have studied pole-zero fitting to precisely parameterize reflectance magnitude and phase for individual ears. A lossless delay, approximating the residual canal contribution, may be directly derived from the pole-zero fit. From this procedure, a method to estimate the residual canal volume and eardrum compliance was developed. This method is evaluated for a known acoustic system (a syringe), and for reflectance measurements of MEs under varying static pressure conditions. Data is drawn from a controlled study of cadaver ears (Voss 2012), and an in vivo study in which subjects were trained to perform the Toynbee maneuver to induce negative ME pressure.

Podium Paper III.B.

Optimizing 2f₁-f₂ DPOAE Serial Measurement for Extended High Frequencies

*Gayla Poling, PhD; Jungwha Lee, PhD, Northwestern University, Evanston, IL
Jonathan Siegel, PhD; Sumitrajit Dhar, PhD, Northwestern University and The Knowles Hearing Center*

Distortion product otoacoustic emissions (DPOAEs) offer a noninvasive, objective measure of cochlear function and provide a clinical tool for detecting/monitoring ototoxicity. Such ototoxic-change in cochlear function typically presents at the highest recordable frequencies initially. Given the variation in cochlear mechanics from base to apex, it is not surprising that different stimulus conditions are necessary to generate the largest 2f₁-f₂ DPOAE amplitude at different frequencies. Typically, stimulus parameters that elicit the largest DPOAEs up to 6-8 kHz in normal-hearing ears are used in clinical applications. However, these parameters have been shown to be suboptimal when extended to higher frequencies. An innovative DPOAE paradigm, comprising three fixed-level combinations and varying stimulus frequency ratios, was developed for stimulus frequencies up to 20 kHz (n=15). The paradigm was subsequently evaluated in normal-hearing (n=15) and hearing-impaired individuals (n=15). Larger DPOAEs were measured using the experimental paradigm relative to commonly used clinical parameters. DPOAE serial

measurements using the new paradigm over 5 sessions will be presented to explore its potential clinical utility.

[Research supported by American Speech-Language-Hearing Foundation, American Hearing Research Foundation, NIDCD R01DC008420/T32DC009399, and Northwestern University.]

Podium Paper III.C.

A Method for Assessing Speech Understanding in Everyday Communication

Harry Levitt, PhD; Elon Ullman, Advanced Hearing Concepts, Bodega Bay, CA

Helen Simon, PhD; Al Lotze, MS, Smith-Kettlewell Eye Research Institute, San Francisco, CA

A person with a hearing loss often requests a speaker to repeat what was said. The frequency of such interruptions reflects how well a person with a hearing loss is able to follow a conversation. The proposed method estimates frequency of interruption in everyday speech communication by means of a button-pressing paradigm, the button being pressed conveniently and unobtrusively whenever a word or phrase is not understood. A mobile device linked to the Internet or a self-contained wearable unit can be used to record the button pressings. It would be useful if the speech could also be recorded for purposes of analysis. Prior to any field measurements, it is necessary to determine for each subject the difference between the frequency of perceived misunderstandings (button pressings) and an objective measure of the frequency of actual misunderstandings. Data on an experimental implementation of the method will be reported. Research supported by NIDCD Awards 1R43DC012202-01 and R01DC012305

Podium Paper III.D.

Detection of Conductive Hearing Loss in Newborns Using Wideband Absorbance

Lisa L. Hunter, PhD; Alaaeldin Elsayed, MD; Leigh Schaid, AuD, Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Douglas H. Keefe, PhD; Denis Fitzpatrick, PhD, Boys Town National Research Hospital, Omaha, NE

M. Patrick Feeney, PhD, National Center for Rehabilitative Auditory Research, Portland, OR

Newborn hearing screening programs refer at least 4% of all infants for follow-up diagnostic hearing assessment using tone burst air and bone conduction auditory brainstem response (TB-ABR). A battery of diagnostic tests that accurately and quickly determines the presence of hearing loss would be a useful tool for audiologists and reduce cost. The objective of this study is to determine whether wideband acoustic aural absorbance measures in ambient and pressurized conditions, and of acoustic reflex thresholds, accurately predict presence of conductive hearing loss in newborns at screening and diagnostic follow-up. These wideband tests are much less time intensive than tone-burst ABR tests. In this prospective, longitudinal study, 383 infants were recruited at newborn hearing screening and had diagnostic ABR and repeated audiologic tests up to age 1 year. Mean differences in wideband tests and conductive loss at visit 1 were tested using Student t tests to determine unadjusted or crude relationships. Factors that were significantly associated were tested in a multivariate model to determine the most accurate predictor of conductive hearing loss in newborns in relation to the gold standard of diagnostic ABR.

Podium Paper III.E.

Auditory Temporal Processing in Children: Rate Sensitivity at Different Ages

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

Michellie Young; Oliver Zobay, PhD; David Maidment, PhD; Johanna Barry, PhD, MRC Institute of Hearing Research, Nottingham, UK

Speech perception depends on temporal processing across three broad rates. Temporal processing deficits have been hypothesized to contribute to listening/learning problems in children, but have not previously been considered across rates in one developmental study. We present data on the ability of typical 6-8 (n=16), 10-11 (n=19) y.o. children and adults (n=25) to detect envelope, periodicity and fine-structure cues using amplitude modulated (AM) tones, backward (BM) and forward (FM) masking, gaps-in-noise (GIN), 1kHz frequency discrimination (FD) and inter-aural phase reversal (IPR). VCV syllable detection in speech-shaped noise (VCV), NVIQ and non-word repetition were also measured. Mean thresholds on all tests improved with age. BM thresholds correlated ($r=0.38$) with FM thresholds but were higher and more variable. FD and IPR were also correlated ($r=0.46$), but neither measure correlated with AM detection at 125Hz, suggesting different mechanisms. AM detection at 8Hz (envelope), BM and FM (periodicity), and FD and IPR (fine-structure), all correlated significantly with VCV threshold. AM8Hz and FD correlated significantly when age corrected. GIN, a common test of temporal processing, did not correlate with VCV. On each test, some individual 6-8y.o. performed at adult levels. These data show the feasibility and validity of testing groups of children on temporal processing.

Podium Paper III.F.

On Estimating Detection and Discrimination Thresholds

Huanping Dai, PhD, Dept of Speech, Language, and Hearing Sciences, Tucson, AZ

Emily Buss, University of North Carolina, Chapel Hill, NC

Beverly Wright, Northwestern University, Evanston, IL

A popular way of estimating detection and discrimination thresholds in auditory psychophysics is the up-down, adaptive tracking procedure (e.g., Levitt, 1971). In this procedure the signal level for each trial is determined based on whether the listener responded correctly on a certain number of previous trials. The track of the signal level over trials, along with the listener's responses, provides the basis for estimating the thresholds. In this presentation we compare different approaches to obtaining the thresholds from the adaptive tracks. One class of approaches, which is popular among auditory-perception researchers, derives thresholds based on features of the track, such as the local maxima and minima, or the reversals, of the track. Another class of approaches derives threshold based on a psychometric function fitted to the listener responses as a function of signal level over the course of a track. We will present empirical and computational evidence illustrating the advantages and shortcomings of each approach.

PODIUM PRESENTATIONS: Saturday, March 8, 2014

PODIUM SESSION IV: COCHLEAR IMPLANTS

Podium Paper IV.A.

Musical Training: Effect on Perception and Electrophysiologic Measures of Discrimination

Carolyn Brown, PhD; Kate Gfeller, PhD; Paul Abbas, PhD; Eun Kyung Jeon, AuD; Virginia Driscoll, MS; Bruna Mussoi, MS; Viral Tejani, AuD, University of Iowa, Iowa City, IA

Perception of music and speech in noise by cochlear implant (CI) users is often challenging. Auditory training can help, but is time consuming and assessing the efficacy of training programs designed for children is difficult. The Auditory Change Complex (ACC) is an evoked potential used to assess discrimination between two acoustic signals. This report describes comparisons between ACC recordings and perceptual measures of discrimination of spectrally complex stimuli by 10 NH musicians and 10 NH individuals without musical experience. Results show musicians detect smaller pitch changes, have higher (better) spectral ripple discrimination thresholds and perform better on a speech in noise task than non-musicians. Parallel trends were also evident in the ACC data. Results from both groups of NH listeners will be compared to preliminary results from CI users. This study provides evidence that auditory training can impact both the way spectrally complex signals are coded within the auditory system and perceived by the listener. Additionally, it seems likely that the ACC may prove to be sensitive enough to the kind of changes induced by training and as a result could play a role in helping assess progress by individual CI users, including children, in an auditory training program.

Podium Paper IV.B.

Localization and ITD Thresholds for Implant Recipients with Hearing Preservation

*Rene Gifford, PhD; Wes Grantham, PhD; Sterling Sheffield, AuD; Timothy Davis, AuD; Robert Dwyer, Vanderbilt University, Nashville, TN
Michael Dorman, PhD, Arizona State University, Tempe, AZ*

Objective: To investigate horizontal plane localization and interaural time difference (ITD) thresholds for 12 adult cochlear implant (CI) recipients with hearing preservation and 5 normal-hearing adults.

Methods: Localization for broadband noise was assessed in an anechoic chamber with a 33-loudspeaker array (-90° to $+90^{\circ}$ azimuth). Three listening conditions were tested: bilateral hearing aids (HA), bimodal (CI + contralateral HA) and best aided (CI + bilateral HA). ITD thresholds were assessed, under headphones, for low-frequency stimuli including a 250-Hz tone and bandpass noise (100-900 Hz).

Result: Localization (overall rms error) was significantly poorer in the bimodal condition (57.9 σ) as compared to both bilateral HA (46.5 σ) and the best-aided condition (44.5 σ). ITD thresholds were highly variable across the listeners ranging from normal to ITDs not present in real-world environments (range: 43 to 1600+ microseconds). ITD thresholds were significantly correlated with localization, the degree of interaural asymmetry in low-frequency hearing, and the degree of hearing preservation related benefit in the speech reception threshold (SRT).

Conclusion: CI recipients with hearing preservation in the implanted ear have access to binaural cues and that the sensitivity to ITDs is significantly correlated with localization and degree of preserved hearing in the CI ear.

Podium Paper IV.C.

Perceived Benefit Across Different Cochlear Implant Profiles

Ann Perreau, PhD, Augustana College, Rock Island, IL

Hua Ou, PhD, Illinois State University, Normal, IL

Richard Tyler, PhD, University of Iowa, Iowa City, IA

Camille Dunn, PhD, University of Iowa Hospitals and Clinics, Iowa City, IA

To determine how self-reported outcomes differ across various cochlear implant (CI) profiles, and to examine the degree of subjective benefit for individual CI users using the Spatial Hearing Questionnaire (SHQ). This was a retrospective study of subjective spatial hearing outcomes from CI recipients. The subjects consisted of 99 unilateral CI, 49 bilateral CI, 32 with CI and contralateral hearing aid (bimodal), and 37 short-electrode CI users with residual hearing bilaterally. All participants completed the SHQ after implantation, and a subset of the participants completed the questionnaire pre and postimplantation. Subjective spatial hearing ability was found to be significantly higher for the bilateral and short electrode CI users compared to the unilateral and bimodal users. There was no significant difference in subjective spatial hearing performance between the bilateral and short electrode CI users, and the unilateral CI and bimodal users. A separate analysis of pre and postimplant performance revealed that all CI groups reported significant improvements in spatial hearing ability after implantation. Overall, results suggested that there are substantial differences in spatial hearing ability among different CI groups. Functional outcomes of cochlear implantation should be considered and incorporated into our determination of benefit when comparing performance among various CI profiles.

Podium Paper IV.D.

Dual-Carrier Strategy: Preliminary Cochlear Implant Data

Frederic Apoux, PhD; Sarah Yoho; Eric Healy, PhD, The Ohio State University, Columbus, OH

Christopher Brown, PhD, University of Pittsburgh, Pittsburgh, PA

Many studies have shown that substituting the original temporal fine structure (TFS) or carrier of a sound mixture with noise or tones (i.e., vocoder processing) may negatively affect speech intelligibility, suggesting that TFS cues play a significant role in speech recognition in noise. In a recent study, we demonstrated that this role is not to support speech sounds identification. In the present study, we hypothesize that the primary role of TFS is to support streaming. Briefly, it is suggested that TFS cues assist in identifying which auditory channels are dominated by the target signal so that the output of these channels can be combined at a later stage to reconstruct the internal representation of that target. To test this hypothesis, an original vocoder strategy, involving two carriers, is proposed. In the main experiment, it is shown that the so-called 'dual-carrier' strategy can alleviate almost completely the deleterious effects of vocoder processing, therefore supporting the streaming hypothesis. Considering the similarity between cochlear implant (CI) and vocoder processing, it was further hypothesized that CI users could greatly benefit from such a strategy. Our preliminary data confirm the potentially dramatic benefit of the dual-carrier strategy for CI users. [Work supported by NIDCD].

Podium Paper IV.E.

Microphone Combination to Improve Cochlear Implant Performance in Windy Environments

King Chung, PhD, Northern Illinois University, DeKalb, IL

Melissa Teske, AuD, Otolaryngology Associates

Adopting the omnidirectional microphone mode and reducing low frequency gain are two most commonly used wind noise reduction strategies in amplification devices. The objective of this study was to examine whether these are effective strategies for improving cochlear implant performance in wind. Wind noise samples were recorded in an acoustically treated wind tunnel using 1) omnidirectional microphone (OMNI), 2) directional microphone (ADM), 3) directional microphone with low frequency roll-off (ADM-LC), and 4) a combination of omnidirectional and directional microphone (COMBO). Wind noise samples recorded at head angles that the COMBO condition simulated a hearing aid designed to take advantage of both omnidirectional and directional microphones, were mixed with sentence materials. Cochlear implant listeners listened to the speech in noise testing materials and they repeated the sentences and rated the overall sound quality preferences. Results indicated that neither adopting omnidirectional microphone for the whole frequency region nor reducing low frequency gain was desirable. Strategies that can maximize release of spectral masking and improve cochlear implant performance in windy environments will be discussed.

Podium Paper IV.F.

Bilateral or Unilateral Cochlear Implants: Propensity Score-Matched Analysis

Hua Ou, PhD, Illinois State University & University of Iowa, Normal, IL

Michael Jones, PhD; Richard Tyler, PhD, University of Iowa, Iowa City, IA

In attempts to compare the performance of bilateral and unilateral cochlear implant (CI) users, a major obstacle has been matching the two groups on important confounding variables. We propose a novel approach using propensity score-matched analysis. The propensity score is defined as the conditional probability of receiving two CIs based on baseline covariates, such as duration of deafness, age at implantation, pre-implanted residual hearing, etc. If the treated (bilateral) and control (unilateral) CI users have the same propensity score, this indicates the distribution of baseline covariates between groups is the same. As a result, matching the two groups using propensity scores can eliminate potential selection bias from treatment assignment.

In this study, we performed a retrospective analysis of 311 CI users and identified over 30 pairs of propensity score-matched patients for word and sentence recognition testing and self-reported spatial hearing ability. Subsequent analyses indicated that bilateral CI users performed significantly better than the matched unilateral CI users for word recognition ($p=0.0038$) and sentence recognition ($p=0.035$). However, self-reported spatial hearing ability was not significant between the two groups ($p=0.449$). Finally, results from sensitivity analyses found that a moderate hidden bias was not enough to change the conclusion of the study.

Podium Paper IV.G.

Vision Alters the Benefit of Bimodal and Bilateral CIs

Shuai Wang; Sarah J. Cook; Michael F. Dorman, PhD, Arizona State University, Tempe, AZ

Adding low-frequency acoustic hearing to a single CI can provide a 30-40 percentage point improvement in speech understanding. Adding a second CI to a first CI provides a smaller (~10 points) benefit. The present study asked how adding visual information changes our view on the value of bimodal fitting (CI+HA) and bilateral fitting (CI+CI). Nine bimodal and four bilateral patients were tested with new audiovisual sentence recognition material -- the AzAV test -- in noise. The results indicated that, when visual information was available, the majority of bimodal patients did not benefit from adding a low-frequency acoustic hearing to CI+V even though all benefited in the auditory-only condition. In contrast, adding a second CI to a first or better CI provided about twice the gain when vision was present compared to when vision was absent. Our view of the value of these two additions to a single CI is significantly altered when visual information is present.

Podium Paper IV.H.

Optogenetic Control of Central Auditory Pathways: The Next-Generation of ABI

*Keith Darrow, PhD; Maryanna Owoc, BS, Worcester State University, Worcester, MA
Elliott Kozin, MD; Daniel Polley, PhD; M. Christian Brown, PhD; Daniel Lee, MD, Harvard Medical School, Mass. Eye and Ear Infirmary, Boston, MA
Ariel Height, MS, PhD Candidate, Harvard Medical School, Division of Medical Sciences, Boston, MA
Edward Boyden, PhD, Massachusetts Institute of Technology, Cambridge, MA
Stéphanie Lacour, PhD, École polytechnique fédérale de Lausanne*

Hearing outcomes in auditory brainstem implant (ABI) users vary considerably. A limiting factor of ABI technology may be the inability to selectively focus electrical stimulation. An optogenetic (i.e. light-based) ABI may provide an alternative to electrical stimulation paradigms. Recent work with light-sensitive proteins, channelrhodopsin-2 (ChR2) and Chronos, in the auditory system has demonstrated the feasibility of this technique in the murine model. ChR2 or Chronos was delivered to the cochlear nucleus (CN) through viral-mediated gene transfer in adult CBA/CaJ mice. After 4-6 weeks recovery, the CN was re-exposed and an optical fiber was placed on the CN. Optical ABR (oABR) and multi-unit recordings from the contralateral IC were recorded in response to blue-laser light. Optical stimulation in ChR2- and Chronos-infected mice evoked spiking activity throughout the IC with similar firing rates. The synchronization index, a measure of synchronization to the stimulus pulse rate, peaked below 50Hz in ChR2 mice. In Chronos mice, synchronization was observed up to 400Hz. An oABR was demonstrated in both ChR2- and Chronos-mice. No light-driven responses were demonstrated in control cases. Histology confirmed localization of ChR2 and Chronos in the injected CN. These results demonstrate the potential for an optically-based neuroprosthetic device in the auditory system.

PODIUM SESSION V: AUDITORY DISORDERS

Podium Paper V.A.

Designing Non-Ototoxic Aminoglycoside Antibiotics

Anthony Ricci, PhD; Markus Huth, MD; Michael Hsieh, MD; Yiju Hsieh, MD; Kyuhee Han, PhD; Robert Greenhouse, PhD; Alan Cheng, MD; Kayvon Soutadeh, BS; Sarah Verhoeven, MD; Andrew Vu, BS, Stanford University, Stanford, CA

Aminoglycoside antibiotics are widely used against gram negative bacteria in spite of their ototoxic side effects. Aminoglycosides target the sensory cells of the inner ear, causing hair cell death and deafness. Recent data demonstrate that hair cell susceptibility is imparted by the aminoglycosides ability to enter at high rates through the mechanosensitive ion channel located at stereocilia tops. Using our knowledge of the biophysical properties of this unique ion channel and the crystal structures of aminoglycosides interacting with ribosomal subunits we designed a series of new compounds less likely to permeate the channel while retaining antimicrobial activity. The hypothesis is that if the drug does not enter the sensory cell it will not cause hearing loss. Nine compounds were developed and initially screened using an E-coli assay to test antimicrobial activity and an organotypic cochlear culture to test for ototoxicity. Three of nine compounds retained antimicrobial activity while all nine compounds had reduced ototoxicity. Lead compounds were tested in whole animal models demonstrating equal potency in a bladder infection model, with virtually no auditory deficits measured using ABR/DPOAEs. These proof of principal experiments demonstrate the feasibility of designing a new class of nontoxic aminoglycosides.

Podium Paper V.B.

Comorbidity or Simultaneity? Sensorineural HL, CAPD, TBI, PTSD, Tinnitus

*Leslie Jr Dalton, PhD; Gary R. Byrd, PhD, West Texas A&M Univ, Canyon, TX
Julia M. Stephen, PhD, The Mind Research Network, Albuquerque, NM*

Sensorineural Hearing loss & tinnitus (HLT), CAPD, TBI and PTSD frequently occur concomitantly presenting multiple problems for service providers of active duty military and veterans because of the concept of a 'specific' test for a 'specific' disorder. The veteran's administration (VA) is particularly affected because of the overwhelming flow of disability claims requiring special testing beyond the basic 'comprehensive audiological battery.' Hearing loss has been called 'a hidden handicap' with tinnitus called 'phantom sounds.' The names are not just labels; they are prophetic, particularly in the presence of evidence showing that HLT is more than a comorbidity of CAPD, TBI and PTSD. We present a computer-generated stimulus/evaluation paradigm that simultaneously evokes bottom/up, top/down behavioral and Magnetoencephalography (MEG) responses providing a concise auditory scene analysis (ASA) of auditory system as it interacts with 'comorbid' disorders. Data confirmed (1) the validity of the behavioral paradigm to adequately define bottom/up pathology of the entire auditory system with a single computer process; (2) confirmed the presence of hearing loss in a population of TBI & PTSD subjects and (3) confirmed a behavioral quantification paradigm that can differentiate motivational non-organic tinnitus from tangible tinnitus. Statistical analyses and MEG displays will be presented.

Podium Paper V.C.

Does Occupational Noise Cause Asymmetric Hearing Loss?

Robert Dobie, MD, University Of Texas HSC, San Antonio, TX

People claiming benefits for occupational noise-induced hearing loss often have asymmetric audiograms, but the cause of the asymmetry may be obscure. The Occupational Noise and Hearing Survey database (Lempert & Henderson, 1973) allowed measurement of audiometric asymmetry in both noise-exposed and non-noise-exposed men (n = 2044). With appropriate controls for previous noise exposure, otologic history, abnormal otoscopy, and binaural average hearing levels, audiometric asymmetry was unaffected by current occupational noise exposure.

Podium Paper V.D.

Dual Sensory Loss: A Hearing Screening and Educational Model

Catherine McMahon, PhD, Macquarie University, North Ryde, NSW

Julie Schneider, PhD; Moira Dunsmore; Stephen Leeder, PhD, Menzies Centre For Health Policy, University of Sydney, Sydney, New South Wales

Bamini Gopinath, PhD; Jie Jin Wang, PhD; Paul Mitchell, PhD, Centre for Vision Research, Westmead, New South Wales

Individuals with dual sensory loss (DSI) are assumed to experience more than the consequences of vision or hearing impairment alone. To evaluate this and help-seeking behavior in this population, we piloted a 'hearing screening and education model' (HSEM) in vision rehabilitation clinics in Sydney, Australia. Three hundred clients with low vision aged 65+ years participated in questionnaires and a hearing screening test. Data was collected on their perceptions of hearing difficulties, contact with services, quality of life, health history and social demographics. Those with 25dB HL at two or more tested frequencies (500-8000Hz) who were not currently receiving hearing services or wearing devices habitually were educated about hearing service availability and practical implications of dual loss. They were reviewed at 12-months to determine whether the HSEM promoted greater use of hearing services / devices, or led to positive improvements in quality of life and independence. Qualitative interviews were conducted in 19 participants. Using a grounded theory approach, a conceptual understanding of the experience of DSI in older age and the process of seeking help was developed. Results indicate that a key challenge in audiology lies in older peoples' tendency to foreground vision and other life priorities above help-seeking for hearing loss.

Podium Paper V.E.

Behavioral and Physiologic Responses in Children with Unilateral Hearing Loss

Megan Carter; Jill Firszt, PhD, Washington University School of Medicine, St Louis, MO

Children with unilateral hearing loss (UHL) experience numerous difficulties in communication including speech recognition in noisy situations. Although behavioral deficits have been identified, little is known about the underlying physiologic responses of the auditory system when listening with one ear. The current study investigated brainstem encoding of a speech syllable in children with UHL and age and gender matched peers with normal hearing (NH). Speech evoked auditory brainstem responses were obtained in quiet and pink noise at two signal-to-noise ratios. Speech recognition was assessed using monosyllabic words in quiet and noise and HINT sentences presented in the R-SPACE which simulates a complex listening environment with speech in the presence of restaurant

noise. Results suggested group differences in physiologic responses for the onset, offset, fundamental frequency and second harmonic in either quiet or noise. Children with UHL performed more poorly than their peers in both quiet and noise on speech recognition measures. The findings further substantiate the detriments that children with UHL encounter in every day listening when they must rely on a single ear. Supported by NIDCD R01DC009010.

Podium Paper V.F.

Could Cognitive Screening Improve Audiologic Rehabilitation for Older Adults?

Akram Keymanesh, MS; Marilyn Reed, MS; Heather Finkelstein, MS; Debbie Ostroff, MS,
Audiology, Baycrest Hospital, Toronto, ON

Kate Dupuis, PhD; M. Kathleen Pichora-Fuller, PhD, Psychology, University of Toronto,
Mississauga, ON

The purpose of the study was to evaluate the usefulness of cognitive screening in a geriatric audiology practice. Fifty participants (60% female, Mage=85 years, half first-time hearing aid users), were administered the Montreal Cognitive Assessment (MoCA). Audiologists recommended management and categorized client's cognitive status. Subsequently, they were provided the MoCA results and could revise their recommendation and cognitive categorization. Intervention outcomes were examined at followup. Based on the MoCA, 15% of participants scored in the normal range, 40% in the mild cognitive impairment range, and 45% in the dementia range. Audiologists' categorizations agreed with MoCA results for 28% of cases, but more often they over-estimated cognition. The audiologists were very confident in categorizing 24% of cases, but more often they were only somewhat confident. Importantly, access to MoCA scores increased their confidence and recommendations were revised for half of the participants when the MoCA results were considered, especially when the MoCA suggested poorer cognition than the audiologist had initially estimated. The majority of individuals who did not try or keep hearing aids were cognitively impaired; however, outcome measures for those who purchased hearing aids did not depend on cognitive status. Findings suggest that it is useful to screen cognitive status.

Podium Paper V.G.

Interaction of Multiple ASSR Stimuli that Vary in Modulation Depth

Robert Burkard, PhD, University at Buffalo, Buffalo, NY

We have previously reported that there are substantial amplitude reductions of the chinchilla auditory steady-state response (ASSR) when two or more stimuli are presented simultaneously. The present study evaluated the effects of varying the depth of modulation on the amplitude of the ASSR to paired stimuli. Carrier frequencies were 1000 and 2000 Hz, with modulation frequencies of 95 and 107 Hz, respectively. Stimulus levels were 50 and 80 dB SPL. Each carrier frequency and depth of modulation (25%, 50%, 75%, 100%) was presented to the right ear in isolation, and for each stimulus level, 100% modulated carriers were paired with all modulation depths of the other carrier. The ASSR was recorded from subdermal scalp electrodes in nine adult isoflurane-anesthetized chinchillas, using the MASTER system. ASSR amplitude increased with increasing modulation depth, for both stimulus levels and both carrier frequencies. As in previous

studies, the presentation of paired stimuli typically resulted in a decrease in ASSR amplitude (for both components). The effects of modulation depth on ASSR amplitude when paired with a second stimulus will be discussed.

Podium Paper V.H.

Electrocochleography Obtained at High Stimulus Rates in Patients with Acoustic Tumor

Krzysztof Morawski, MD, PhD; Kazimierz Niemczyk, MD, PhD; Aleksandra Wezyk, MD; Katarzyna Pierchala, MD, PhD, Department of Otolaryngology, Medical University of Warsaw, Warsaw,

Jorge Bohorquez, PhD; Rafael Delgado, PhD, Department of Biomedical Engineering, College of Engineering, University of Miami, Coral Gable, FL

Objectives: To investigate a new strategy of auditory evoked responses recorded at high stimulation rates in acoustic tumor ears (ATEs). **Methods and Measures:** Control ears (CEs) and 32 ATs were tested using an evaluation strategy of the auditory system involving a “Continuous Loop Averaging Deconvolution” technique (CLAD) (Delgado & Ozdamar, JASA 2004; Ozdamar & Bohorquez, JASA 2006). Hearing was tested by transtympanal electrocochleography (TT-ECochG). Ears were stimulated using clicks (85 dB nHL) presented at rates of 7/s-780/s with the CLAD option. **Results:** In the CEs, the SP/AP ratio reached ≈ 1 at a stimulation rate of 600/s while in ATEs at 250/s for small and 50/s for bigger tumors. AP latencies in the CEs were found to be increasing at stimulation rates equal to 300/s, then were stable, and for rates of ≥ 500 /s, were found to be decreasing. For small tumors, latency changes were relatively similar, except at stimulation rates > 500 /s, where the latency remained stable. Relations between CLAD and various audiological tests were analyzed. **Conclusions:** These very high stimulation rates provide a valuable tool for the assessment of the adaptation processes of the peripheral auditory system in CEs and AT ears. The CLAD strategy supports traditional audiological test battery in diagnosis of retrocochlear auditory pathologies.

PODIUM SESSION VI: EPIDEMIOLOGY; AUDITORY NEUROSCIENCE

Podium Paper VI.A.

Hearing Aid Use and Communication Difficulties Among Older US Adults

Kathleen Bainbridge, PhD; Howard Hoffmann, MD, National Institute on Deafness and other Communication Disorders, Bethesda, MD

Randomized, controlled trials demonstrate the effectiveness of hearing aids to improve hearing-related quality of life, but participants have been limited to male Veterans. Using data collected during the 2007 National Health Interview Survey, we examined whether extent of trouble hearing was associated with frequency of communication difficulty in noise and frustration when talking to family and friends among 3179 adults age 65 years. Further, we assessed whether these associations varied by use of hearing aids or assistive listening devices (ALDs) among a subsample of 1592 adults with at least a little trouble hearing. Among people who do not use hearing aids, those with a lot of trouble hearing are

2-3 times more likely to always or usually experience communication difficulty in noise (OR=3.0 (95% CI 1.7, 5.2)) and frustration when talking to family or friends (OR=2.6 (95% CI 1.4, 5.1)) compared to people with moderate trouble hearing. Among hearing aid users, associations are non-significant. We observed a similar modifying effect of ALD use. These observational data suggest hearing aid or ALD use attenuates the effect of hearing difficulty on experiencing communication problems in a nationally-representative sample and lend support to testing interventions in the general population.

Podium Paper VI.B.

Generational Differences in the Risk of Hearing Impairment

Karen J. Cruickshanks, PhD; David M. Nondahl, MS; Dayna S. Dalton, MS; Mary E. Fischer, PhD; Barbara E.K. Klein, MD; Ronald Klein, MD; Ted S. Tweed, MA, University of Wisconsin, Madison, WI

Previous studies have reported lower prevalence of hearing impairment (HI) in more recent birth cohorts; however, there have been no longitudinal studies of generational differences in the incidence of HI. Using data from two longitudinal cohort studies (the Epidemiology of Hearing Loss Study (EHLS) and Beaver Dam Offspring Study (BOSS)), the effect of birth cohort (generation) on the 5-yr incidence of HI was determined. Hearing thresholds were measured by pure tone audiometry at baseline and the five-year follow-up examinations. HI was defined as a pure-tone average > 25 dB HL at 500, 1000, 2000, and 4000 Hz in either ear. Participants (n=3514) born between 1906 and 1984 who did not have hearing impairment at baseline were included in these analyses. Adjusting for age and sex, the incidence of HI declined by birth cohort (OR=0.78 per generation, 95% Confidence Interval (CI) =0.61, 0.99). Adjusting for age, sex, education, and waist circumference, this generational effect remained (OR=0.77, 95% CI=0.59, 0.99). The rapidly decreasing incidence of HI suggests that today's aging baby-boomers are retaining better hearing longer than previous generations and is strong evidence that modifiable factors play important roles in the etiology of age-related hearing impairment.

Podium Paper VI.C.

Fish and Fatty Acid Consumption and Hearing Loss in Women

*Sharon Curhan, MD; Molin Wang, PhD; Eric Rimm, PhD; Gary Curhan, MD, Channing Division of Network Medicine, Brigham And Women's Hospital, Boston, MA
Roland Eavey, MD, Vanderbilt Bill Wilkerson Center for Otolaryngology and Communication Sciences, Vanderbilt University School of Medicine, Nashville, TN*

Background: Prospective data on dietary risk factors for acquired hearing loss are limited. Fish consumption may help maintain cochlear blood supply and may be associated with lower risk of hearing loss.

Methods: We examined independent associations between fish consumption, intake of specific fatty acids, and self-reported hearing loss in 65,521 women in the Nurses' Health Study II (1991 to 2009). Baseline and updated dietary information was obtained from validated questionnaires.

Results: Over 18 years, 12,789 cases of incident hearing loss were reported. Fish consumption once/week or more was inversely associated with risk of hearing loss. Compared with women who consumed <1 serving/month, the multivariate-adjusted

relative risk (RR) was 0.92 (95%CI 0.87, 0.98) among women who consumed 1 serving/week, and 0.80 (0.68,0.94) for 5+ servings/week (p-trend<0.001). Results for specific types of fish were similar. Compared with women in the lowest quintile of intake of long chain omega-3 polyunsaturated fatty acids (PUFA), the multivariate-adjusted RR among women in the highest quintile was 0.90 (95% 0.85,0.96)(p-trend <0.001). Conclusion: Fish consumption and higher intake of long-chain omega-3 PUFA are associated with lower risk of hearing loss in women. These findings suggest that dietary factors may help reduce the risk of hearing loss.

Podium Paper VI.D.

Intellectual Disabilities and Hearing Loss

Gilbert Herer, PhD, Chapman University, Orange, CA

Few hearing detection studies of non-institutionalized adults with intellectual disabilities (ID) appear in the professional literature. One noteworthy study of 1598 individuals reported 36% with hearing loss, and 48% previously unidentified. These findings suggests utilizing a public health outreach model rather than a clinical self-referral model for the early detection of hearing loss among adults with ID living in general communities. A public health model was used with large numbers of non-institutionalized adults with ID participating at Special Olympics sports events over the past decade. The hearing of 9961 people was evaluated, with outcomes reported in this podium presentation. An overall hearing loss rate of 24% (half sensorineural, half conductive) was found; an amount 1.4 times greater than reported in general population studies (16%) for similar ages (18 to 55 years). Analyses by age decades (20-29, 30-39, 40-49) revealed progressively greater rates of hearing loss from 17% to 36%; compared to general population study reports of 2% to 8% for same age decades. A considerable number of the overall 24% with hearing loss was previously undetected or unserved. This study's findings support a public health outreach model of hearing loss detection for adults with ID living within the general community.

Podium Paper VI.E.

Hearing Ability in Older Adults: U.S. NHANES versus Iceland AGES-RS

Howard J. Hoffman, MA; Chuan-ming Li, PhD, Epidemiology & Statistics Program, NIDCD/NIH, Bethesda, MD

Christa L. Themann, MA, Hearing Loss Prevention Team, Division of Applied Research Technology, NIOSH/CDC, Cincinnati, OH

Hannes Petersen, MD, Department of Otorhinolaryngology, Reykjavik

Tamara B. Harris, MD, Geriatric Interdisciplinary Studies Section, Laboratory of Population Sciences, IRP, NIA/NIH, Bethesda, MD

Lenore J. Launer, PhD, Neuroepidemiology Section, Laboratory of Population Sciences, IRP, NIA/NIH, Bethesda, MD

Vilmundur Gudnason, MD, Icelandic Heart Association, Heart Preventive Clinic and Research Institute, and University of Iceland, Kopavogur

The U.S. National Health and Nutrition Examination Survey (NHANES) collected self-reported risk factor information and conducted audiometric assessments on 70+ year-old adults during 2005-2006 and 2009-2010 (N=1,676). The Age, Gene/Environment Susceptibility - Reykjavik Study (AGES-RS), 2002-2006, collected similar data on a

population cohort (born 1907-1935 in Iceland) followed since 1967 by the Icelandic Heart Association (N=5,170). We used multiple regression models to predict hearing ability, defined as the pure-tone average (PTA) of air conduction thresholds at 0.5, 1, 2, and 4 kHz, separately for better ear (BE) and worse ear (WE), based on WHO recommendations. Among 70+ year olds, 11.1% in Iceland and 9.8% in U.S. had 'good/excellent' hearing (WE PTA <20 dB hearing level [HL]). 'Mild' hearing impairment (HI), 20 dB HL <BE< 35 dB HL, was found in 42.7% and 40.8% of Iceland and U.S. older adults, respectively. More than one-third had 'moderate/greater' HI (35.3% in Iceland and 40.0% in U.S.). HI risk factors, by decreasing relative importance were: age, male sex, repeated ear infections (Iceland), tinnitus, work-related noise exposure, and lower education. Alcohol was protective (U.S.), while cigarette smoking was of borderline significance for HI (Iceland). Associations were similar for BE/WE and cross-country comparisons.

Podium Paper VI.F.

Epidemiology of Dizziness, Balance and Falling Problems in U.S. Children

Chuan-Ming Li, PhD; Howard Hoffmann, MA, Epidemiology And Statistics Program, Division of Scientific Programs, NIDCD, NIH, Bethesda, MD

Helen Cohen, Department of Otolaryngology-Head and Neck Surgery, Baylor College of Medicine

Rose Marie Rine, PhD, Specialty Therapy Source, LLC and School of Physical Therapy, Marshall University

Bryan Ward, MD, Vestibular NeuroEngineering Laboratory and Otolaryngology-Head and Neck Surgery Department, Johns Hopkins University and Hospital

The 2012 National Health Interview Survey (NHIS) Child Balance Supplement (CBS) is the first nationally-representative survey devoted to pediatric balance problems (N=10,954). Based on parent's report, 5.3% of U.S. children (3.3 million) aged 3-17 years, had a problem with dizziness, balance or falling during the past year; 3.7%, 5.0% and 7.2% for 3-7, 8-12 and 13-17 years, respectively. Percentages are adjusted for the complex sample design, which also ensures correct variance estimates for significance testing and calculation of 95% confidence intervals. 1.9% (1.1 million) children were reported with light-headedness, fainting, or feeling he/she is about to pass out; 2.4% (1.5 million) were reported as having body or motor coordination problems or clumsiness; 1.6% (1 million) were reported with poor balance, an unsteady or woozy feeling that makes it difficult to stand-up or walk; 1.3% (0.8 million) were reported as having frequent falls. Logistic regression was used to calculate odds ratios. Overall, balance problems are significantly associated with age, other developmental delays, frequent headaches/migraines, recurring headaches other than migraine, seizures, stuttering/stammering, learning disabilities, and excessive sleepiness during the day. The prevalence estimates will be used as a baseline for Healthy People 2020 objectives that promote increased utilization of health care for diagnosis and treatment of children with these problems.

Podium Paper VI.G.

ECLiPS: Assessment of Listening Difficulties Relative to Different Developmental Disorders

Johanna Barry, PhD; Sophie Richardson, MRC Institute of Hearing Research, Nottingham, UK

David Moore, PhD, Cincinnati Children's Hospital, Cincinnati, OH

Auditory processing disorder (APD; listening difficulties) is typically diagnosed alongside a broad range of other developmental disorders of language, literacy and social communication. With the ultimate aim of developing a gold standard to guide clinical practice and research, we have developed the ECLiPS, a report based measure of parent/carer observation, to help understand the reason(s) why children with similar presenting symptoms follow different referral routes.

The ECLiPS assesses listening, structural language, pragmatic language, auditory sensitivity and memory/attention. Here, we compare ECLiPS profiles of children with three diagnoses associated with co-morbid listening difficulties: Language impairment (LI, n=41), Dyslexia (n=50), High functioning autism (HFA, n=31). The three groups were subdivided according to whether or not parents rated them as at risk for APD (CHAPPS). Significant ($p < .001$) differences were found in ECLiPS profiles between the diagnostic groups. Children with HFA had the greatest difficulties across 4/5 abilities assessed by ECLiPS (listening, memory/attention, auditory sensitivity and pragmatic language). Listening difficulties in children with LI were associated with greater structural and pragmatic language, and memory difficulties, while in children with dyslexia they were associated with memory/attention difficulties. Overall, the diagnostic groups demonstrate significant, but relatively complex patterns of difference in behavioral profiles.

Podium Paper VI.H.

Linking Hearing and Cognition to Participation in Leisure Activities

M. Kathleen Pichora-Fuller, PhD; Kate Dupuis, PhD, Psychology, University of Toronto, Mississauga, ON

Henrik Danielsson, PhD, Linkoping University, Linkoping

There is evidence that 1. hearing loss is associated with incident dementia, 2. hearing loss reduces communication functioning and increases risk for social isolation, and 3. engagement in leisure activities is related to cognitive decline. This trio of findings is consistent with the hypothesis that diminished participation in social activities could mediate the association between hearing loss and incident dementia. Measures of hearing and memory will be examined in relation to self-reported participation in common leisure activities. Structural equation models based on data from each of two samples were constructed and compared. One sample consists of 300 older adults who volunteered for lab-based research on aging in Toronto, Canada. The other sample consists of 297 adults from Umea, Sweden who are participants in the Betula longitudinal study. The majority of participants in both samples had relatively good hearing and would not be candidates for hearing aids. Models for both samples suggest that age predicts hearing and memory, that hearing predicts memory, and that memory (but not hearing) predicts participation in social activities. Of note, standard pure-tone average thresholds did not contribute significantly to the models, but high-frequency hearing thresholds did. Future research directions will be discussed.