Interaction of Working Memory, Compressor Speed and Background Noise Characteristics

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POSTER ABSTRACTS

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ELECTROPHYSIOLOGIC RESPONSES / AUDITORY NEUROSCIENCE

Poster #1 – ELECT01 **Mentored Student Research Poster Award**

The Effects of Aging on Subcortical Encoding of Speech in Noise

Alessandro Presacco, MS; Samira Anderson, PhD, University of Maryland, College Park, MD

Older adults often report that during a conversation they can hear what is said, but cannot understand the meaning, particularly in a noisy environment. Here, we compared the effects of noise on subcortical responses in younger and older adults with normal hearing, hypothesizing that the frequency following response (FFR) in older adults shows no significant differences between quiet and noise conditions. Participants comprised 8 younger adults and 8 older adults. FFRs were recorded at a sampling rate of 16.384 kHz to a 170-ms speech syllable, [da], presented binaurally with alternating polarities at 80 dB SPL. Three thousands sweeps were recorded for two conditions, quiet and in single-talker competing speech (0 SNR).

A mixed-model ANOVA demonstrated an age √ó condition interaction ($p < 0.01$); specifically, noise resulted in a significant decrease in the RMS amplitude in the younger adults but not in the older adults. The results from the phase-locking factor suggested that the most remarkable differences between younger and older adults were localized at the higher harmonics.

The differences in higher harmonic encoding between older and younger adults suggest that a lack of subcortical temporal precision may be a factor in the older adult's difficulty with understanding speech in noise.

Poster #2 – ELECT02

Development of Subcortical Speech Representation in Infants

Samira Anderson, PhD, University of Maryland, College Park, MD
Nina Kraus, PhD, Northwestern University, Evanston, IL

Brainstem responses to clicks and tone bursts in infants have been well-documented; however, there is limited information regarding the brainstem response to speech in the first year of life. Although robust representation of the fundamental frequency in the frequency following response (FFR) has been recorded in infants as young as one month of age, the development of other aspects of the FFR, such as timing and timbre, has not yet been examined. We evaluated brainstem responses to a speech syllable in 25 infants, ages three to nine months, who had normal peripheral function. We found that the amplitude of the fundamental frequency was variable, but was strongly represented in some infants as young as three months of age, replicating previous findings. The harmonics, however, showed a systemic increase in amplitude with age. In the timing domain, we found that the onset latency decreased with age, but peak latencies of the FFR did not change. These data are discussed in the context of subcortical changes across the lifespan and implications for early experience-dependent plasticity. This work is supported by the National Institutes of Health Institutional Research Training Grant (T32 DC009399-01A10) and the Knowles Hearing Center.

Poster #3 – ELECT03

Brainstem Differentiation of Stop Consonants During the First Year of Life

Rachel Lieberman; Alessandro Presacco, MS; Samira Anderson, PhD, University of Maryland, College Park, MD

Previous research has shown that replicable and reliable brainstem responses to a stop consonant /da/ can be elicited in infants as young as 3 months of age. Additionally, evidence of brainstem stop-consonant differentiation in pre-school and school-age children has been found. Furthermore, evidence of a relationship between stop-consonant differentiation and phonological awareness has been demonstrated. However, subcortical differentiation of stop consonants in infants has not yet been shown. Brainstem responses to two consonant-vowel speech syllables, /ga/ and /ba/, were evaluated in infants ages 3 to 12 months. Phasogram analysis showed clear phase differences between the two speech syllables, indicating subcortical differentiation of the sounds. Correlation above .8 between responses generated from two sets of sweeps indicated replicability and reliability of the responses. These data indicate that brainstem differentiation of stop consonants is a reliable method of subcortical processing and could potentially be used as an assessment of auditory processing in infants.

Poster #4 – ELECT04

Determining Appropriate Force Applied For Bone Conduction ABR in Infants

Leigh Schaid, AuD; Alaaeldin Elsayed, AuD; Lisa Hunter, PhD, Cincinnati Children's Hospital Medical Center, Cincinnati, OH
Sue Windmill, AuD, The University of Mississippi Medical Center, Jackson, MS

A challenge when performing bone conduction (BC) auditory brainstem response (ABR) testing in infants is ensuring that adequate calibrated force is applied. A prototype device that measures the force applied on the oscillator (Etymotic Research (Elk Grove, IL)) was investigated to determine its effect on BC ABR. Seven infants were tested; ABR wave V latencies were obtained for 500- 4000 Hz at 30 dB nHL and then to threshold. Results were obtained without and with the force meter respectively, for each infant. An

audiologist experienced in holding the oscillator for BC ABR testing in infants applied the oscillator and device. No significant differences in threshold, latency, correlation between split waveforms, or number of sweeps needed were found for this initial subject group. These findings suggest that experienced audiologists are likely using the recommended amount of force (~5.4 Newtons) when using the hand held technique with the oscillator. Results will also be compared with those of novice testers. A force meter like the one used in this study may prove useful for not only monitoring proper force application when testing bone conduction ABR for experienced audiologists, but also when training less experienced audiologists and students.

Poster #5 – ELECT05 **T35 Research Trainee Poster**

Effects of High-Pass Masking on Stimulus Rate Changes in ABR

Ellen Hambley, The Ohio State University, Columbus, OH
Linda Hood, PhD, Vanderbilt University, Nashville, TN

The auditory brainstem response (ABR) to frequency-specific stimuli is routinely used in estimating hearing sensitivity. ABR latency and amplitude vary with stimulus frequency, intensity, and rate. While many characteristics are known, interactions among the stimulus parameters together have only recently been examined. Hess and Hood (2012) demonstrated a latency shift of ABR Wave V with increased stimulus rate that was significantly greater for low frequency, low intensity stimuli. The primary goal of the current study was to apply high-pass masking to the previous paradigm to determine if previous findings were appropriately isolated to low and high frequency regions. A secondary goal was to replicate findings of the previous study. ABRs were recorded from sixteen adults with normal hearing across the eight stimulus parameter conditions. The new finding in this study was that latency shifts with increased rate were reduced for all conditions with the addition of high-pass masking; however, the previously observed significantly greater shift in Wave V latency for the low frequency, low intensity condition, remained. These results confirm a frequency effect that interacts with intensity and support the importance of consideration of stimulus characteristics across a parametric space when interpreting effects of stimulus rate. [Supported by NIH-NIDCD T35-DC008763]

Poster #6 – ELECT06

Equalization of Insert Earphone Frequency Response Improves Chirp ABR Morphology

Sinnet Greve Bjerge Kristensen, MA; Kristian Goetsche-rasmussen; James M. Harte, PhD, Interacoustics Research Unit, Kgs. Lyngby

Auditory brainstem responses (ABRs) were recorded as a function of stimulus level to three short-duration stimuli, to compare the resulting waveform morphologies. Specifically, the thresholds for waves I-V were determined as well as the inter-wave latencies. The first stimulus is available in the current Interacoustics Eclipse EP25 ABR system¬Æ; the classical click (100 us duration pulses). The next, CE-Chirp (LS), was designed to compensate for cochlear delay and upward spread of excitation as a function of level. The third stimulus used belongs to a new generation of stimuli, the CE-Chirp (LSY), created to retain the properties of the CE-Chirp (LS) but with an additional level-independent high-frequency boost. This compensates for the high frequency roll-off of the ER-3A insert earphones, commonly used for clinical ABR recording. The present study increases the range of levels investigated previously and shows a reduced wave-V threshold for the CE-Chirp (LSY) for a fixed residual noise level, over the other two stimuli. Further, this study has shown an increased benefit in overall morphology when using the new CE-Chirp (LSY), particularly for identifying the lower amplitude waves I & III. This has the potential to increase the clinical utility of ABR inter-wave latencies.

Poster #62 – ELECT07

Effects of Complex Tonal Stimuli on P1 Latency and Amplitude

Charles Marx, AuD; Edward Goshorn, PhD, University of Southern Mississippi, Hattiesburg, MS

The optimum stimulus for evoking late auditory potentials is not well established. A typical stimulus for clinical purposes is either a brief speech signal or a brief single-frequency tone. Previous research suggests that a complex tonal stimulus may produce improved waveforms. The current project investigated the effects on P1 latency and amplitude of a two-tone complex stimulus with either a dissonant or harmonic relationship to a reference stimulus. An 80 millisecond 1000 Hz tone with 10 millisecond rise/fall times served as the reference stimulus. The two-tone complex stimuli consisted of the reference tone plus an additional tone of equal duration and amplitude at 1100, 1250, 1500, 2000, or 4000 Hz, resulting in three dissonant and two harmonic stimuli. One dissonant stimulus (1000+1100 Hz) was designed to have the additional tone fall within the critical band of the reference stimulus. Stimuli were presented in a counter balanced order to twenty normal hearing adult subjects. Two replicate runs were obtained for each stimulus condition. Results showed that the complex stimuli had a minimal effect on P1 latency relative to the reference stimulus but produced a significant increase in P1 amplitude with the harmonic stimuli producing larger amplitudes than the dissonant stimuli.

Poster #63 – ELECT08

Cortical Masking Level Differences: Nonsense Syllable vs. 500-Hz Tone Burst

Colleen Ireland; Emily Janz; Cynthia Fowler, PhD, University of Wisconsin, Madison, WI
Laura Spencer, AuD; Elizabeth Leigh, PhD, William S. Middleton Va Medical Center, Madison, WI

Speech is characterized by dynamic changes in intensity, frequency, and time that the auditory system must resolve for accurate perception to occur. The coding of temporal changes is critical to speech understanding, particularly in noise. Masking level differences are one measure of binaural temporal coding that can be measured using tonal and speech stimuli. The purpose of the present study was to investigate the potential relationship between behavioral and electrophysiologic masking level differences (MLDs) obtained by tonal and speech stimuli. SoNo and S¬øNo thresholds were obtained behaviorally and by recording auditory late latency responses in response to two separate stimuli (1) a 500-Hz tone burst in 500-Hz narrow band masking noise and (2) speech stimulus /wa/ in speech shaped noise. The MLD was calculated as the difference between the SoNo threshold and the S¬øNo threshold. Twenty listeners (18 ¬ø 30 years of age) with normal hearing were tested. These data show that speech LLR MLDs can be recorded at the cortical level and that the /wa/ MLDs were consistent with 500-Hz MLDs. Comparisons between stimuli and future use of these LLR MLDs will be discussed (work supported by VA RR&D Career Development Award C7893-W).

Poster #64 – ELECT09

Neuronal Coupling of Cell Surface Receptor with DNA Repair Enzyme

O'neil Guthrie, PhD, Loma Linda VA Medical Center, Rancho Cucamonga, CA
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We conducted experiments to determine whether or not spiral ganglion neurons that constitutively express DNA repair enzymes also express the epidermal growth factor receptor (EGFR). Gene and enzyme expression of the EGFR and the xeroderma pigmentosum-A (XPA) DNA repair factor were

determined. Immunofluorescence assays were used to localize neurons expressing both EGFR and XPA. This work was then confirmed with double-immunohistochemical reactions. Rosenthals¬ø canal served as the reference space in these experiments and design-based stereology was employed. The results revealed that three populations of spiral ganglion neurons could be distinguished. For instance, there was a population that only expressed XPA and these neurons were predominantly clustered in the superior-medial quadrant of Rosenthal's canal. There was a second population that only expressed the EGFR and these neurons were predominantly distributed throughout the inferior and superior-lateral quadrants of Rosenthal's canal. The third and most abundant population, were neurons that expressed both the EGFR and the XPA enzyme. These neurons were distributed throughout four quadrants of Rosenthal's canal. The combined results provide the basis for future experiments designed to manipulate the EGFR in order to regulate DNA repair capacity and regenerate gene function after DNA damage.

Poster #65 ELECT10 **Mentored Student Research Poster Award**

Voltage-Dependent Potassium Conductances Shape Action Potential Properties Around Hearing Onset

Hui Hong; Louisa Xu; Jason Tait Sanchez, PhD, Northwestern University, Evanston, IL

Mature neurons in the anteroventral cochlear nucleus (AVCN) generate a single rapid action potential (AP) at the start of sustained depolarization. This control of excitation is dependent upon specialized potassium channels and is considered necessary for the temporal encoding of sound. Less clear are factors regulating AP properties around hearing onset, a developmental time period undergoing significant biophysical changes. The purpose of this study was to elucidate the role of potassium channels in shaping AP properties around hearing onset. Using nucleus magnocellularis (NM, the avian analog to the mammalian AVCN) as a model system for auditory development, we found that both low- and high-voltage-activated potassium channels (KLVA and KHVA, respectively) differentially regulate AP properties around hearing onset. Applications of potassium channel blockers with patch-clamp recordings from NM neurons revealed that KLVA channels control AP threshold, number and reliability while KHVA channels shape AP kinetics. This contrasts mechanisms regulating AP properties before hearing begins and suggests a strong up-regulation of voltage-dependent potassium conductances at hearing onset. A better understanding of factors that control excitability in the developing auditory brainstem may help guide temporal coding strategies used for cochlear implant design.

Poster #67 – ELECT11 **Mentored Student Research Poster Award**

The Efferent System's Role in the Neural Encoding of Speech-in-Noise

Spencer Smith; Barbara Cone, PhD, The University of Arizona, Tucson, AZ

The medial olivocochlear (MOC) reflex decreases the gain of the cochlear amplifier by inhibiting outer hair cell (OHC) motility. Physiological and psychophysical data suggest that the MOC reflex may be involved in the neural encoding and perception of signals in noise, such as human speech. Although several studies have measured contralateral suppression of otoacoustic emissions during MOC reflex activation, little is known about how this circuit shapes masked signals as they pass from the cochlea into the ascending auditory pathway. The aim of this study is to test the hypothesis that the MOC reflex is involved in unmasking of signals at the level of the auditory nerve and brainstem.
Transient- and speech-evoked compound action potentials (CAPs) and auditory brainstem responses (ABRs) were measured in quiet and in the presence of noise masking with and without activation of the MOC reflex using contralateral noise. Our results replicate previous findings that noise masking increases peak latencies and decreases amplitudes of the speech-evoked CAP and ABR waveforms. New data

support the MOC unmasking hypothesis by demonstrating that activation of the MOC reflex with contralateral broadband noise results in an improvement in neural transcription of noise-masked speech in the auditory nerve and brainstem.

AMPLIFICATION/HEARING TECHNOLOGY / REHABILITATION

Poster #7 – AMP01
Benefit of Telephone Solutions for Children and Adults
Matthias Latzel, PhD, Phonak Ag, Staefa, Denmark

Hearing on the telephone is a common challenge for hearing aid wearers. The difficulty which they face when using the phone is due to a number of factors: the lack of visual clues, reduced frequency bandwidth, monaural listening, background noise and difficulties coupling the phone to the hearing aid. Hearing aid manufacturers offer a variety of solutions, e.g. special phone programs, telecoil, streaming solutions, binaural features or specialized phones.
This poster describes recent studies looking at the usability and benefits of several phone strategies in difficult listening situations.
A pediatric study revealed that the use of the Phonak DuoPhone feature over a monaural phone program significantly improved speech understanding for children. For older children (6-14 years) speech recognition improved on average by 32% with DuoPhone compared to hearing the phone signal monaurally. For younger children (2 to 5 years) the average improvement was 19.5%.
An adult study showed an overall improvement in speech intelligibility. There was an SRT improvement of 2,5 dB when using DuoPhone and a 9 dB improvement when using the Phonak DECT phone solution. In addition, the results demonstrated that using electro-magnetic coupling simplifies the handling of the phone providing a solution with real user benefit.

Poster #8 – AMP02
Hearing Aid Setting Personalization Using Smartphones
Gabriel Aldaz, MS, Stanford University, Stanford, CA

The smartphone has the potential to revolutionize the way users interact with their hearing aids, providing unprecedented personalization and increased satisfaction levels. We discuss the findings of a real-world study in which 14 hearing impaired persons used a context-aware hearing system comprising hearing aids, gateway, and Android smartphone for 6 weeks.
Approximately four times daily, participants listened to two random hearing aid settings ¬ø A and B, such as directionality on, noise reduction off, high frequency boost ¬ø and gave a subjective, relative evaluation (¬øA better,¬ø ¬øB better,¬ø or ¬øNo difference¬ø). A/B Tests performed during the four-week-long training phase informed a model of participant preferences according to sound environment, sound level, location, movement, and time of day. During the two-week-long validation phase, the model-predicted best setting was assigned to A, while the best setting predicted by the default hearing aid automatics was assigned to B (or vice versa).
Results showed that 11 of 14 participants preferred model-predicted settings ($p = 0.02285$). Encouragingly, degree of preference for model-predicted settings positively correlated with (a) number of training phase tests taken and (b) accuracy of evaluations. These results are a first step in demonstrating how smartphones could take personalization beyond the audiogram and fitting rationale.

Poster #9 – AMP03

Mobile Device Hearing App Usage: The "Who" and the "How"

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

The past few years have seen the emergence of a new category of mobile applications that are often referred to as 'hearing apps.' These apps use the capabilities of a mobile device (e.g., smart phone or tablet) to pick up, process, and deliver to earphones the sounds in the user's environment. Despite the increasing number of hearing apps, little is known about how they are actually used in the field. Here we present an overview of user data gathered with our hearing app EarMachine made for Apple's iOS platform. EarMachine allows users to modify sounds picked up by a microphone or music files via a 9-band compressor, limiter, and expander. Parameter value manipulation is accomplished by moving two on-screen wheels that simultaneously adjust nearly all of the DSP parameters according to a large-scale demographic analysis. EarMachine collects de-identified information about how the app is being used. Here we present an overview of (1) the demographics of the hearing app user, (2) the acoustic environments in which the hearing app is used, and (3) various usage characteristics including selected parameter values, app use frequency, and session duration. [Work supported by NIDCD grant R44 DC013093]

Poster #10 – AMP04

User Self-Adjustment of Amplification Settings in Laboratory Versus Real-World Noise

Peggy Nelson, PhD; Dianne Vantasell, PhD; Gregan Melanie, PhD; Joseph Hinz; Eugene Brandewie, PhD; Adam Svec, MA, University Of Minnesota, Minneapolis, MN
Andrew Sabin, PhD, Ear Machine, LLC

Noisy environments --- especially noisy restaurants and meeting places --- are among the most challenging for hearing aid users, but little is known about optimal hearing aid settings for those environments. One reason for this is the challenge of evaluating users¬ø listening preferences in real-world environments. This report will focus on validation of a lab environment that replicates noisy real-world environments. Noise was recorded from three area noisy restaurants and a quiet office. Stereo recordings were convolved with room impulse responses and played in a multisensory lab through 48 loudspeakers. Participants listened using an iPod Touch running a real-time simulation of a multichannel compression hearing aid, with all gain/compression parameters adjustable via a simple user interface (EarMachine). They adjusted hearing aid parameters while listening in the lab at noise levels from 45 to 75 dB SPL. Participants then went to the original restaurants and made iPod adjustments in the real environment from which the lab simulation was derived. A comparison of participant-adjusted settings from real and simulated situations will be presented. Validation of the lab environment will allow us to conduct future experiments in the laboratory, where stimulus conditions can be controlled much more precisely than they can in real settings.

Poster #11 – AMP05

Quantifying Processing Interactions in Hearing Aids

James Kates; Kathryn Arehart, PhD; Melinda Anderson, PhD; Cory Portnuff, PhD, University of Colorado, Boulder, CO
Pamela Souza, PhD, Northwestern University, Evanston, IL

Hearing aids typically contain many different signal processing algorithms which may be active at the same time. Algorithm interactions affect speech intelligibility and quality, but clinical procedures for predicting the interaction effects are lacking. However, it may be possible to develop accurate fitting procedures by using recently-developed speech intelligibility and quality indices to measure the effects of hearing-aid processing and algorithm interactions.
The algorithms considered in this study are noise suppression and wide dynamic-range compression (WDRC). Noise suppression reduces the gain for noisy portions of a noisy speech signal, while WDRC increases the gain for the less-intense portions of the speech. For speech combined with noise, the two algorithms may work at cross-purposes and the processing combination will yield results that differ from those due to either algorithm alone.
To quantify this difference in processing, the outputs from several hearing aids implementing noise suppression and WDRC have been recorded for noisy speech. The hearing aid compression was programmed for different standard audiograms, and different degrees of noise suppression were selected. The expected impact on intelligibility and speech quality was then predicted using intelligibility and quality indices that measure the changes in the signal envelope and temporal fine structure.

Poster #12 – AMP06
Validity of RECD in Fitting Vented and Open-Canal Hearing Aids
Ryan Irey, MA; Jason Galster, PhD, Starkey Hearing Technologies, Eden Prairie, MN
Ryan Mccreery, PhD, Boys Town National Research Hospital, Omaha, NE

Successful use of the real-ear to coupler difference (RECD) in the fitting of hearing aids relies on a series of assumptions, one of which is similar impedance of coupling configurations in the in situ and coupler measurement conditions. In practice, however, the occluding characteristics of an earmold vary with physical fit and venting, yielding an in situ impedance that differs from the commonly used HA2 coupler. The current study investigates how ear-coupling configuration affects the in situ prescriptive accuracy of hearing aids prescribed in a 2cc coupler using measured RECDs. RECDs were obtained from 13 participants using four ear-coupling configurations. DSL v5 prescriptions were generated for two simulated hearing losses. In situ measurements of the prescribed hearing aids were made for each combination of the two hearing losses and four ear-coupling configurations. Results suggest RECD-based fitting methods become less valid as the ear-coupling configuration is progressively less occluding. Also, the fitting of open-canal hearing aids using a RECD-based fitting routine was not possible due to acoustic feedback. Further, the use of a patient's earmold to obtain the RECD, as opposed to an ER3A foam tip, provided a more accurate in situ match to target.

Poster #13 – AMP07
Acoustic Variability of Occluded Earbuds in Receiver-in-the-Canal Hearing Aid Fittings
Courtney Coburn, AuD; Joyce Rosenthal, MA; Kenneth Jensen, PhD, Starkey Hearing Technologies, Eden Prairie, MN

Receiver-in-the-canal hearing aids are commonly coupled with non-custom, stock earbuds in clinical practice. Stock earbuds may offer convenience, comfort, and cosmetic advantages over custom earmolds. Additionally, manufacturers offer various earbud styles intended for use with varying degrees of hearing loss from open styles for milder losses, to occluding styles for moderate-severe losses. However, the acoustic effects of earbuds are unknown. This is problematic, as using an occluded earbud to extend the fitting range assumes that it consistently and reliably occludes the ear canal. The accuracy of the prescribed gain and the sound quality of the fitting may be compromised without complete occlusion.

This study aimed to quantify the in-situ acoustic effects of various commercially-available earbuds using real-ear measurements. Appropriately-sized earbuds were selected for each participant and verified through otoscopic examination; in-situ acoustic effects were measured with a probe microphone routed through a custom hole in each earbud to avoid system-induced acoustic leakage. Results indicated that open earbuds behaved as expected, whereas occluded earbuds showed high variability. These results suggest that clinicians should use occluded earbuds prudently, as the wide-ranging in-situ acoustic effects may result in unpredictable fitting outcomes, and further emphasize the importance of real-ear verification in hearing aid fittings.

Poster #14 – AMP08 **T35 Research Trainee Poster**

Effects of Linguistic Environment on Detection of /s/ and /z/

Hannah Hodson, University Of North Carolina, Chapel Hill, NC
Meredith Spratford, AuD; Marc Brennan, PhD; Ellen Hatala; Ryan McCreery, PhD, Boys Town National Research Hospital, Omaha, NE

Previous studies have examined the effects of bandwidth on detection of high-frequency speech sounds (e.g. Stelmachowicz et al. 2001); however, high-frequency morpheme recognition may also be influenced by other cues. This project examined the possible influence of linguistic environment on high-frequency phoneme detection by comparing detection of word-final /s/ and /z/ for stimuli presented in isolation versus embedded in low-context sentences. Participants were 25 children with normal hearing (NH) and 10 children who were hard of hearing (HH) ages 5-12 years. Open-set word and sentence lists and the UWO Plural Test were used as stimuli. All stimuli were presented in noise with a +10 dB SNR. NH participants listened to 4 and 8 kHz low pass filtered lists. HH participants listened to the 8 kHz filtered materials and wore their own hearing aids. Analysis of variance (ANOVA) revealed that word-final /s/ and /z/ detection is more accurate when targets are embedded in sentences and when targets are in closed-set, explicit instruction tasks. This finding suggests in addition to bandwidth, co-articulation and the nature of the task (open vs. closed set with explicit instructions) also influence /s/ and /z/ detection.

Poster #15 – AMP09

Change in Fricative Production after Fitting Frequency Compression Hearing Aids

Kanae Nishi, PhD; Judy Kopun, MA; Ryan Mccreery, PhD; Patricia Stelmachowicz, PhD, Boys Town National Research Hospital, Omaha, NE

One of the unresolved issues in speech science is whether there is a direct link between speech perception and production. The present study evaluated longitudinal changes in fricative production after the fitting of nonlinear frequency compression hearing aids. A 10-year-old male with bilateral, severe-to-profound, sensorineural hearing loss recorded fricatives in monosyllabic real words with and without sentence frames. The participant made six sets of recordings between one week before and six months after the fitting. Speech samples were analyzed for a set of acoustic measures. In addition to changes over time, measurements were evaluated in reference to measurements of hearing aid output and for two age-matched males with normal hearing. Results showed that for many of the measures, the greatest change occurred by two weeks after fitting. The majority of these changes were consistent with the acoustic changes with nonlinear frequency compression in the hearing aid output. However, interestingly, only a few fricatives continued to approximate the measurements for age-matched participants with normal hearing. For others, the initial changes were gradually lost and returned to the pre-fitting values. These results illustrate how auditory access influences speech production and how individuals with hearing loss may accommodate new, yet distorted auditory information.

Poster #16 – AMP10

Asymmetric Directional Microphone Fittings for Listeners with Severe Hearing Loss

Erin Picou, PhD; Todd Ricketts, PhD, Vanderbilt University Medical Center, Nashville, TN

Directional microphones in hearing aids can help improve speech recognition in noise in specific listening situations, but may negatively affect localization ability. Previous investigations have suggested that asymmetric directional fittings (directional microphone for only one aid) may offer a compromise between symmetrical omnidirectional and directional fittings. However, the effect of this type of fitting on localization is unknown. Furthermore, asymmetric fittings have not yet been studied in listeners with more severe hearing loss. The purpose of this investigation was to evaluate asymmetric directional fittings for listeners with severe hearing loss in complex listening environments. Adult listeners with severe sensorineural hearing loss were tested with a complex localization / memory task and a sentence recognition task. Participants were fitted with behind-the-ear instruments for use during testing. All testing was completed in a reverberant environment in the presence of background noise. Sentence recognition scores, word recall scores, localization accuracy, and localization speed were analyzed using parametric statistics. Consistent with previous findings, the results suggest that listeners with severe hearing loss can achieve significant benefit from directional microphone technology. Furthermore, symmetrical microphone settings may not be necessary to optimize sentence recognition, memory, or localization performance in this population.

Poster #17 – AMP11

Spatial Monitoring of Complex Speech by Hearing Aid Users

Julie Cohen, AuD; Danielle Zion, AuD; Hector Galloza, MS; Douglas Brungart, PhD, Walter Reed National Military Medical Center, Bethesda, MD
Sridhar Kalluri, PhD, Starkey Hearing Research Center, Berkeley, CA

In realistic environments, listeners are often aware of changes from multiple sound sources both within and outside the focus of attention. While it is known that hearing impaired listeners are at a disadvantage in these types of tasks, and that use of amplification at least improves audibility, it is not known whether use of a hearing aid can better preserve localization information that is necessary for such spatial awareness. The purpose of this experiment is to investigate to what extent different style hearing aids may change the hearing impaired listener's performance in a complex speech localization task. Sentences were presented from multiple speaker locations from an array of 26 loudspeakers located in a spherical pattern, and listeners were asked to identify the loudspeaker location where any of the following changes in the sound scene might occur: addition or removal of a talker, or change in talker identity (e.g., gender). Additionally, a headtracker worn by listeners recorded their head movements throughout testing. Binaural hearing aid users and normal hearing listeners will be tested in this experiment. Results are presented in terms of angular error for the number of simultaneous sources, with and without hearing aids.

Poster #18 – AMP12 **Mentored Student Research Poster Award**

Effects of Nonlinear Frequency Compression on Cortical Potentials and Perception

Benjamin Kirby, AuD; Paul Abbas, PhD; Carolyn Brown, PhD, University of Iowa, Iowa City, IA

Nonlinear frequency compression can be used to increase the audibility of speech sounds for hearing aid users with high frequency hearing loss. However, excessive compression ratios may reduce spectral

contrast between sounds and negatively impact speech perception. This is of particular concern in infants and young children, who may not be able to provide feedback about frequency compression settings. This study explores use of objective cortical auditory evoked potentials in the verification of frequency compression parameters. We recorded auditory change complex (ACC) cortical responses in 10 normal hearing adult listeners to a spectral ripple contrast stimulus processed with a range of frequency compression ratios (1:1 to 4:1). Vowel identification, consonant identification, speech recognition in noise (QuickSIN), and behavioral ripple discrimination thresholds were also measured under identical frequency compression conditions. While no significant relationship of compression ratio and vowel identification was found, repeated measures ANOVAs revealed significant effects of compression ratio on ACC amplitude, consonant identification, ripple discrimination threshold, and QuickSIN scores. These results indicate that the ACC response, like perceptual measures using speech and non-speech sounds, is sensitive to frequency compression ratio and may be useful as an objective outcome measure in young hearing aid users.

Poster #19 – AMP13

Aided Evoked Potentials: Effects of Stimulus Onset and Signal-to-Noise Ratio

Ingyu Chun, PhD; Kelly Tremblay, PhD; Christi Miller, PhD, University of Washington, Seattle, WA
Curtis Billings, PhD, Portland VA Medical Center, Portland, OR

There is interest in using cortical auditory evoked potentials (CAEPs) clinically to estimate aided thresholds and verify hearing aid gain. A potential confound however is that CAEPs have been shown to be sensitive to signal-to-noise ratio (SNR) and stimulus onset modifications that result from hearing aid signal processing. Our approach is to equate SNRs across unaided/aided conditions by adding hearing aid noise to the unaided signals, leaving only stimulus onset to vary across conditions. We hypothesized that neural response effects due to hearing-aid-induced onset modifications would be small compared to the robust SNR effects that have been demonstrated previously. We tested 13 normal-hearing participants using a pure tone signal with hearing aid background noise at four SNRs in both unaided and aided conditions. Our results confirm that aided CAEP morphology with hearing aids is primarily driven by SNR. Results also indicate that onset-related effects with this specific hearing aid are present, but small compared to the changes in amplitude and latency that are seen as a function of SNR. These results confirm that the combined use of CAEPs and hearing aids introduce variables, such as SNR, that complicate the verification of hearing aid gain. NIH/NIDCD 1R01DC012769

Poster #20 – AMP14

Masking Release for Children with Hearing Loss using Amplified

Marc Brennan, PhD; Ryan Mccreery, PhD; Dawna Lewis; Judy Kopun, MA; Patricia Stelmachowicz, PhD, Boys Town National Research Hospital, Omaha, NE

Masking release was measured in children with hearing loss (HL) with amplification and it was determined if working memory predicted masking release. Masking release in children with HL could depend on the audibility of the signal during dips in the masker level. Previous studies did not apply amplification, therefore the diminished masking release observed in listeners with hearing loss may have been due to reduced audibility compared to children with normal hearing (NH). This study measured masking release in children (n=42) and adults (n=38) with NH and HL. Speech was amplified with slow and fast amplitude compression using a hearing-aid simulator. Working memory was assessed using the digit span test. Adults (NH, HL) demonstrated masking release but children (NH, HL) did not; suggesting that amplification improves audibility during the dips and adults with HL are better able to take

advantage of the signal during the dips than children with HL. Listeners with better working memory demonstrated more masking release with slow compression than listeners with poorer working memory. Working memory did not predict masking release with fast compression. These findings indicate that working memory supports speech recognition when audibility is compromised with slow compression.

Poster #21 – AMP15

Health Behavior Change in Adults with Hearing Impairment

Melissa Frederick, AuD; Gabrielle Saunders, PhD; Shienpei Silverman, MS, National Center for Rehabilitative Auditory Research (NCRAR), Portland, OR
Ariane Laplante-Lévesque, PhD, Eriksholm Research Centre

Successful hearing aid rehabilitation depends to a large extent on people's beliefs about hearing disability and hearing aids (Knudsen et al. 2010). This study examines models of Health Behavior Change commonly used in health psychology and their application to adults seeking hearing help for the first time. This study focuses on the Health Belief Model (Rosenstock 1966) and the Transtheoretical Model (Prochaska & DiClemente 1983). It investigates the utility of these two theories in describing Health Behavior Change in terms of hearing aid uptake.
Over 50 adults with hearing impairment who were seen for the first time by an audiology clinic in Oregon completed questionnaires to measure their Health Beliefs and Attitudes. This was assessed using the Health Belief Questionnaire (targeting the Health Belief Model: Saunders et al, 2013), and the University of Rhode Island Change Assessment (targeting the Transtheoretical Model: McConnaughy et al, 1983). They also completed the Hearing Handicap Inventory, Psychosocial Impact of Hearing Loss and a demographics questionnaire. Relationships between Health Behavior Beliefs and Attitudes profiles at baseline and findings from the background questionnaire will be presented. The applicability of the health behavior theory to help seeking help and acquiring hearing aids will be discussed.

Poster #22 – AMP16

Speech Recognition in Noise with Four Remote Microphone Technologies

Krishna Rodemerk, AuD; Jason Galster, PhD, Starkey Hearing Technologies, Eden Prairie, MN

The inability to understand speech in noisy environments is a common complaint amongst hearing aid wearers and as such, hearing aid manufacturers have developed accessories to improve the signal-to-noise ratio in these difficult listening situations. The aim of this presentation is to highlight the findings of a recent study that evaluated the behavioral performance of four remote microphone systems. Each of these four systems used a different protocol for wireless audio transmission. The primary research question addressed in this comparative evaluation was: Do four different remote microphone systems provide equivalent improvements in speech recognition in noise, when compared to hearing aids alone? Sixteen participants with mild-to-severe sensorineural hearing loss were fit with three different bilateral sets of hearing aids. Data collected from real-ear measurements and the Hearing in Noise Test (HINT; Nilsson et al., 1994) will be reported.
The results of objective testing are consistent with previously documented remote microphone performance trends. Participants showed significantly improved speech recognition in noise when comparing remote microphone listening and listening with hearing aids only. With limited exceptions, differences in performance among the four remote microphones were not significant.

Poster #23 – AMP17

Social Support Predicts Hearing Aid Satisfaction

Gurjit Singh, PhD, Phonak Ag, Toronto, Canada
Sin-tung Lau, Toronto Rehabilitation Institute
Kathy Pichora-Fuller, PhD, University of Toronto Mississauga, Mississauga, Canada

The goal of the current research was to determine if and how well perceived social support predicts hearing aid satisfaction. In Study 1 (n = 173, mean age = 68.0 years, SD = 13.4) and Study 2 (n = 169, mean age = 32.4 years, SD = 13.1) adult owners of hearing aids completed self-report measures assessing perceived social support, hearing aid satisfaction, hearing handicap, personality, and other factors. In both studies, perceived social support was found to be significantly correlated ($r = 0.34$, $r = 0.48$, $ps < 0.001$, respectively) with hearing aid satisfaction. The results of a regression analysis revealed that in both studies perceived social support was the best predictor of hearing aid satisfaction. The results from Study 1 provide quantitative evidence to suggest that perceived social support is a significant predictor of satisfaction with hearing aids, a finding that was replicated in Study 2. Importantly, a significant relationship was observed between perceived social support and hearing aid satisfaction in both studies, even though the composition of the two samples differed in terms of age, relationship status, income, proportion of individuals with unilateral versus bilateral hearing impairment, and lifetime experience with hearing aids.

Poster #24 – AMP18
Acceptable Noise Levels and Words-in-Noise as Predictors of Hearing-Aid Success
Sherri Smith, PhD, VA Medical Center, Mountain Home, TN
Richard Wilson, PhD, VA Medical Center, Phoenix, AZ
Anna Nabelek, University of Tennessee, Knoxville, TN

Speech-in-noise performance may be an important indicator of hearing-aid success. The Acceptable Noise Level (ANL) quantifies the background noise level (BNL) a listener accepts while following running discourse presented at the most comfortable listening level (MCL), ANL = MCL -¬ø BNL, The Words-In-Noise (WIN) test quantifies the 50%-recognition point words presented in babble. This study examined the relation between ANL and WIN performances in aided and unaided conditions and determine how well unaided ANL and WIN predicted hearing-aid success. 120 veterans with bilateral hearing aids participated. After verification of hearing-aid function and fit, unaided and aided ANL and WIN were administered at 0¬∞ azimuth. Self-report measures and the Pattern of Hearing Aid Use question were administered. The mean ANLs were 15.5 dB (unaided) and 13.5 dB (aided); the mean WIN 50% points were 14.4 dB S/N (unaided) and 12.6 dB S/N (aided). Correlations showed no relation between ANLs and WIN thresholds. Unaided ANL was not significantly correlated with any (sub)scale on any self-report measure but unaided WIN thresholds were significantly correlated with at least one (sub)scale score on each self-report measure. At best, unaided ANLs predicted hearing-aid success with 43% accuracy and unaided WIN thresholds with 63% accuracy.

Poster #25 – AMP19 **T35 Research Trainee Poster**
Adaptation of the International Outcome Inventory for Hearing Aids (IOI-HA)
Jessi Middaugh, The Ohio State University, Columbus, OH
Gabrielle Saunders, PhD; Melissa Frederick, AuD; Shienpei Silverman, MA, National Center For Rehabilitative Auditory Research, Portland, OR

The International Outcomes Inventory for Hearing Aids (IOI-HA) is a hearing aid outcome measure that has been widely adopted by audiologists to assess outcome and the VA has adopted it as the preferred

outcome measure for demonstrating efficacy of hearing aid intervention. The purpose of this study was to determine whether assessing IOI-HA outcomes for listening in quiet versus in noise results in a more sensitive tool. The seven domains were evaluated using two scales. Results indicated that quiet and noise conditions reveal significantly different results, and outcomes are affected by lifetime hearing aid use and unaided hearing difficulties.

Poster #26 – AMP20

Amplification Benefits in Adults: Systematic Review Update Including Digital Devices

Carole E. Johnson, PhD; Anna Marie Jilla, MA, University of Oklahoma Health Sciences Center, Oklahoma City, OK
Jeffrey Danhauer, PhD, University of California Santa Barbara, Goleta, CA

Over 10 years ago, an American Academy of Audiology Task Force conducted a systematic review (SR) with meta-analysis on Health-Related Quality of Life (HRQoL) Benefits of Amplification in Adults. That SR was conducted when mainly analog devices were available. Mean effect sizes (ESs) and confidence intervals for within-subject designs and disease-specific instruments suggested that hearing aids had small-to-medium impacts on HRQoL. Between-subject studies supported at least a small effect for generic measures, and medium-to-large effects for disease-specific measures that hearing aids had positive impacts on adults' HRQoL. The advent of advanced digital hearing aids warranted an update (from 2004 to 2014) of the original SR, which we conducted using the same methodology applying search strings (including new ones reflecting digital devices) to the same (i.e., PubMed and other relevant) databases. The updated SR produced additional articles that met criteria for meta-analysis to strengthen data from the initial SR. After adjusting for publication bias, ESs resulted in a continued positive recommendation of hearing aids to improve HRQoL. Unfortunately, lack of use of rigorous experimental designs and HRQoL outcome measures in studies still continue to preclude determining if advanced digital hearing aids result in increased HRQoL over analog technology.

Poster #27 – AMP21

Effects of Hearing Impairment on Primary Communication Partners

Rebecca Kamil; Frank Lin, MD, Johns Hopkins University, Baltimore, MD

BACKGROUND: Hearing impairment is prevalent in older adults and can affect a hearing-impaired person's (HIP) daily activities. The impact of hearing impairment may have collateral effects on the HIP's primary communication partner (PCP; e.g. spouse, close family member, or caregiver).
DESIGN: We conducted a systematic review of manuscripts examining the consequences of hearing impairment in a HIP on the PCP. We searched PubMed, Embase, Scopus, PyscINFO, CINAHL Plus with full text, and Web of Science for peer-reviewed articles using a pre-defined search string and hand-searched reference lists of relevant articles. Descriptive information on study populations, hearing assessments, outcome metrics, and conclusions were extracted from full-length manuscripts.
RESULTS: Of the 1,047 abstracts retrieved from database searching and 4 hand-searched articles, 23 articles met inclusion criteria. These articles included observational clinical studies, randomized clinical trials, and epidemiologic studies. Overall, PCPs experienced a restricted social life, increased burden of communication, and poorer quality of life (QOL) and relationship satisfaction. Effects of hearing impairment in the HIP on PCP mental health were unclear. Treatment of hearing impairment in the HIP tended to improve these metrics.
CONCLUSIONS: This review highlights the broad effects of hearing impairment and the importance of involving PCPs in treatment decisions.

Poster #28 – AMP22

Advanced Digital Hearing Aids for Mild Losses: Benefit and Satisfaction

Carole E. Johnson, PhD; Anna Marie Jilla, MA, University of Oklahoma Health Sciences Center, Oklahoma City, OK
Jeffrey Danhauer, PhD, University of California Santa Barbara, Goleta, CA
Bettie Borton, AuD, Doctors Hearing Clinic, Montgomery, AL
Sarah Kate Fisher, Auburn University, Auburn, AL

Although audiologists recommend that patients with mild sensorineural hearing loss (MSNHL) pursue amplification to prevent its insidious effects, what benefit and satisfaction these patients should expect to receive from amplification, particularly costly advanced digital technology (ADT), remains unknown. We conducted a systematic review with meta-analysis searching PubMed and other relevant databases through fall 2013. Only 10 articles met inclusion criteria (i.e., > level III of evidence, including patients with MSNHL, and reporting outcomes for them). Data from five studies were suitable for meta-analysis, which after adjusting for publication bias, yielded a moderate effect size indicating significant benefit from hearing aids, but mostly from analog devices. We also measured outcomes from ADT fit to patients at two clinics from 2006-2010. Forty-five of 138 respondents had MSNHL; they tended to be younger, first-time users who paid as much for, and achieved similar benefit from and satisfaction with their ADT devices as those with moderate and severe SNHL. In some areas, patients with MSNHL fared even better with ADT than those with severe impairment. Linear regression showed similar predictor variables for patient success across degrees of SNHL. Findings have implications for rehabilitation and planning clinical trials of ADT for patients with MSNHL.

Poster #29 – AMP23

Self-Stigma Associated to Hearing Loss and Ageism in Older Adults

Jean-Pierre Gagne, PhD; Tony Leroux; Luc Dargia, University De Montreal, Montreal, Canada
Martine Lagace, University of Ottawa, Ottawa, Canada

A qualitative research design was used to obtain the perceptions of older adults concerning self-stigma associated with hearing loss and auto-ageism. The participants were 37 older adults, with or without hearing loss, who lived in Qu√©bec, Canada. Data collection consisted of a semi-structured interview during which the following topics were broached: (1) their general health, (2) society's view of aging, (3) their own perception of aging, (4) society's view of hearing loss associated with aging, and (5) their own view of hearing loss associated with aging. The interviews were recorded and transcribed. A content-analysis of the transcriptions provided information on seven main themes: hearing loss, hearing loss stigmatization, self-stigma associated with hearing loss, aging, ageism, auto-ageism and social identity. In addition, several profiles emerged from the analyses. For some older adults aging did not have a negative effect on their social identity. Some older adults displayed self-stigma associated with their hearing loss. Yet another group of older adults experienced auto-ageism which had a deleterious effect on their self-image. In some cases, hearing loss was perceived as one marker of aging and loss of autonomy. The implications of the findings for audiologic rehabilitation will be discussed.

Poster #30 – AMP24

Exploring Strategies for Telling Others About Hearing Loss

Jessica West, Massachusetts Eye And Ear Infirmary, New York, NY
Jacob Low, MD, University of Manchester, Manchester

Konstantina Stankovic, MD, PhD, Massachusetts Eye and Ear Infirmary, Boston, MA

The decision-making processes involved in disclosing hearing loss (HL) have been little studied. 331 people completed a 15-question survey instrument that explored the variables and specific phrases that adults (>18 years of age) with HL of any etiology consider when deciding whether or not to disclose their HL. Survey responses were analyzed across participants' objective characteristics as recorded in their medical records, including current age, sex, and audiologic scores. We find that HL disclosure phrases fall into one of three categories: multipurpose disclosure (phrases that disclose the HL and provide information to facilitate communication), basic disclosure (phrases that disclose HL through the term, a label, or details about the condition), or nondisclosure (phrases that do not disclose HL). Multipurpose disclosers tended to be female, have worse pure tone averages and word recognition scores, and a worse self-identified degree of HL. Basic disclosers were predominantly male, 18-40 years old, and diagnosed with a mixed HL. Non-disclosers were mostly over 61 years of age, diagnosed with a bilateral HL, and received a diagnosis at the age of 75 or older. Our results suggest specific disclosing strategies that can benefit individuals with HL, and impact their treating clinicians and society at large.

Poster #31 – AMP25

Auditory and Working Memory Training: Assessing the Real World Benefits

Melanie Ferguson, PhD; Helen Henshaw, PhD, Nihr Nottingham Hearing Biomedical Research Unit, Nottingham, UK

For home-based training interventions to benefit people with hearing loss (PHL), any task-specific learning needs to transfer to functional benefits in real-world listening. A randomised controlled trial (RCT) of n=44 adults with mild sensorineural hearing loss (SNHL) showed significant on-task learning for a phonetic-discrimination task ($p<.001$), and generalisation to improvements in self-reported hearing ($p<.05$), working memory ($p<.05$) and divided attention ($p<.01$), with the greatest improvements in complex conditions. No improvements were shown for speech-in-noise.
A second study of existing hearing aid (HA) users (n=33) trained on a phonetic-discrimination-in-noise task, showed on-task learning ($p<.001$) generalised to post-training improvements in competing-speech ($p<.05$) and a dual-task of speech perception and memory ($p<.01$), with the greatest improvements in challenging listening conditions. Findings suggest that outcome measures should be sensitive to the cognitive effects of training, and set at a challenging level.
An ongoing double-blind RCT assessed benefits of Cogmed RM working memory training directly in n=54 existing HA users with mild-moderate SNHL (to date, 54 recruited). Trained task performance and generalisation of on-task learning to untrained measures of listening, cognition and communication will be assessed. Findings will help inform the most effective training modality (auditory vs. cognitive) for PHL.

Poster #32 – AMP26 **Mentored Student Research Poster Award**

Audiomotor Training Enhances Neural and Perceptual Salience of Noise-Corrupted Signals

Jonathon Whitton, AuD, Massachusetts Institute of Technology, Boston, MA
Kenneth Hancock, PhD; Daniel Polley, PhD, Harvard Medical School

All sensory systems face the fundamental challenge of encoding weak signals in noisy backgrounds. Though perceptual sensitivity can improve with practice, these benefits rarely generalize to untrained stimulus dimensions. Inspired by recent findings that action videogame training can impart a broader spectrum of benefits than traditional perceptual learning paradigms, we trained adult humans and mice

in an immersive audiogame that challenged them to forage for hidden auditory targets in a two-dimensional soundscape. Both species learned to modulate their angular search vectors and target approach velocities based on real time changes in the level of a weak tone embedded in broadband noise. In humans, mastery of this tone in noise task generalized to an improved ability to comprehend spoken sentences in speech babble noise. Neural responses in the auditory cortex of trained mice exhibited an improved coding of low-intensity sounds at the training frequency with an enhanced resistance to interference from background masking noise. These findings highlight the potential to improve the neural and perceptual salience of degraded sensory stimuli through immersive computerized games.

Poster #33 – AMP27

Do Combination Instruments Reduce the Effects of Tinnitus?

Harvey Abrams, PhD, Starkey Hearing Technologies, Eden Prairie, MN
Melissa Frederick, AuD; Susan Griest; James Henry, PhD, National Center for Rehabilitative Auditory Research, Portland, OR

Purpose: The purpose of this study was to examine the efficacy of a combination device designed to reduce the disturbing effects of tinnitus.
Methods: Thirty individuals were randomized into a hearing aid + sound therapy (experimental) or hearing aid alone (control) group. The Tinnitus Functional Index (TFI) was administered at baseline and again at 3 months post-fitting.
Results: Repeated measures ANOVA was used to compare between groups and conditions. The mean reduction in the TFI at 3 months post-fitting of 32.9 points (with hearing aids) and 16.2 points (without hearing aids) were both significant ($p<.0001$ and $p=.002$, respectively). Comparing groups, there were no significant differences in mean TFI scores between groups at baseline, 3 months with hearing aids, and 3 months without hearing aids.
Conclusions: Both groups of participants revealed significant improvement based on reductions in mean TFI scores, indicating that hearing aids alone or hearing aids plus sound generators provided significant benefit for alleviating the effects of tinnitus. The experimental group, however, showed a mean reduction in the TFI that was 8.6 points greater than the control group. This difference approached significance ($p=.09$), suggesting that a larger group of participants may have resulted in a significant difference between groups.

Poster #34 – AMP28 **T35 Research Trainee Poster**

A New Perspective on Tinnitus Pitch Matching

Garnett McMillan, PhD; James Henry, PhD; Emily Thielman, MS; Kristyn Wypych, BS, VA Medical Center (NCRAR), Portland, OR

Many patients with tinnitus have reported benefit from acoustic therapy. For many of these therapies, it is necessary to identify the frequency, or frequency range, of the tinnitus percept. To date, no clinical method of tinnitus pitch matching has been shown to provide repeatable pitch matches (PMs), including our own computer-automated Tinnitus Evaluation System (TES). It is known that repeating PMs increases the precision of the match. However, different numbers of repeated PMs are needed for different people. We therefore are evaluating a Bayesian approach to this problem whereby clinicians collect as many PMs as needed to achieve the desired level of precision. Using the TES, 10 subjects each provided 30 consecutive PMs. Using Bayesian statistics, it was determined how many PMs would be needed for each subject to achieve the desired level of precision. 70% of subjects reached the desired

precision level around 15 PMs, although 30% never achieved the desired level of precision and a reliable PM could not be determined.

PSYCHOACOUSTICS / HEARING SCIENCE

Poster #35 – PSY01 **T35 Research Trainee Poster**

Auditory Motion Perception of Sound Source Acceleration and Deceleration

Carol Pang, AuD; Wesley Grantham, PhD; Daniel Ashmead, PhD, Vanderbilt University, Nashville, TN

Introduction: Auditory motion perception is used for everyday activities such as street crossing by pedestrians, and is especially important for persons with visual impairments. However, the research literature on auditory perception of spatial acceleration/deceleration is limited. Therefore, this study investigated thresholds for discriminating acceleration versus deceleration at different velocities and points of closest approach. The effectiveness of cues related to direction and sound level were also considered.
Methods: Six normal hearing young adults were tested in an anechoic chamber. The sound source (gaussian noise) moved on a simulated horizontal linear path in front of the participant. Discrimination thresholds were obtained for 8 selected combinations of four average velocities (2, 4, 8, 16 m/s) and three distances of the sound source at its closest approach to the listener (1, 3, 9 m).
Results: Thresholds increased linearly across velocity, and also increased across distances of closest approach at the same average velocity.
Conclusions: The ability to distinguish between acceleration and deceleration worsens at higher velocities and farther closest approach. Based on the sound level and direction cues that occurred at threshold values, listeners may use both cues to discriminate acceleration and deceleration.

Poster #36 – PSY02 **Mentored Student Research Poster Award**

Temporal Aspects of Binaural Interference

Jacqueline Bibee, University of Washington, Seattle, WA
G. Christopher Stecker, PhD, Vanderbilt University, Nashville, TN

Binaural interference refers to reduced sensitivity to a binaural ¬øtarget¬ø cue in the presence of a competing ¬øinterferer¬ø stimulus at a distant frequency. This decreased sound localization ability affects how listeners navigate complex auditory scenes. Aims of this experiment were to investigate binaural interference for three temporal patterns of interaural differences carried by 4kHz Gabor click trains and determine which temporal conditions (if any) are more immune to interference. Targets contained an interaural level difference (ILD) or interaural time difference (ITD) cue at sound onset, offset, or both. Interferers were 500 Hz tones presented simultaneously but with zero interaural differences. Preliminary analyses show binaural interference for both ITD and ILD conditions with most subjects, but not all. For ITD, sounds lacking onset cues were more affected by binaural interference than those that had usable onset cues. In ILD conditions, some subjects experienced similar amounts of interference when onset and offset cues were compromised, whereas others demonstrated a cue preference in avoiding interference. Individual differences in these trends were substantial, though patterns were generally consistent with demonstrations of interaural onset and offset salience for ITD and ILD detection, respectively. Thus, temporal features appear to impact the amount of binaural interference experienced.

Poster #37 – PSY03
Release from Retention Interference for Acoustic Duration
Meghan Smith; Margaret Tomko; Dennis Ries, PhD, Ohio University, Athens, OH
Danielle Gadd, AuD, Miracle Ear, Peoria, IL

Listener retention of stimulus duration was studied. Measures of difference-limen-for-duration (DLD) between standard and comparison stimuli were obtained for intervals with and without intervening-noise bursts, including an intervening condition with a localization cue. The DLD was significantly higher when intervening sounds were present, but a localization cue mitigated the interference. General interference results are in keeping with those reported for pitch, loudness, and timbre retention, but not for retention of gap length. Release from interference with a location cue is akin to that reported for pitch. Overall, the behaviorally-measured ramifications of retroactive interference on duration retention are more similar to those reported for pitch than for another temporal-based attribute, namely gap length.

Poster #38 – PSY04 **Mentored Student Research Poster Award**
Categorical Loudness Scaling and Equal Loudness Contours in Individuals with Hearing Loss
Jessa Gombert; Lauren Liebig Trehearn; Daniel Rasetshwane, PhD; Stephen Neely; Judy Kopun, MA; Michael Gorga, PhD, Boys Town National Research Hospital, Omaha, NE

The percept of loudness may be one factor that influences satisfaction with hearing aids for patients with sensory hearing loss. These individuals often experience loudness recruitment that causes loudness to grow at an abnormally rapid rate. This study describes categorical loudness scaling (CLS) data from 79 subjects with mild-to-severe hearing loss. The CLS functions varied systematically with degree of hearing loss. The CLS data were used to provide estimates of gain that would be expected to restore normal loudness in subjects with hearing loss. The data were converted into phons (a measure of loudness level) and plotted as equal-loudness contours (ELC) organized according to the magnitude of hearing loss at each frequency. When data analyses are complete, the ELCs will be compared to ELCs from normal-hearing subjects (see companion poster, Liebig et al., 2014). It is expected that ELCs will vary systematically as a function of hearing loss, much as the CLS functions do. The CLS functions provide descriptions of loudness growth in hearing-impaired subjects, and we expect that the ELCs will also provide descriptions of loudness in these subjects as well. These data may provide a framework for selecting gain characteristics for hearing aids in efforts to normalize loudness.

Poster #39 – PSY05 **Mentored Student Research Poster Award**
Categorical Loudness Scaling and Equal Loudness Contours in Individuals with Normal Hearing
Lauren Liebig Trehearn; Jessa Gombert; Daniel Rasetshwane, PhD; Stephen Neely; Judy Kopun, MA; Michael Gorga, PhD, Boys Town National Research Hospital, Omaha, NE

The sensation of loudness is subjective and can be difficult to quantify. Methods such as magnitude estimation, magnitude production, and cross-modality matching are time consuming and lack ecological validity. Categorical loudness scaling (CLS) circumvents these problems, but has been criticized because it uses an arbitrary, categorical scale. The reliability of the measurements has also been questioned. CLS measurements might be accepted if they are shown to be reliable and could be converted into a standard unit of loudness level, such as the phon, which is defined as the loudness level of tones equal in loudness to a 1000-Hertz (Hz) tone at a specific level in dB SPL. The goals of this study were to demonstrate the reliability of CLS measurements and to describe a technique in which CLS data can be converted into

phons. To this end, CLS data were collected from 60 subjects with normal hearing. These data were converted into phons (a measure of loudness level) and plotted as equal-loudness contours (ELC). Results indicate that the measurements are reliable and provide a normative reference for loudness perception that might be useful in studies focused on loudness perception in subjects with hearing loss (see Gombert et al., 2014).

Poster #40 – PSY06 **Mentored Student Research Poster Award**
Specific Coupling Can Affect Perceived Loudness in Insert Earphones
Kristen D'Onofrio, MA; Todd Ricketts, PhD, Vanderbilt University, Nashville, TN
Stephen Ambrose, Asius Technologies

Previous data have demonstrated that lower in-ear sound levels are necessary for non-occluding (open) earphones to provide the same loudness as measured from an occluding earphone for low frequency sounds. The purpose of this study was to evaluate the relative loudness perception provided by fully occluding commercial insert earphones and a new modification of these devices. The modification consisted of membrane covered venting. This configuration greatly reduces the low frequency output loss associated with traditional venting. Normal hearing listeners were asked to balance the loudness of four different signals between one modified and one unmodified earphone. Two different commercially available earphones were evaluated and all testing was completed using a fully crossed design. Results demonstrated that a reduction in sound level of approximately 4 to 7 dB for the modified earphones led to matched loudness with the unmodified earphones. There was considerable variability across listeners, but when averaged across frequency and earphone brand, all individuals demonstrated an advantage ranging from 1 to 11 dB. These data demonstrate a magnitude of advantage similar to that previously reported for open earphones. In contrast to these previous results, however, the advantage was present across all frequencies tested.

Poster #41 – PSY07 **Mentored Student Research Poster Award**
Development and Verification of a Two-Interval, Forced-Choice Infant Behavioral Testing Procedure
Jenna Browning; Emily Buss; Lori Leibold, The University of North Carolina at Chapel Hill, Chapel Hill, NC

Current behavioral methods used to test infants in the clinic and in the laboratory can be influenced by response bias of the listener and/or the examiner. Visual Reinforcement Audiometry provides some control for examiner bias in the clinic when control trials are used, but does not account for listener bias. A single-interval, observer-based procedure controls for examiner bias in the laboratory (Olsho et al., 1987), but listener bias remains a potential issue. Infant-adult differences in listener bias limit age group comparisons for adaptive-threshold estimates. The purpose of this study was to develop and validate a two-interval forced-choice (2IFC) infant psychophysical test procedure. Infants (7- 9 months) and young adults were tested to determine the number of trials required to achieve a criterion of 80%-correct detection of a 50-dB SPL noise band presented in quiet. All 16 subjects (8 infants, 8 adults) reached criteria in a single testing session, with infants requiring an average of 12.5 trials (range = 8-14 trials). Fewer trials were needed to reach the criterion than reported in previous studies using a single-interval procedure. These results suggest that using a 2IFC procedure is feasible and efficient while also controlling for both examiner and listener response bias.

Poster #74 – PSY08
Effects of Age, Hearing Impairment and Efferent Feedback on Overshoot

Skyler G. Jennings, PhD, Department of Communication Sciences and Disorders, The University of Utah, Salt Lake City, UT
Jayne B. Ahlstrom, MS; Judy R. Dubno, PhD, Department of Otolaryngology-Head And Neck Surgery, Medical University of South Carolina, Charleston, SC

The detection of a short sinusoidal probe in simultaneous masking improves as the probe's onset is delayed from the masker's onset. This "overshoot" may be mediated by the medial olivocochlear (MOC) reflex, whose pathway includes spiral ganglion neurons (SGNs), olivocochlear neurons and the outer hair cells (OHCs). Overshoot was measured in younger adults with normal-hearing (YNH), older adults with normal hearing (ONH), and older adults with hearing loss (OHI) to test the hypothesis that overshoot decreases as components in the MOC reflex pathway are compromised. Thresholds measured when the probe was near the masker's onset showed large differences across listeners, resulting in appreciable individual differences in overshoot. Activity from the MOC reflex is likely absent near the onset of the masker. This suggests that, while the MOC reflex may be responsible for overshoot, individual differences in overshoot are not related to varying degrees of MOC reflex strength among listeners. Overshoot was significantly reduced in older adults, but only those with hearing loss, which is consistent with overshoot depending primarily on the status of the OHCs and only minimally influenced by age-related reductions in SGNs.

Poster #75 – PSY09
Impacts of Aging on the Central Auditory System
Sean Kampel, AuD; Frederick Gallun, PhD; Michelle Molis, PhD; Serena Dann, AuD; Nirmal Kumar Srinivasan; Sam Gordon, BSEE; Kasey Jakien, BA; Dawn Konrad-Martin, PhD, National Center for Rehabilitative Auditory Research (NCRAR), Portland, OR

One of the main contributing factors to declines in speech understanding ability associated with aging is hypothesized to be degraded temporal processing at varying levels in the auditory system. Reduced auditory nerve output, temporal jitter in auditory brainstem nuclei and impaired cognition may contribute to imprecise encoding of auditory signals leading to poorer performance in real world hearing-in-noise situations and in tests of binaural hearing ability. The ability to separate sounds sources and to use spatial and spectrotemporal cues is critical for hearing in noise, probably the most difficult listening task for all listeners. We investigated the effects of age and hearing sensitivity by asking seventy-eight listeners to perform a set of monaural and binaural temporal processing tasks, and sixty-nine listeners to perform a set of tests of spatial release from masking over headphones and in an anechoic chamber. The analysis explores the independent contributions of age and hearing loss to performance on these tests, as well as the relationships among tests and the impacts of individual listener variables on performance. Results support the hypothesis that aging, independent of an individual's hearing threshold, can result in changes in the cortical and/or subcortical structures essential for spatial hearing and temporal encoding.

Poster #76 – PSY10
Spatial Release from Masking in Reverberant Environments for Elderly Listeners
Nirmal Kumar Srinivasan, PhD; Frederic Gallun, PhD; Sean Kampel, AuD; Samuel Gordon; Kasey Jakien, National Center for Rehabilitative Auditory Research (NCRAR), Portland, OR

It is well documented that elderly listeners have more difficulty in understanding speech as compared to young listeners in reverberation and multi talker environments. Spatial release from masking in

simulated reverberant listening environments is measured in this experiment. Virtual acoustic methods were used to simulate four reverberant listening environments (reverberation times (T60) of 0, 0.25, 0.50, and 0.75 seconds). Single channel reverberant signals were presented from loudspeakers in an anechoic chamber. Release was measured by comparing threshold target-to-masker ratios obtained with a target sentence presented from directly ahead of the listener and two masking sentences presented in one of three spatial configurations: collocated with the target, or symmetrically separated by 300 or 600. Performance in two reverberant listening conditions was compared: a "blocked" condition where the reverberant listening environment was kept constant throughout a block of trials, and an "unblocked" condition where the reverberant listening environment was varied from trial to trial. Previous research has shown that adaptation to reverberation builds up with blocked presentation but not with unblocked presentation. Target-to-masker ratios observed in the blocked and unblocked conditions for younger listeners with normal hearing will be discussed in comparison with data from older listeners with normal and impaired hearing.

SPEECH PERCEPTION

Poster #42 – SP01 **Mentored Student Research Poster Award**

Effect of Motion on Speech Recognition

Timothy Davis, AuD; D. Wesley Grantham, PhD, Vanderbilt University, Nashville, TN

The benefit of spatial separation of talkers in a multi-talker environment is well documented. However, few studies to date have examined the effect of motion of talkers on speech recognition. Effects of (1) target and distracter location, (2) a priori information about the target and distracter spatial configurations, and (3) motion of the target or distracters were evaluated in this study. Eleven young adults with normal hearing were tested in a large anechoic chamber. Seven stimulus conditions were tested using the Coordinate Response Measure speech corpus. Results showed a significant benefit of spatial separation of talkers compared to a collocated control. Motion of the target talker was more beneficial than motion of the distracters. Performance was better when the key words were presented from zero degrees azumith than from the listener's left. A priori information about the stimulus configuration was beneficial only in two conditions. These results suggest that in the presence of distracting messages a speech target is more easily recognized when presented from the front than from the left, and that motion of either target or distracters may be beneficial for sound source segregation and thus for improved speech recognition.

Poster #43 – SP02

Sound Localization and Speech-in-Noise Abilities in Hearing Impaired Listeners

Danielle Zion, AuD; Julie Cohen, AuD; Douglas Brungart, PhD, Walter Reed National Military Medical Center, Bethesda, MD

Spatial hearing has been shown to be an important factor for understanding speech in noisy environments where there are multiple sources of sound present. Previous research has shown that individuals with hearing loss experience difficulty understanding speech in noise and may also exhibit sound localization errors. However, few if any studies have systematically examined the link between sound localization abilities and speech in noise recognition. The purpose of this study is to quantify localization ability in hearing impaired listeners and to compare their performance in sound localization tasks to speech in noise recognition. To this end, participants completed three tasks: QuickSIN, single

source localization in quiet, and single source localization in noise, where the noise was adapted to track a fixed percentage of correct loudspeaker identification. Stimuli were presented from an array of 26 loudspeakers located in a spherical pattern surrounding the listener, and azimuth error was recorded after each response. Additionally, a headtracker worn by listeners recorded their head movements throughout testing. Preliminary results indicate that listeners with hearing loss exhibit greater difficulty localizing sounds when they are of shorter duration and relatively low intensity, as compared to normal hearing listeners. Planned analyses will investigate the relationship between a listener's SNR loss and localization ability, both in quiet and in noise.

Poster #44 – SP03
Importance of High Frequencies on Speech Recognition With and Without Visual Cues
Amanda Silberer, PhD, University of Iowa/Western Illinois University, Iowa City, IA
Ruth Bentler, PhD; Yu-hsiang Wu, PhD, University of Iowa

In a randomized crossover design, speech recognition of children and adults was assessed using speech perception tests that were low-pass filtered and presented in quiet and noise. Three research questions were posed: How do visual cues impact the frequency bandwidth necessary for optimizing speech recognition performance? How does the speech material affect the necessary bandwidth? How does age affect the necessary bandwidth? The speech materials consisted of The Multimodal Lexical Sentence Test (MLST), presented in auditory-only and in auditory-visual modalities, and the University of Western Ontario Plurals Test and the Maryland CNC, which were both presented in an auditory-only format. Results across 60 subjects (30 adults, 30 children) were analyzed using a repeated measure analysis of variance (ANOVA). There were a number of significant findings: Adults and children require significantly less bandwidth as the speech material becomes more representative of real-world listening. This is especially true when visual cues are present. The minimum bandwidth required for optimal performance outcomes data suggest that current hearing aid bandwidth is adequate for most listeners.

Poster #45 – SP04 **Mentored Student Research Poster Award**
Word Recognition in Competing Backgrounds: Effects of Development and Hearing
Nicole Corbin, AuD, The University of North Carolina at Chapel Hill, Chapel Hill, NC
Emily Buss, PhD; Angela Bonino, PhD, The University of North Carolina at Chapel Hill, Department of Otolaryngology/ Head and Neck Surgery, Chapel Hill, NC
Lori Leibold, PhD, Division of Speech and Hearing Sciences, The University of North Carolina at Chapel Hill, Chapel Hill, NC

The goals of this experiment were to: (1) determine the age at which children with normal hearing demonstrate adult-like word recognition in the presence of speech-shaped noise or two-talker speech and (2) examine the influence of hearing loss on children's susceptibility to masking in these conditions. Children are more susceptible to auditory masking than adults, and the time course of development for masked word recognition differs according to masker type. While speech recognition in the presence of speech-shaped noise is mature by early adolescence, speech-on-speech recognition follows a more prolonged time course of development, still undefined. These effects appear to be exacerbated for children with hearing loss (e.g., Leibold et al. 2013). In the present study, children (5-17 years old) and adults (18-32 years old) with normal hearing, and children with bilateral sensorineural hearing loss (7-15 years old) were tested. Listeners completed an open-set monosyllabic word recognition task in the presence of speech-shaped noise or two-talker speech. Mature speech recognition was confirmed by late adolescence in the two-talker speech, and at a significantly earlier age in the speech-shaped noise.

Hearing loss reduced children's performance in both maskers, with the largest reduction observed for younger children in the two-talker masker.

Poster #46 – SP05 **T35 Research Trainee Poster**
Effects of Looking Behavior on Understanding in a Simulated Classroom
Shannon Wannagot, University of Connecticut, Storrs, CT
Dawna Lewis, PhD, Boys Town National Research Hospital, Omaha, NE

Elementary-age students are commonly involved in listening tasks that require attention to multiple talkers in classrooms with poor signal-to-noise ratios (SNR) and prolonged reverberation times (RT). The effort to locate talkers and listen may consume cognitive resources negatively impacting learning. The purpose of this study was to evaluate the effects of looking behavior on the performance of children and adults with normal-hearing during a simulated classroom learning task conducted in an acoustic environment typically found in school classrooms. Forty children (ages 8-11 years) and 10 adults completed two listening tasks with instructed looking behavior. All subjects listened to a short play read by a teacher and four students reproduced on LCD monitors and loudspeakers and sentences spoken by a single talker quasi-randomly presented from five loudspeakers. Results from 39 children (ages 8-11 years) and 20 adults from previous studies without required looking were included to compare performance across listeners. All subjects wore a gyroscopic head tracker to record looking behavior. Results revealed that 11-year-olds and adults performed more poorly when required to look, compared to previous subjects in the same age groups without required looking. Scores in the sentence recognition task were not affected by required looking behavior.

Poster #47 – SP06 **T35 Research Trainee Poster**
Consonant Recognition in Noise for Bilingual Children with Normal Hearing
Megan Espinosa, University of Maryland, College Park, Severn, MD
Kanae Nishi, PhD, Boys Town National Research Hospital, Omaha, NE

Background noise has a greater impact on speech communication for bilinguals than for monolinguals. However, previous research has focused on adults and little is known how noise influences on speech development in bilingual children. The present study investigated the effects of noise and vowel context on consonant recognition for 32 highly fluent Spanish-English bilinguals (6-13 year olds) with normal hearing. Listeners heard vowel-consonant-vowel nonsense syllables (17 consonants in /i ae a u/ contexts) in four conditions (0, 5, 10 dB SNR, and quiet). Results suggested that, similar to monolingual English listeners: 1) bilinguals¬ø performance improved with age; 2) performance was poorer in the /i/ and /u/ contexts than in the /a/ and /ae/ contexts. Additionally, bilinguals' performance was significantly poorer than that of monolinguals at 0 and 5 dB SNRs. Analyses also suggested significant influence of language background, listener age, vowel context, and listening condition on the perception of place, manner, and voicing cues. Interestingly, although no difference was observed between bilinguals and monolinguals in quiet, interaction among vowel, language, and condition was significant for manner and voicing cues, suggesting that language background and listening condition interact with phonological differences between languages in a complex manner.

Poster #48 – SP07
Dynamic Range of Speech Materials in Korean, English, and Mandarin
In-Ki Jin, MS; James Kates, MS; Kathryn Arehart, PhD, University of Colorado at Boulder, Boulder, CO

The purpose of this study is to identify whether differences in dynamic range are evident across the spoken languages of Korean, English, and Mandarin. Recorded sentence-level speech materials were used as stimuli. Dynamic range was quantified using different definitions of dynamic range (that is, what defines the maximum and minima), for several integration times (from 1ms to 512ms) and in different frequency bands. The signal envelope was computed in each of 21 critical bands having center frequencies ranging from 150 to 8600 Hz. The results show that changes with dynamic range definition and integration time were similar across the three languages but that dynamic range in specific frequency bands differed. Specifically, dynamic range of English was wider than the dynamic range of Korean and Mandarin in high frequency areas (above 4000 Hz). The results of this study may be applicable to deriving band-audibility functions of the Speech-Intelligibility Index (SII, ANSI, 1997(R2007)) and the application of the SII in fitting hearing aids for different languages.

Poster #49 – SP08

Rise-Fall Shape Characteristic and Locations of Interruptions in Interrupted Words

Richard Wilson, PhD, VA Medical Center, Phoenix, AZ

The effects of two variables on the intelligibility of interrupted words were studied (rise-fall shape of the on-segment and the temporal location of the interruptions in the words) using 10 ips, 50% duty cycle, and 100% modulation depth characteristics. Word onset was used to define the complementary halves of the modulated signal (Huggins, 1964) that included unshaped and shaped (4-ms, cosine squared) onsets and offsets. 12 listeners with normal hearing and 12 listeners with sensorineural hearing loss participated. 70 NU No. 6 words were studied. The 280 test words (70 words, 2 complementary halves, 2 rise-fall shapes) were randomized for each listener and recorded on CD along with 25 additional practice words. The listeners with normal hearing performed 10-15% better than the listeners with hearing loss. There was no significant differences between the unshaped and shaped rise-fall characteristics for either group of listeners, which indicates rise-fall shape is not an important variable. Performance on one complementary half was better than on the other half by 17% (normal) and 12% (hearing loss), both of which were significant differences [$F(1,69) = 66.4$, $p<.001$; $F(1,69)=20.1$, $p<.001$]. These results indicate that the temporal placements of the interruption pattern have a significant impact on intelligibility.

Poster #50 – SP09

Word Placement and Sentence Context Impact Vowel Recognition in Noise

Janine Wotton, PhD; Andrea Blom, Gustavus Adolphus College, St Peter, MN

The influence of sentence context on the recognition of naturally spoken vowels slightly degraded by Gaussian noise (3 dB) was investigated. Target words were paired to have similar consonant sounds but different vowels (e.g. ¬øpig/peg¬ø) and were embedded in sentences which provided congruent, incongruent or neutral semantic context. All participants did multiple trials with the three different contexts. Participants were randomly assigned to listen to stimuli with the target word placed either at the beginning (n=17), middle (n =16) or end (n=17) of the sentence. Placement impacted vowel recognition with the most errors for end, followed by middle and least for beginning. The reaction time for correct responses was quicker than for errors and all responses were quicker when the target was at the end compared to other positions. The incongruent context produced the most errors followed by neutral with fewest for congruent, however this was strongly affected by interaction with placement. Only the target at the end group showed a significant improvement in error rate for congruent compared

to neutral. Both the amount and type of semantic context impact the speed and accuracy of vowel recognition.

Poster #51 – SP10
Effects of Linguistic Background and Noise on Vowel Duration Perception
Harisadhan Patra, PhD; Petula Vaz, PhD; Natalie Greenholt, Bloomsburg University, Bloomsburg, PA

Vowel duration is a phonemic feature in American-English but not in Spanish. Native American-English speakers perceive and produce differences in vowel-length. Native Spanish speakers may not perceive and/or produce differences in vowel length consistently when they use American-English. It may be hypothesized that native American-English listeners would find vowel-length features difficult to perceive in native Spanish speakers, more so in noise. To test the above hypothesis, ten normal-hearing native American-English-speaking listeners, aged 18 ¬ø 30 years, were recruited. One native American-English and Spanish speaker recorded 54 CVC words containing six vowels (/i, √Æ/, /u, √õ/, /a, √¢/). Listeners were presented these words randomly in quiet and in four-talker babble bilaterally at 65 dB SPL. Noise levels were varied to achieve +3, 0, -3, -6 dB signal-to-noise ratio (SNR). Results revealed that listeners had significant difficulty in vowel perception when spoken by Spanish speakers. A decrease in SNR resulted in poorer perception, especially in the poorer SNR conditions. The implications of this study will be discussed further.

Poster #52 – SP11 **Mentored Student Research Poster Award**
Cognition and Speech Perception in Older Normal Hearing Listeners
Stacey Samuels-Cole, MA; Sandra Gordon-Salant, PhD, University of Maryland College Park, College Park, MD

Purpose: To determine if differences in working memory span and speech recognition in noise among older listeners are related.
Research Design: A randomized block design was used to compare speech recognition performance of younger and older participants with high and low working memory.
Study Sample: 28 older normal-hearing listeners (ONH) aged 61 through 75 years and 25 young normal hearing listeners (YNH) aged 18 through 25 years.
Data Collection and Analysis: Neurocognitive tests (working memory and processing speed) and speech recognition tests in noise were presented. Correlational analyses examined the association between cognitive scores and speech recognition performance. Regression models identified the auditory and cognitive factor(s) most strongly associated with speech recognition performance.
Results: ONH listeners with high working memory exhibited lower SNRs than those with low working memory. Significant negative correlations between verbal WM span and SNRs for speech stimuli were revealed, even when verbal processing speed, hearing sensitivity and age were controlled.
Conclusion: ONH listeners with low working memory are more susceptible to signal distortions caused by background noise and this increased susceptibility should be considered in the selection of appropriate audiological remediation techniques.

Poster #53 – SP12
New Insight Regarding Psychometric Functions of Dual-task Paradigms
Yu-Hsiang Wu, PhD; Ashely Bahr; Elizabeth Stangl, University of Iowa, Iowa City, IA

Dual-task experiments, which require the listener to simultaneously perform a speech recognition task and a secondary task, have been widely used to quantify listening effort. The purpose of this study was to characterize the psychometric functions, which describe the performances of the speech recognition task and the secondary task as a function of signal-to-noise ratio (SNR), for younger adults with normal hearing. Two visual reaction-time tasks with different difficulty levels were used as the secondary task and the reaction time (RT) was used to quantify the performance. The results indicated that RT did not increase monotonically as SNR became lower (poorer) and as speech performance became worse. That is, the psychometric functions of the secondary task were not simple reverse-sigmoid shapes mirroring speech recognition performance. Instead, the secondary task psychometric functions were peak-shaped. As SNR decreased, the RT initially increased and then decreased. The SNR corresponding to the peak of the function was dependent on the difficulty level of the secondary task. These findings demonstrate the complicated relationship between speech recognition performance and listening effort, and suggest that researchers need to be cautious when selecting the test SNR in dual-task experiments. (Work supported by NIH/NIDCD R01DC012769 and ASHFoundation.)

Poster #54 – SP13 **Mentored Student Research Poster Award**

Interaction of Working Memory, Compressor Speed and Background Noise Characteristics

Barbara Ohlenforst, MS; Pamela Souza, PhD, Northwestern University, Evanston, IL
Ewen Macdonald, PhD, Technicial University of Denmark, Lyngby

Previous studies have shown that individuals with poor working memory perform worse in speech recognition tests when fast compression release time is applied. However, it is not clear why this effect occurs only when modulations are present in the background noise. This study explored the relationship between working memory capacity, compression release time and characteristics of the background noise. This relationship is important to understand because the majority of everyday listening situations involve modulated noise. The investigation was carried out by testing two groups of older adults with similar degrees of mild-to-moderate sensorineural loss but different working memory abilities. The two groups were tested in their ability to understand a speech signal presented within a modulated background noise, processed with slow and fast compression. The extent of background noise modulation was varied. Results suggest that the combined effect of short compression release times, a low working memory capacity and glimpsing due to presence of amplitude modulation results in poor speech recognition performance. There was no interaction between working memory and different noise backgrounds, with the poor working memory group demonstrating susceptibility to fast compression in all background noise conditions. [Supported by NIH]

Poster #55 – SP14

Auditory Working Memory under Varying Perceptual and Cognitive Loads

Sarah Olson; James Shehorn; Nicole Marrone, PhD; Mary Alt, PhD; Gayle DeDe, PhD, The University of Arizona, Tucson, AZ

Understanding speech in background noise draws on perceptual and cognitive resources, such as working memory. However, it is unclear how variables that affect perceptual and cognitive load interact. To begin to examine this interaction, we investigated whether manipulations of perceptual and cognitive load influenced performance on verbal working memory tasks. Participants were young native English speakers with normal hearing. We varied perceptual load by presenting stimuli in quiet or speech-spectrum-shaped noise. Participants completed two working memory tests with different cognitive loads. In alphabet span, participants repeated word lists of increasing length after rearranging them in

alphabetical order. In subtract 2 span, participants repeated number lists of increasing length after subtracting two from each. Pilot data show that alphabet span is more demanding than subtract 2 span, possibly because the stimulus pool is larger (i.e., all words vs. digits 2-10). Preliminary analyses reveal reduced auditory working memory performance for both the more cognitively demanding task (alphabet span) and at more difficult signal-to-noise ratios. The effect of noise appears to be greater in alphabet span than subtract 2 span, suggesting a strong interaction between perceptual and cognitive task demands even in a young adult population with normal hearing.

Poster #56 – SP15
How Does Level of Perceptual Processing Affect Audiovisual Integration?
Kaylah Lalonde, Indiana University, Bloomington, IN
Rachael Frush Holt, PhD, Ohio State University, Columbus, OH

Adults show audiovisual benefit to speech perception across levels of processing (detection, discrimination, identification), but the relationship between level of perceptual processing and audiovisual integration has not been defined. Twelve adults with normal hearing will complete auditory-only and audiovisual measures of speech detection, discrimination, and identification. All tasks use the same stimuli (22 auditory and audiovisual monosyllabic words from the Lexical Neighborhood Test in speech-shaped noise) and experimental paradigm (two-interval forced choice); thus, the three tasks differ only in the level of perceptual processing required to complete them, allowing evaluation of the effects of increasing the level of perceptual processing on speech performance under unimodal and multimodal conditions. Adaptive staircase procedures will be used to determine the 71% threshold signal-to-noise ratio (SNR) for auditory-only detection, discrimination, and identification. Then, the 71% threshold SNR for auditory-only detection will be used to test auditory-only and audiovisual detection, discrimination, and identification (equating SNR across all conditions) and the 71% auditory-only threshold SNR for each task will be used to test on the corresponding task in auditory-only and audiovisual conditions (equating auditory-only difficulty across tasks). Preliminary analyses suggest that multimodal speech is more robust to increases in perceptual processing demands than auditory-only speech.

Poster #57 – SP16 **T35 Research Trainee Poster**
Reverberation and Listening Effort for Listeners with Normal Hearing
Erin Picou, PhD; Todd Ricketts, PhD, Vanderbilt University, Nashville, TN
Julia Gordon, University of Pittsburgh, Bridgeville, PA

The purpose of this study was to investigate the effect of reverberation on listening effort for listeners with normal hearing. Nineteen participants were evaluated using a dual task paradigm to measure objective listening effort. Three levels of reverberation were tested: mild (RT60 < 100 ms), moderate (RT60 = 650), and high (RT60 = 1200 ms). In each of these levels, listening effort in quiet and in noise was assessed via the dual-task paradigm. The primary task was monosyllable word recognition and the secondary task was a physical reaction time based on a button push. Participants were instructed to respond if the word presented was a noun. Longer reaction times were taken as an indication of increased listening effort. The level of the background noise, when present, was varied individually for each participant as a function of level of reverberation so that listening effort could be evaluated with constant word recognition performance, constant reverberation, and constant signal-to-noise ratio (SNR). The results suggest that background noise consistently negatively affected listening effort.

Conversely, reverberation did not affect effort in any condition. The study found that noise affects listening effort more than reverberation for listeners with normal hearing.

Poster #58 – SP17
The Effect of Multi-talker Babble on Dual Task Performance
Jaclyn Hellmann; Nicole Marrone, PhD; Daniel Bos, University of Arizona, Tucson, AZ

Multitasking in background noise may involve greater cognitive processing demands than multitasking in quiet due to an increase in listening effort (Rabbitt, 1968; Pichora-Fuller and Schneider, 2000). This study explored the influence of background noise on the capacity of individuals to function when multitasking. A dual-task paradigm was used based on theories of attentional limitations that state that the ability to perform multiple discrete tasks is limited based on a finite pool of resources that can be allocated among tasks or mental operations (Broadbent, 1958; Kahneman, 1973; Pashler & Johnston, 1998). Twenty native English speakers between 19-25 years of age participated in the experiment. All had pure-tone thresholds within normal limits in both ears. Participants were required to perform two tasks concurrently and in isolation (visual serial recall and word recognition). Multi-talker babble was presented, through loudspeakers, in spatially separated as well as collocated conditions. As compared with single task performance in quiet, background noise and multitasking degraded performance on both tasks. Results indicate that background noise can have negative effects on the ability to multitask. Preliminary data collected on older adults with hearing loss will also be presented.

Poster #59 – SP18
Effects of Aging and Spectral-Shaping on Brainstem Differentiation of Consonants
Dania Rishiq, PhD, Starkey Hearing Technologies, Eden Prairie, MN
Ashley Harkrider, PhD; Mark Hedrick, PhD, University of Tennessee Health Science Center, Knoxville, TN

Objectives: To determine if (1) aging affects brainstem differentiation of stop consonant sounds and (2) spectrally-shaped gain applied to the place of articulation cue (i.e. F2 formant transition) reduces any aging effects.
Subjects: 11 older adults with "near-normal" to normal hearing; 16 younger controls.
Methods: Psychometric functions were generated to assess behavioral identification of 15-step perceptual unshaped and shaped /b-d-g/ continua. Speech- ABRs were recorded for three 100-ms /b-d-g/ CV exemplars in unshaped and shaped conditions, for a total of 6 stimuli.
Findings: Older listeners showed robust categorical perception, and subtle age-related brainstem changes. However, individual data of older adults, when compared to that of controls, showed weaker latency-distinctions among the /b-d-g/ brainstem responses, especially for speech-ABR major peaks. Additionally, spectral-shaping improved the stop consonant differentiation scores for major peaks in older listeners, such that it moved older adults in the direction of the younger adults¬ø responses.
Conclusion: Results indicate that aging reduces the brainstem responsiveness to dynamic spectral cues. Further, the enhancement of the F2 transition cue seems to diminish the age-related deficits detected at the sub-cortical level. Hence, spectral-shaping may reduce the listening effort of older listeners and free up their sub-cortical resources for other tasks.

Poster #60 – SP19
Visual and Auditory Phonetic Context Effects in Persons with Hearing Loss
Sheila Pratt, PhD, University of Pittsburgh and VA Pittsburgh Healthcare System, Pittsburgh, PA
Min Zhang, MS, University Of Pittsburgh, Pittsburgh, PA

Lindsey Jorgensen, PhD, University of South Dakota, Vermillion, SD

Purpose: This study sought to determine if categorical perception along the /r/ - /l/ acoustic continuum is influenced by auditory vs. a visual /b/ contexts, and if the effect differs by of high-frequency hearing loss and audibility.
Methods: Synthesized VCV syllables representing the /r/ to /l/ continuum (i.e., /ara/ - /ala/) were presented to 44 adult normal-hearing listeners and 11 listeners with high-frequency sensorineural hearing loss. With each trial the participants were asked to indicate whether the consonant within the syllable was an /r/ or an /l/. These syllables were presented binaurally and then monaurally with the syllable /aba/ presented in the opposite ear to assess the influences of phonetic context. The /ara/-/ala/ syllables also were presented with a visual /aba/ displayed on a computer monitor. The normal hearing listeners were administered all three conditions with and without high-frequency amplification, whereas the normal hearing listeners completed the conditions with and without high-frequency simulated hearing loss.
Categorical boundary and the identification function slopes were established and a within-subject design was used to assess differences across the acoustic and visual phonetic contexts, hearing status and audibility.
Results: Auditory and visual context effects were documented and diminished by hearing loss and reduced audibility.

Poster #61 – SP20 **Mentored Student Research Poster Award**
Development of a Pediatric Vowel Discrimination Task
Sadie Schwarz; Lauren Calandruccio, PhD, The University of North Carolina, Chapel Hill, NC
Emily Buss, PhD, The University of North Carolina, Chapel Hill, Department of Otolaryngology/Head and Neck Surgery, Chapel Hill, NC

Intelligibility of connected discourse strongly relies on vowel information for adult listeners (Fogerty & Humes, 2012). To better understand the importance of vowels in young children, an easy to administer, pediatric vowel discrimination task is needed. Closed-set, picture pointing paradigms such as the Word Intelligibility by Picture Identification (WIPI; Ross & Lerman, 1970) are effective for pediatric word discrimination tasks (ASHA, 2012). Most WIPI word sets share a vowel but vary in the initial and/or final consonant, such that discrimination relies on consonant information. The goal of the current project was to develop a companion test to the WIPI that relied on vowel information. The task includes monosyllabic words arranged in sets of three. The words within each set vary only by the central vowel and are within the lexicon of a typically developing young child. Words are separated into three lists that are balanced for vowel articulation (i.e., position of tongue and degree of lip rounding) and word frequency. Preschool children easily identified the images and audio recordings that were created to depict the words. Data on the recognition of the word sets in noise for normal-hearing children will be presented.

Poster #71 – SP21
Effects of Aging and Hearing on a Time-Compressed Speech Test
Michelle Molis, PhD; Serena Dann, AuD; Frederick Gallun, PhD; Sean Kampel, AuD; Dawn Konrad-Martin, PhD, NCRAR, PVAMC, Portland, OR
Oded Ghitza, PhD, Boston University, Boston, MA

The reductions in speech understanding ability observed in older listeners are often attributed to declines in temporal processing that occur with age. These reductions are further exacerbated by hearing

loss and the presence of background noise. To better understand the effects of age and hearing sensitivity on speech intelligibility, listeners varying in age and hearing were presented with time-compressed speech in quiet and a steady-state speech-shaped background noise (SNR +5). Listeners identified the final four digits of seven-digit strings presented at three uniform compression ratios (2:1, 3:1, and 5:1). In additional conditions, the total duration of the compressed stimuli was expanded by the insertion of periodic gaps at two rates. Performance was near ceiling and uncorrelated with age or hearing loss for unprocessed conditions in quiet and in noise. As expected, increased time compression together with the presence of background noise impaired performance for all listeners. For these conditions, significant relationships were observed with age and hearing loss, especially at the highest compression rates. Partial correlations indicate the significant relationship with age is maintained for high compression rates even after controlling for hearing loss. The effects of time compression were somewhat mitigated through the introduction of periodic gaps.

Poster #72 – SP22

Aging and the Effect of Response Time Limitation on Speech Understanding

Karen Helfer, PhD; Angela Costanzi; Sarah Laakso, University of Massachusetts, Amherst, MA

Most studies of speech understanding allow participants to take a relatively long time to respond. Results of these studies likely underestimate the difficulties that older adults face in real life, where they must keep up with the flow of conversation. The present experiment incorporated response time limitation in order to examine the influence of imposing time constraints on the processing of auditory information. Participants were younger, middle-aged, and older adults. Pairs of sentences were presented from a loudspeaker located in front of the listener. Subjects were instructed to repeat the two key words in the sentence beginning with ¬øTheo¬ø (the competing sentence began with a different name). On half of all trials, listeners were given an unlimited amount of time to respond. On the other half of trials, subjects were cued (via a visually-displayed symbol) that they had four seconds to complete their verbal response, after which any responses made were scored as incorrect. Participants also completed a battery of cognitive tests. This poster will show results of analyses that focused on identifying differences among participant groups in the effect of response time limitation and associations of this effect with hearing loss and cognitive abilities (work supported by NIH DC012057).

Poster #73 – SP23

Effects of Talker Accent and Age on Recognition of Multisyllabic Words

Sandra Gordon-Salant, PhD; Grace Yeni-komshian, PhD; Peter Fitzgibbons, PhD, University of Maryland, College Park, MD
Julie Cohen, AuD, Walter Reed National Military Medical Center, Bethesda, MD

The effect of accent on recognition of words of varying syllable number by younger and older listeners was investigated. It was hypothesized that with increments in syllable number, there would be atypical alterations in syllable stress in accented compared to native English, and that these altered stress patterns would be sensitive to auditory temporal processing deficits with aging. Sets of 1-, 2-, 3-, and 4-syllable words with the same initial syllable were recorded by one native English speaker and two Spanish-accented speakers. Lists of these words were presented in isolation and in sentence contexts to younger and older normal-hearing listeners and to older hearing-impaired listeners. Hearing loss effects were apparent for unaccented and accented monosyllabic words, whereas age effects were observed for recognition of accented multisyllabic words, consistent with the notion that altered syllable stress patterns with accent are sensitive to aging. Older listeners also exhibited lower recognition scores for

moderately accented words in sentence contexts than in isolation, suggesting that the added demands on working memory for words in sentence contexts impact recognition of accented speech. The general pattern of results suggests that hearing loss, age, and cognitive factors limit the ability to recognize Spanish-accented speech.

VESTIBULAR

Poster #68 – VEST01

Correlations Between Unilateral Centrifugation Testing And Ocular Vestibular Evoked Myogenic Potential Testing

Chris Zalewski, PhD; Carmen Brewer, PhD, NIH – NIDCD, Bethesda, MD
R. Steven Ackley, PhD; M. Diane Clark, PhD, Gallaudet University, Washington, N.E., DC
Devin Mccaslin, PhD, Vanderbilt University - Bill Wilkerson Center, Nashville, TN
Wendy Hanks, PhD, Pacific University, Hillsboro, OR

Within the last decade, significant advancements have been made toward the clinical assessment of utricular function; specifically, through ocular vestibular evoked myogenic potentials (oVEMP) and unilateral centrifugation (UCF) testing. To date, no study has examined intra-subject relationships between these measures. The purpose of this study was twofold. The first was to determine the normal response characteristics of oVEMP and UCF. The second was to investigate the existence of intra-subject correlations between each test. The study hypothesis was that intra-subject responses from oVEMP and UCF testing would be correlated inasmuch as both tests assess utricular function.
Correlational analyses of data obtained from 30 healthy volunteers, aged 18-42, failed to reveal any significant relationships between oVEMP and UCF responses suggesting these tests might be inciting different response properties within an individual's utricular system. Various anatomical / physiological differences within the utricle, in addition to the fundamental differences in stimulus properties between the oVEMP and UCF tests, could explain the lack of significant correlations and further suggest that oVEMP and UCF testing may be complimentary in the evaluation of the utricular system. These data reinforce the complexities of the utricular system and provide further insight into the difficulties encountered in its clinical assessment.

Poster #69 – VEST02

Characterizing Nonorganic Balance Performance in Patients with Anxiety and/or Depression

Brittany Dowling; Ashley Zaleski, MS; Madalyn Rash; Matthew Wester, AuD; Laurie Davis, AuD; Jamie Bogle, PhD; Michael Cevette, PhD, Mayo Clinic, Scottsdale, Arizona, Scottsdale, AZ

Patients with psychological conditions including anxiety and depression often report chronic dizziness and imbalance. While these patients often demonstrate appropriate vestibular function, as measured by VEMPs, VNG, and calorics, functional balance may be impaired. When inconsistencies are noted between reported symptoms/functional balance and objective measures, these individuals are often classified as having nonorganic balance performance. It is hypothesized that these disorders may significantly influence a patient's self-perceived balance ability.
Patients with nonorganic balance dysfunction (Mallinson & Longridge, 2005), but otherwise normal vestibular test findings, were identified through retrospective chart review. Balance function was measured using a NeuroCom EquiTest. Anxiety and depression self-report measures (GAD-7, PHQ-9) were documented from the time of testing. These standardized tools were reviewed to determine which

patients were referred for psychological evaluation, and the final diagnosis was documented. Patients with nonorganic balance performance were categorized according to GAD-7 and/or PHQ-9 scores. The aim of the present study was to 1) assess the prevalence of patients with nonorganic balance dysfunction, 2) analyze this subset of patients for comorbid psychological disorders in the absence of identifiable vestibular dysfunction, and 3) compare the final diagnoses of this population to those patients without self-reported anxiety and/or depression

Poster #70 – VEST03

Analysis of the Relationship Between Gait and Postural Motor Control

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Emily Nairn-jewell, AuD, University of Michigan Health System, Ann Arbor, MI

Previous research at our center had demonstrated a link between motor control abnormalities and gait abnormalities. This investigation was to further evaluate the relationship between the type of motor control abnormalities and gait changes. The spatial and temporal aspects of balance were evaluated by both computerized posturography motor control and a computerized gait assessment system.
A retrospective review was performed in 60 patients (23 male, 37 female) who had both motor control abnormalities on posturography and had performed computerized gait analysis. Motor control variables investigated were medium and large forward and backward translations. The gait measures included cadence, stride length, velocity, double support, and a global functional ambulation performance score (FAP).
The results indicated that those persons with abnormal backward translations on motor control tests were more likely to have abnormal gait scores. Persons with abnormal forward translations did not necessarily have abnormal gait scores. In particular, backward abnormalities showed significant changes in velocity, double support, cadence and FAP. But forward movement abnormalities were significantly related only to cadence changes.
These findings suggest that motor control posturography and gait analysis provide both related and independent information regarding balance assessment, further contributing to a more comprehensive clinical evaluation of balance patients.

PHYSIOLOGY: MIDDLE EAR AND COCHLEA

Poster #77 – PHYS01

Compensation for Probe Insertion Depth in Wideband Acoustic Ear-Canal Measurements

James Lewis, PhD; Sara Fultz; Daniel Rasetshwane, PhD; Judy Kopun, MA; Michael Gorga, PhD; Stephen Neely, Boys Town National Research Hospital, Omaha, NE

Ear-canal absorbance (A) is often considered to be independent of the distance between the probe and eardrum. However, changes in the diameter of the canal along this distance may alter the absorbance measurement, especially at high frequencies. The goals of the current study were (1) to quantify the effects of probe-insertion depth (PID) on absorbance and (2) to develop a method to reduce PID effects. Ear-canal pressure measurements through 20 kHz were made in 14 normal-hearing subjects at two probe-insertion depths (¬ø2 mm apart). A sound source with known The¬øvenin-equivalent characteristics allowed absorbance to be calculated from these pressure measurements. PID effects at frequencies below 5 kHz were small; the change in absorbance between the measures (¬øA) was

typically less than 0.05. Between 5 - 10 kHz, ¬øA ranged from 0.1 - 0.15. Above 10 kHz, ¬øA often exceeded 0.3. An impedance transformation based on an ear-canal model removed reflections associated with (1) changes in ear-canal diameter and (2) eardrum stiffness. As a result of this transformation, ¬øA was reduced at frequencies through 10 kHz. Removal of reflections due to ear-canal geometry may allow for more reliable clinical diagnosis based on measurements of ear-canal absorbance.

Poster #78 – PHYS02

Modeling Average Versus Individual Human Middle Ear Data

Lucia Schnetzer; Robert Withnell, Indiana University, Department of Speech and Hearing Sciences, Bloomington, IN

Zwislocki's circuit model of the middle ear (1962) has been used, in original or modified form, in many subsequent studies modeling the ear (e.g., Kringlebotn, 1988; Goode et al. 1994; O'Connor & Puria, 2008). This model represents the acoustic input impedance of the average human middle ear. By modeling the average human middle ear rather than a number of individual middle ears, important features of the middle ear may be under-described or not included. A model of the acoustic input impedance of the ear, incorporating the ear canal as a uniform transmission line, with a circuit model that included the middle ear cavities, eardrum coupling to the ossicular chain, and the cochlea as an RC circuit, was fit to acoustic input impedance data from healthy human ears. It was found that the multiple resonances of the middle ear are not well described by Zwislocki's model, and that an assumption of only one mode of sound transmission to the middle ear (Fay et al., 2006) is adequate to describe individual data.

Poster #79 – PHYS03

Improved Bandwidth Acoustic Probe for OAE Measurements with FPL Calibration

Noori Kim, MS; Jont B. Allen, PhD, UIUC, Champaign, IL

The ER10C is a probe that is widely used in research and clinical settings to make ear canal otoacoustic emission (OAE) measurements. Following the probe's Theveinin calibration, OAE stimuli are calibrated to have constant forward pressure levels (FPL). Here we report on a new OAE probe developed by Mimosa Acoustics which extends the upper frequency limit of the ER10C by one octave, from 6 kHz to approximately 12 kHz. The wider bandwidth Thevenin pressure and admittance for the new probe will be compared to that of the ER10C. The new system may be used for wideband reflectance (FPL calibrations), Tympanic membrane admittance estimates, and iso-FPL OAE level measurements.

Poster #80 – PHYS04

Reflectance Measurement Validation Using Acoustic Horns

Daniel Rasetshwane, PhD; Stephen Neely, Boys Town National Research Hospital, Omaha, NE

Wideband acoustic reflectance (and absorbance) measurements have been suggested for clinical diagnosis of middle-ear disorders. Reflectance measurements are also required for sound-level calibration in the earcanal in terms of the forward-propagating component of the pressure wave. However, better methods are needed to validate reflectance measurements. A reflectance standard would not only encourage consistency across different measurement systems, it could also facilitate identification of problems with equipment and data analysis. Theoretical equations exist for the reflectance of finite-length exponential, conical and parabolic acoustic horns. Reflectance measurements were repeatedly made in each of these horn shapes and the results were compared to the corresponding theoretical reflectance. There was good agreement between measured and theoretical reflectance in the

frequency-domain and better agreement in the time-domain. Agreement was also observed between actual horn diameters and estimated diameters obtained from measured reflectance by recently-published inverse-solution method. The good agreement between measured and theoretical reflectance of horns, especially in the time domain, suggests that the distributed reflectance of acoustic horns may be useful for validating reflectance measurements made in human ear canals. [Work supported by the NIH].

Poster #81 – PHYS05

Long Term Variability of Distortion-Product Otoacoustic Emissions (DPOAEs) in Children

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Distortion-product otoacoustic emissions (DPOAEs) may provide early detection of ototoxicity in young children receiving chemotherapy treatment, in whom it is difficult to obtain reliable behavioral hearing thresholds. Treatment may be ongoing for several months. However, there is a lack of information regarding the long-term variability of DPOAEs measured in young children not undergoing treatment, providing no way for determining when DPOAE change is clinically significant. Our purpose is to provide normative data for DPOAE level shifts over time obtained in a pediatric population. DPOAEs were measured in 38 healthy children (mean age 3.2 years) with normal hearing. Subjects had on average six evaluations, every 3-4 weeks over 4-12 months. DPOAEs were recorded as DP-grams (f2 = 1453 to 10031 Hz in ¬Ω octave steps; L1/L2=65/55 dB SPL, f2/f1=1.22). DPOAE shift reference limits were deduced from a linear model of DPOAE level with baseline age, monitoring period, and f2 primary predictors. The most accurate and parsimonious model to derive DPOAE shift reference limits was selected using leave-one-out cross validation. DPOAE level shifts obtained clinically that exceed the ¬±90% reference limits do not occur in the majority of unexposed subjects by definition, and thus suggest a potential change in cochlear function.

Poster #82 – PHYS06

Relationship Between the Medial Olivocochlear Reflex, Attention, and Hearing in Noise

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The medial olivocochlear reflex (MOCR) may improve hearing in noise by modulating outer hair cell responses to sound. MOCR strength may be altered by attention. The MOCR can be indirectly measured using transient-evoked otoacoustic emissions (TEOAEs). We examined the relationship between MOCR, auditory attention, and speech perception in noise by comparing TEOAE amplitudes obtained during active and passive listening. During active listening, the subject attended to speech-in-noise (SIN) in the contralateral ear at -3 dB and -12 dB signal-to-noise ratios (SNRs). During passive listening, time-reversed SIN at -3 and -12 dB SNRs was presented to the contralateral ear. Subjects with absent MOCR (9/50) or activation of the stapedial reflex (7/50) were excluded from analysis. TEOAE amplitude changes in 7 frequency bands from 1-4 kHz were examined in the remaining 34 subjects. Two-way repeated measures ANOVAs showed no significant (¬ø = 0.01) main effects (active vs. passive listening and good vs. poor SNR) or interactions. MOCR strength (assessed by the magnitude of change in TEOAE amplitude) was not correlated with performance on the speech perception task. Results demonstrate no

measurable effect of active versus passive auditory attention on MOCR and suggest no relationship between MOCR strength and speech perception in noise.

Poster #90 – PHYS07

Effects of Oxaliplatin across Treatment on Various Auditory/Cochlear Measures

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Platinum-containing agents, such as cisplatin and carboplatin, are known to be ototoxic, affecting the basal end of the cochlea initially. Oxaliplatin, a newer platinum derivative, has not been found to be ototoxic, possibly due to a difference in cochlear uptake compared to the older drugs. However, a few case reports cite evidence that oxaliplatin is ototoxic. These case reports examined hearing only out to 8 kHz or relied on self-reports by patients. In the current study, we monitored four patients throughout oxaliplatin treatment using various auditory measures at the highest frequencies obtained for each individual. Specifically, middle ear reflectance, behavioral thresholds, spontaneous otoacoustic emissions, and distortion product otoacoustic emission (DPOAE) gross frequency (f2=16-2 kHz ; f2/f1=1.2; L1/L2=62/52 dB SPL), concentrated frequency (f2=highest frequency with present DPOAE; f2/f1=1.2; L1/L2=62/52 and L1/L2=72/72 dB SPL), level (L2=57 dB SPL, L1=27-67 dB SPL and L1=57 dB SPL, L2=12-67 dB SPL), and ratio (f2/f1=1.1-1.25; L1/L2=62/52 dB SPL) sweeps were monitored. Preliminary results indicate changes during treatment. Whether these changes are significant will be discussed on an individual basis. These high-frequency measures may be sensitive to slight changes in auditory function due to oxaliplatin.

Poster #91 – PHYS08

Using Wideband Chirp-Evoked Otoacoustic Emissions to Assess Cochlear Function

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Wideband chirp-evoked transient otoacoustic emissions (TEOAE) at one-half octave frequencies from 1-8 kHz were used to evaluate cochlear status in adults. This study is an initial step in a longer-term study to measure ototoxicity effects in patients using TEOAEs. The subjects were 19 males (mean age 43 y) and 34 females (mean age 41 y) with either normal hearing (NH) and middle ear function (N=39) or various degrees of sensorineural hearing loss (SNHL, N=14). Most subjects received a repeat test approximately 1 month after the initial test. TEOAE data were obtained at ambient pressure using a wideband research system (Interacoustics) consisting of an AT235 tympanometer, sound card (CardDeluxe), and computer using custom software. There was a flat power spectrum across frequency in the incident chirp with an average overall level measured in the ear canal of 65 dB SPL. The signal-to-noise ratio for TEOAEs averaged 7.4 dB (SD= 5.6 dB) for NH ears and 2.3 dB (SD= 1.6 dB) for SNHL ears. Mean absolute deviation between repeated tests averaged 3 dB for NH ears and 1.3 dB for SNHL ears across frequency. Results are encouraging for monitoring cochlear status using TEOAEs.
Support provided by NIH-NIDCD R01DC10202

Poster #92 – PHYS09

Wideband Acoustic Middle Ear Reflectance in Rheumatoid Arthritis

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Navid Shahnaz, AuD, University of British Columbia, Vancouver, Canada

Introdution: Rheumatoid arthritis (RA) is an autoimmune clinical entity. Sensorineural and conductive hearing loss have been reported, but the results are not in agreement. Middle ear (ME) wideband acoustic reflectance (WBR) may provide better sensitivity to subtle changes in the ossicular joint. Aim: Describe the effects of RA in ME function using WBR in addition to immittance measures, pure tone and high-frequency audiometry. Material and Methods: This research gathered data from fourteen participants ranging age from 26 to 47 years old, females, with RA, pooled into two groups: RA1 ¬ø RA for five years or less; RA2 ¬ø RA for ten years or more, seven participants each group. Immittance 226 Hz probe tone; pure tone and high-frequency audiometry and WBR were performed. Results: The mean ages for RA1 and RA2 were 38 and 39.71 years old respectively. The results compared years between both groups, the means were analyzed with Student T test. Comparison of tympanometry, acoustic reflexes, pure tone and high-frequencies audiometry didn¬øt revealed difference between groups. Comparison of WBR in both ears revealed significant difference (p value< 0.05) mostly between frequencies 250 to 400Hz. Conclusion: WBR shows evidences of possible ME alterations on RA, contributing for hearing diagnosis in these patients.

Poster #93 – PHYS10

Improvements in Cochlear Reflectance Test Performance

Sara Fultz; Daniel Rasetshwane, PhD; Stephen Neely; Judy Kopun, MA; Michael Gorga, PhD, Boys Town National Research Hospital, Omaha, NE

Cochlear reflectance (CR) is the cochlear contribution to total ear-canal reflectance. CR has theoretical advantages for cochlear modeling, which may lead to improved interpretation of cochlear status. The clinical utility of CR has been evaluated in terms of reliability and test performance in a clinical screening paradigm (Fultz et al. 2013; Rasetshwane et al. 2013). Although CR measurements were reliable and repeatable, and CR level was correlated with behavioral threshold, CR did not predict auditory status or behavioral threshold as accurately as other otoacoustic emission measurements. CR performance appeared to be linked to stimulus level and signal-to-noise ratio (SNR), suggesting directions for further developments in CR measurement and analysis methods. This study evaluated several methods for improving the quality of CR measurements. CR measurements were made in 13 participants with normal hearing and 13 with hearing loss using broadband noise stimuli. The following factors were evaluated: (1) increased averaging time, (2) a broadband noise stimulus with multiple levels, (3) data exclusion based on the presence of air leaks, and (4) data exclusion based on SNR. Results indicate that these factors improve the quality of CR measurements, and, in turn, may improve the clinical utility of CR.
[Work supported by the NIH].

Poster #94 – PHYS11 **T35 Research Trainee Poster**

Effects of Air-Leak on Ear-Canal Acoustic Absorbance

Katherine Groon, Gallaudet University, Washington, DC
Daniel Rasetshwane, PhD; Judy Kopun, MA; Michael Gorga, PhD; Stephen Neely, Boys Town National Research Hospital, Omaha, NE

Air leaks can compromise the validity and increase variability of ear-canal acoustic measurements, such as wideband acoustic admittance, absorbance and otoacoustic emissions. Methods are needed for detecting the presence of air leaks. The purpose of this study is to determine how to quantify the effects of air leaks during ear-canal probe microphone measurements and to develop objective criteria to detect their presence. To analyze the effect of air leaks, foam eartips were modified to produce calibrated air leaks of different sizes. Acoustic measurements were made in cylindrical cavities and in ear canals of 21 normal-hearing adults. Four acoustic metrics were evaluated for predicting the presence of air leaks and for quantifying these leaks: (1) low-frequency admittance phase (averaged over 0.1-0.2 kHz), (2) low-frequency absorbance, (3) the ratio of compliance volume to physical volume, and (4) the air-leak resonance frequency. Results suggest that the effect of air leaks can be significant when their equivalent diameter exceeds 0.01 inches. Low-frequency admittance phase and low-frequency absorbance were highly correlated with air leaks and may be useful for predicting air leaks.

NOISE-INDUCED AUDITORY DAMAGE

Poster #83 – NIHL01

Subtoxic Levels of Jet Fuel Result in Abnormal Auditory Function

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The U.S. Armed Services have now adopted jet propulsion fuel-8 (JP-8) as a standard fuel source and consumes over 2.5 billion gallons annually. Therefore, all military personnel who work within and around jets are at risk for exposure to JP-8. However, the ototoxic profile of JP-8 has not received much attention. In the current study, we evaluate whether low level exposures to JP-8 could be ototoxic. Long-Evans rats were used as subjects and they were divided into four experimental groups: control, noise-only, JP-8 only and JP-8+noise. A low dose of JP-8 (1000 mg/m3) was used alone or in combination with a non-damaging level of noise (85 dB). Cochlear nerve thresholds, distortion product otoacoustic emissions and cytocochleograms revealed that peripheral auditory function was not affected by the individual exposures and there was no effect when the exposures were combined. However, auditory brainstem responses revealed impaired brainstem encoding of stimulus intensity. These findings suggest that military personnel who are suffering with the effects of jet fuel exposure may be misidentified because they may exhibit normal audiograms but harbor a "hidden" brainstem dysfunction. Therefore, the current study provides a basis for further research focused on jet fuel induced ototoxicity.

Poster #84 – NIHL02 **T35 Research Trainee Poster**

Central Auditory Processing Deficits Associated with Blast Exposure: Electrophysiological Data

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Melissa Papesh, AuD; Robert Folmer, PhD; Marjorie Leek, PhD; Michele Hutter, MS; Frederick Gallun, PhD, National Center for Rehabilitative Auditory Research - Portland VA Medical Center, Portland, OR

Many Veterans have reported difficulty understanding speech in noisy environments, despite normal peripheral hearing. This may be related to exposure to high-intensity blasts and resultant damage to neural networks involved in central auditory processing. Here we report the results of two

electrophysiological tests designed to assess this processing. Test subjects were normal-hearing Veterans reporting blast exposure. P300 evoked potentials were tested using an oddball stimulus paradigm. Interaural phase difference (IPD) responses were tested using tones which shift from in-phase to out-of-phase between ears. P300 peaks had greater latencies and lower amplitudes in blast-exposed subjects compared to non-blast-exposed subjects. Further, more blast-exposed subjects than control subjects had abnormal P300 amplitudes and latencies. This may indicate that blast exposure impairs the ability of neural networks to distinguish changes in ongoing trains of stimuli. Blast exposed subjects' grand averaged waveforms showed a less robust response to the IPD phase shift than controls, indicating that blast exposure may reduce the ability to detect changes in the fine structure of sound and determine spatial sound sources. These findings suggest that blast exposure may impair central auditory processing abilities that are important to speech understanding in noise and sound localization.

Poster #103 – NIHL03

Creation of a Tool for Education in Hearing Health Worker

Andrea Lopes; Andreia Araejo; Amanda Bozza; Ewelyn Domenico; Nelfa Ferreira; Marina Panelli; Graziella Munhoz, University of Sao Paulo, Brazil

Occupational noise is considered the problem that affects the auditory system of the Brazilian worker, disrupts work, rest, sleep and communication in humans, impairs hearing and may cause or result in psychological, physiological and perhaps even pathological reactions, directly affecting the quality of life. Investment in implementation of hearing conservation programs can minimize the general health problems and hearing, as well as the occurrence of HSPLIHL, promoting a better quality of life for workers. Therefore, this study aimed to develop a multimedia tele-education materials on preventing occupational being provided by teams of professionals work referral center for health (CEREST), National Network of Integrated Healthcare Workers (RENAST) and community hearing loss in line with the objectives of CEREST. The development of the CD- ROM will help education programs provide information about hearing health risks caused by high sound pressure levels (SPL).

Poster #104 – NIHL04

Development of a Hypermedia Tool for Promoting Hearing Health Dentists

Andrea Lopes, PhD; Graziella Munhoz; Ewelyn Domenico; Amanda Bozza; Nelfa Ferreira; Marina Panelli; Lia Uieda, University of Sao Paulo, Brazil

The unknowledge of the dentists surgeon (DS) about auditory effects on health, as well as preventive measures have been discussed in recent years. The website developed provides informations about hearing health, just as the clarification of questions, addressing concepts of noise-induced hearing loss (NIHL) and its effects. OBJECTIVE: Develop a hypermedia material about prevention of NIHL for students of odontology graduation. METHOD: The development of the material followed the phases of "contextualized instructional design" suggested by Filatro and Piconez (2004). The material was applied in 10 DS formed in over 5 years, 03 Audiologists, 10 of Dental and 20 Speech pathologists, all enrolled in the last year of the graduation course, 03 web designers, 01 psychologist, 01 physical educator, 02 administrative assistant, 01 student of Journalism and 06 laymen in health. RESULTS: The www.offruido.com.br was evaluated and 100% of the sample of groups reported that the topics covered on the website were satisfactory, as the esthetic, the arrangement of topics and the importance of having a website development. CONCLUSIONS: The elaboration of the site www.offruido.com.br brought information about the knowledge level of the DS on hearing health, as well as ease of access to this information health through distance learning.

EPIDEMIOLOGY

Poster #85 – EPI01

Association of Hearing Impairment and Frailty in Older Adults

Rebecca Kamil; Frank Lin, MD, Johns Hopkins University, Baltimore, MD
Lingsheng Li, University of Oklahoma College of Medicine

BACKGROUND: Frailty is a state characterized by decreased physiologic reserve and weakness that is associated with poor health outcomes. Whether hearing impairment, which is associated with physical and cognitive decline, is associated with frailty is unknown. METHODS: We analyzed 2,109 individuals 70 years and older in the 1999-2002 cycles of the National Health and Nutrition Examination Survey (NHANES). Hearing impairment was measured by self–report (good, little trouble, lot of trouble). Frailty was defined as the presence of at least 3 of the following: 5% unintentional weight loss in the last year and/or BMI <18.5 kg/m2, slow walking speed, weakness, exhaustion, and low physical activity. Logistic regression models were adjusted for demographic characteristics, cardiovascular risk factors, hearing aid use, and health status. RESULTS: Among all individuals, self-reported hearing impairment was significantly associated with frailty in fully adjusted models (OR 1.68 [95% CI 1.00, 2.82]). Analyses stratified by gender demonstrated that this association was observed in women (OR 3.79 [95% CI 1.69, 8.51]) but not men (OR 0.85 [95% CI 0.44, 1.66]). CONCLUSIONS: In these cross-sectional analyses, self-reported hearing impairment was significantly associated with frailty in women. Further research utilizing objective hearing measures and longitudinal assessment of frailty are needed.

Poster #87 – EPI02 **T35 Research Trainee Poster**

Auditory and Cognitive Effects of Diabetes: Influence of Disease Severity

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Type 2 Diabetes Mellitus (DM) is a metabolic disease with complications that can impair auditory and cognitive function. This report describes pure-tone thresholds (0.25kHz threshold and pure-tone averages developed for low/mid- [0.5, 1, 2kHz], high- [3, 4, 6, 8kHz] and ultra-high frequencies [10, 12.5, 14kHz]), speech understanding (QuickSIN and time-compressed speech), and cognitive function (Digit Symbol Coding [DSC] and Letter-Number Sequencing subtests of the WAIS-III) in Veterans with and without DM (N=133). Groups were constructed based on indices related to glycated hemoglobin (HbA1c) levels (control, prediabetic, all DM), or whether insulin was required to manage the DM (control, non-insulin-dependent [NIDDM], insulin-dependent [IDDM]). Separate multiple linear regression models were fit to response measures. After adjusting for age, elevated pure-tone thresholds at 250Hz and low/mid-frequency PTA were associated with all DM but not prediabetes. Among diabetics, poorer thresholds were observed in IDDM compared with NIDDM groups. Additionally, decreased DSC scores were associated with IDDM after adjusting for age and hearing. Results were interpreted as indicating that premature peripheral-auditory and cognitive senescence occurs among individuals with DM; however, speech frequencies were, on average, clinically normal in our cohort and therefore not surprisingly, speech understanding was not significantly affected. Responses will be monitored longitudinally.

Poster #88 – EPI03

Association of Hearing Impairment and Hospitalization in Older Adults

Dane Genther, MD; Frank Lin, MD, PhD, Johns Hopkins University School of Medicine, Baltimore, MD
Joshua Betz, MS, Johns Hopkins University, Bloomberg School of Public Health
Sheila Pratt, PhD, VA Pittsburgh Healthcare System
Kathryn Martin, PhD, MPH; Tammy Harris, MD, MS; National Institute on Aging, Bethesda, MD
Suzanne Satterfield, MD, DrPH, University of Tennessee Health Science Center
Douglas Bauer, MD, University of California, San Francisco School of Medicine
Anne Newman, MD, MPH, University of Pittsburgh Graduate School of Public Health
Eleanor Simonsick, PhD, Intramural Research Program, National Institute on Aging, Baltimore, MD

Background: Epidemiologic studies have demonstrated that hearing impairment (HI) is independently associated with poorer cognitive and physical functioning in older adults. Whether HI is associated with broader health economic outcomes is unclear. Methods: We analyzed 12 years of longitudinal data from 2,176 older adults enrolled in the Health ABC Study to investigate the association of HI with incident hospitalization and annual rate of hospitalization. Hearing was defined as pure-tone average (PTA) of thresholds at 0.5-4 kHz in the better ear (mild HI >25-40 dB HL; moderate-or-greater HI >40 dB HL). Data on hospitalizations were gathered every 6 months by self-report and adjudicated with hospital records. Results: In models adjusted for demographics and cardiovascular comorbidities, mild and moderate-or-greater HI, respectively, were associated with a 16% (HR: 1.16, 95% CI: 1.04-1.29) and 19% (HR: 1.19, 95% CI: 1.03-1.37) increased risk of incident hospitalization compared to normal hearing. Additionally, mild and moderate-or-greater HI, respectively, were associated with a 14% (IRR: 1.14, 95% CI: 1.02-1.29) and 15% (IRR: 1.15, 95% CI: 1.00-1.33) increased annual rate of hospitalization compared to normal hearing. Conclusions: Hearing impairment is independently associated with risk of hospitalization in older adults. Understanding the basis of this association requires further study.

Poster #89 – EPI04 **Mentored Student Research Poster Award**

Racial/Ethnic and Socioeconomic Disparities in Hearing Care Among Older Americans

Carrie Nieman, MD, Johns Hopkins University School of Medicine, Dept Otolaryngology-HNS, Baltimore, MD

Although hearing impairment is prevalent in older adults and may carry implications for cognitive, social, and physical functioning, little is known about hearing health care among older minority adults. We hypothesized that racial/ethnic and socioeconomic disparities exist in hearing health care. We analyzed nationally-representative, cross-sectional data from 1,544 older adults ¬ø70 years with audiometry and hearing health care data from the 2005-06, 2009-10 National Health and Nutritional Examination Surveys. Adjusting for age and better ear speech-frequency (0.5-4kHz) pure tone average (PTA), race (OR=1.68, 95%CI 1.21-2.33, Black compared to Whites) and education (OR=1.63, 95%CI 1.05-2.52, ¬øcollege versus <high school), were associated with having a recent hearing screening. However, hearing aid use was associated with socioeconomic status (higher education, income, poverty-to-income ratios, having private insurance), and with race (Blacks OR=0.42 [95%CI 0.19-0.91] and Mexican Americans OR=0.22 [95%CI 0.06-0.74] versus Whites). In a multivariate analysis, adjusting for age, hearing loss, race/ethnicity and socioeconomic status, Blacks were not more likely than Whites to use hearing aids despite higher levels of hearing screening (OR=0.74, 95%CI 0.28-1.93). With increasing populations of older minority adults and growing evidence of the detrimental effects of hearing loss, disparities in hearing health care represent critical areas for research and intervention.

DIAGNOSTIC AUDIOLGY / OTOLOGY

Poster #95 – DX01
Audiometric Properties of Three Circumaural Earphones
Brandon Madsen; Robert Margolis, PhD, University of Minnesota, Minneapolis, MN

The aim of the study was to compare the audiometric properties of three different Sennheiser circumaural earphone models: HDA 200, HD 280 Pro, and HDA 300. Occlusion effect, and ambient noise attenuation were determined for all three earphones by making measurements on 10 normal-hearing subjects. For the HD 280 Pro and HDA 300 earphones, RETSPLs were calculated from pure-tone threshold comparisons relative to HDA 200 RETSPLs from the audiometer standard (ANSI S3.6-2010). Occlusion effect, was determined from ear-canal sound pressures produced by bone-conducted tones with the ear open and occluded by the earphone. Ambient noise attenuation was measured in the ear canal for a sound field ¬øpink¬ø noise with the ear open and occluded by the earphone. RETSPLs were successfully established for the two non-standard earphones. The HDA 200 earphones demonstrated a smaller occlusion effect and greater ambient noise attenuation than the two other models. HDA 300 earphones have the greatest sensitivity. The RETSPLs obtained in this study provide the basis for using HD 280 Pro and HDA 300 earphones for audiometric testing. (Supported by Sennheiser Electronic Corporation)

Poster #96 – DX02
The Effect of Visual Cues on Scoring of Speech Tests
Heekyung Han, MS; Robert S. Schlauch, PhD; Aparna Rao, PhD, University of Minnesota, Minneapolis, MN

During routine hearing exams, when the person being tested writes down what they heard, it does not always match what the audiologist heard when grading responses (Nelson and Chaiklin, 1970). The purpose of this study was to compare what was written down by the listener to what the audiologist heard with the use of visual cues. Testers were divided into three categories: normal hearing native speakers of English, normal hearing non-native speakers of English, and native speakers with hearing loss. Each tester assessed four normally hearing listeners. Two NU-6 lists were presented to each listener; one was scored without visual cues and one with visual cues. Lists were presented at 50 dB HL in the presence of speech noise at 0 dB SNR. Results analyzed by percentage correct phonemes and words showed improved accuracy of scores for all 3 tester groups when visual cues were used, with a substantial improvement for testers with hearing loss. The finding of errors between talkback vs writedown scoring of lists for all of the testers, even with visual cues, suggests a need for modification of the clinical word-recognition procedure in certain applications (e.g, cases of borderline disproportionate loss in word recognition).

Poster #97 – DX03
Defining and Describing Progressive Hearing Loss in Children
John Lee; Linda Hood, PhD, Vanderbilt University, Nashville, TN

This study examines methods of defining progressive hearing loss in children along with factors that affect variation among definitions. The specific question of interest relates to how much of a difference, in terms of the number of children classified as having progressive versus non-progressive hearing loss,

the specific definition used from various published sources makes. Data utilized were from clinical audiometric records of patients ranging from 1 to 21 years of age. Records from 629 patients were reviewed that yielded 369 right ear and 367 left ear audiograms that included thresholds at 0.5, 1, 2 and 4 kHz. Test results with missing frequencies and no responses were eliminated along with patients who had only a single audiometric threshold test. The number of audiograms available for individual patients ranged from 2-27. Patients demonstrating progressive SNHL were specifically analyzed using three difference methods that are recommended in the published literature. Application of each of the methods, which involved different numbers of frequencies and cut-off values for defining progression, resulted in variable numbers of individuals classified as having progressive hearing loss. Distributions and factors that may influence classification will be discussed in the presentation. [Supported by NIH-NIDCD R24DC012207]

Poster #106 – DX04

Characterizing Severe Hearing Loss

Pamela Souza, PhD; Michael Blackburn; Eric Hoover, Northwestern University, Evanston, IL
Frederick Gallun, PhD, National Center for Rehabilitative Auditory Research, Portland, OR

Among all individuals with hearing loss, patients with severe hearing loss are the most significantly impaired, and the least successful with hearing aids. The poor speech recognition seen in this population has been attributed to impaired suprathreshold processing, but there are few quantitative data. To explore the relationships between suprathreshold processing and speech recognition, we focus on adults with pure-tone thresholds between 60 and 90 dB HL. Test measures included (1) full audiometric exam including pure-tone thresholds, assessment of dead regions, and frequency-specific dynamic range; (2) characteristics of the participants¬ø own hearing aids, including signal processing and directionality; (3) measurements of spectral resolution, including psychoacoustic tuning curves and spectral ripple thresholds; (4) objective speech reception thresholds in noise (low-context sentences in background babble); (5) self-rated speech-recognition ability across a variety of everyday situations. A control group of age-matched adults with age-typical hearing thresholds was also tested. Results demonstrated relationships between speech recognition and spectral resolution; and between objective and subjective speech recognition. Of particular interest is the extent of overlap between the severely-impaired listeners and the control group, and the predictive factors which identify those severely-impaired listeners who may require more than ¬øtypical¬ø audiologic rehabilitation. [Work supported by NIH]

AUDITORY PROCESSING

Poster #98 – AP01

Middle Ear Muscle Reflex (MEMR) in Children with Unmedicated ADHD

Kyoko Nagao, PhD; L. Ashleigh Greenwood, AuD; Steven Reader, PhD; Thierry Morlet, PhD, Nemours/Alfred I. Dupont Hospital for Children, Wilmington, DE
Laura Grinstead, Towson University, Towson, MD

There is evidence that some children with ADHD have difficulties perceiving and processing sounds and/or have different sensitivity to loud sounds. The current study examined the function of the middle ear muscle reflex (MEMR) in children who have been diagnosed with ADHD but have not been medicated to treat their symptoms. Ipsilateral and contralateral MEMRs were measured binaurally at 0.5, 1, 2, and 4 kHz between 70 and 100 dB in 5 dB increments. A 2-way contingency table was created to analyze the

risk factor of abnormal MEMR by categorizing the very low and high MEMR thresholds (70 and 100 dB HL) and no response as abnormal, and 75 to 100 dB HL thresholds as normal. The results of a chi-square test comparing MEMR thresholds between eight children with unmedicated ADHD (mean age = 8.4 years) and eight typically developing children (mean age = 8.8 years) indicated a significant difference between two groups (chi-square (1) = 16.839, $p < 0.0001$). The odds ratio was 3.442 with a 95% confidence interval of 1.804 to 6.606. Results suggest that the children with ADHD are 3.4 times more likely to exhibit abnormal MEMR thresholds than the typically developing children.

Poster #99 – AP02

Are Listening Difficulties Unique to Children with Auditory Processing Disorder?

Melanie Ferguson, PhD, Nihr Nottingham Hearing Biomedical Research Unit, Nottingham, UK
David Moore, PhD, Cincinnati Children's Hospital Medical Center, Cincinnati, OH

It has been suggested that children with developmental disorders, such as auditory processing disorder (APD), specific language impairment (SLI) and autistic spectrum disorder (ASD), have similar characteristics.
A population study (IMAP) tested 1438 normally-hearing children, aged 6-11 years. The children were categorised according to the Children's Communication Checklist (CCC-2) into diagnostic categories aligned to either language impairment (general, LI, or specific, SLI) or autistic spectrum disorder (ASD, or Asperger's syndrome). Listening abilities were also classified according to the Children's Auditory Processing Scale questionnaire.
Cognition, language and reading were significantly poorer for the 'clinical' groups who had communication or listening difficulties compared to the typically developing (TD) group, with the exception of the Asperger's group. Listening abilities were significantly poorer for all the 'clinical' groups compared to the TD children. Furthermore, a significant proportion of children who had listening difficulties, were also shown to have poorer structural (56%) and pragmatic (35%) language abilities, as well as demonstrating autistic behaviours (35%).
The clinical implications are that APD co-occurs with LI and ASD, and is likely to sit along the LI-ASD spectrum. Children with listening difficulties who attend audiology clinics should be screened for functional everyday communication difficulties to ensure appropriate onward referral.

Poster #100 – AP03

Presentation Level Effects on the SCAN-3 in Children and Adults

Tina Stoody, PhD, University of Northern Colorado, Greeley, CO

The SCAN-3 is often used to evaluate patients for auditory processing disorders. Standard administration is through a clinical audiometer at 50 dB HL. The manual also permits administration through a CD player, at the listener's most comfortable listening level (MCL) or at the examiner's MCL. While there is little information in the literature about the variability of loudness measures in children, MCL has been shown to vary across adults, and is affected by test procedure and test instructions. Therefore MCL is likely to vary for individuals; and may not equate to 50 dB HL.
To investigate the effects of presentation level on the SCAN-3, 22 young adults (ages 20-38) and 24 children (ages 5-11) were administered the diagnostic protocol of the SCAN-3:A or SCAN-3:C at 40, 50, and 60 dB HL. The presentation level was counterbalanced to avoid test order effects. Significantly different scores and medium-large effect sizes across the different presentation levels were observed. Additionally, MCLs were measured for each child at each session; MCL varied across and within

participants from 40 to 75 dB HL. This further suggests that administration of the SCAN-3 at levels other than 50 dB HL may compromise the reliability of the scores.

Poster #101 – AP04

Perception of Filtered and Dichotic Speech in Two APD Populations

Julianne Ceruti; Frank Musiek, PhD, University of Connecticut, Storrs, CT
Jeffrey Weihing, PhD, University of Louisville, Louisville, KY

Low pass filtered speech (LPFS) and dichotic listening (DL) both evaluate central auditory deficits but may have different mechanisms. LPFS consists of spectrally degraded words, by low pass filtering, and results in a muffled, yet intelligible word list for normal subjects and decreased performance in individuals with certain types of auditory processing deficits (APD). The bilateral deficits typically seen in LPFS are thought to be due to auditory closure deficits. Dichotic Digits (DD) is a dichotic listening test that is thought to evaluate integration and typically reveals interaural asymmetries, namely a left ear deficit, when deficits exist. The current retrospective study aims to investigate the relationship between LPFS and DL performance to substantiate the theory of different underlying mechanisms in a neurologic and pediatric group. Preliminary results of 269 patients demonstrate that DL has a significantly higher failure rate in the neurologic group while LPFS shows no group differences. This finding supports differences in the underlying neural mechanisms between LPFS and DL and may suggest greater callosal involvement in the neurologic group. Further investigation aims to describe the relationships between LPFS and DL performance, neurologic status and receptive language.

Poster #105 – AP05

Biomarkers of Listening Difficulties in Children: an fMRI Study

Rola Farah, PhD, Cincinnati Children's Hospital Medical Center, Cincinnati, OH
Vincent J. Schmithorst, PhD, Children's Hospital of Pittsburgh of UPMC, Dept. of Radiology, Pittsburgh, PA
Robert W. Keith, PhD, University of Cincinnati, Dep. of Communication Sciemces and Disorders, Cincinnati, OH
Scott K. Holland, PhD, Cincinnati Children's Hospital, Pediatric Neuroimaging Research Consortium

Objective: To identify neurobiological markers and the neural circuitry underlying listening difficulties (LiD) in children with abnormal dichotic listening performance and suspected of auditory processing disorder (APD). Functional magnetic resonance imaging (fMRI) was used to test one of the major hypotheses concerning APD; namely, that it stems from top-down, supramodal deficits influencing perception.
Methods: fMRI was acquired from twelve children with LiD/ suspected APD, with atypical left ear advantage (LEA) in dichotic listening and twelve age-and gender-matched typically developing children. Dichotic and diotic word pairs were randomly presented and the subjects were instructed to repeat both stimuli verbally in any order.
Results: Children with LiD/ APD showed attenuated deactivation of the default mode network (DMN), increased activation in the dorsal anterior cingulate cortex and decreased functional activation in the left frontal eye fields in the dichotic condition compared to the diotic condition.
Conclusions: Differences in brain activation were consistent with lapses of attention previously associated with attenuated suppression of the DMN, and increased task-related activation in response to increasing difficulty of the dichotic task. Supramodal factors, including attention and cognitive control, seem to be the main contributor to the differences observed between the groups.

ANATOMY

Poster #86 – ANAT01
3D Printed Temporal Bone Model for Surgical Training in Mastoidectomy
Joss Cohen, University at Buffalo School of Medicine And Biomedical Sciences, Buffalo, NY
Samuel Reyes, MD, Buffalo Ent Specialists / Ub, Williamsville, NY

The successful otolaryngologists must master complicated surgical procedures involving the anatomy of the temporal bone (TB.) Mastoidectomy is used to treat multiple otologic disease as well as cochlear implantation. This requires comprehensive anatomical knowledge of the TB and surgical drill dexterity in order to avoid damaging adjacent structures like the facial nerve, internal carotid artery, cochlea, and sigmoid sinus. Residents train for this procedure by practicing on cadaveric specimens. However, cadavers present with significant anatomical variance, infectious concerns, and limited availability. We researched the validity of 3D printing to produce a rapid prototype TB model. Freely available software (ITK-SNAP) was used to segment CT data and create a 3D model composed of ABS plastic. The validity of the model was assessed based on presence/absence and size of structures. An experienced surgeon performed mastoidectomy on the prototype to qualitatively evaluate the efficacy of the model for dissection and response to surgical drilling. We found that this TB model is a good anatomical model providing students with a reproducible, hygienic, and affordable surgical training aid. The rapid prototype TB model has limitations that we expect to improve upon advances in 3D printing technology but is currently adequate to supplement resident training.

Poster #102 – ANAT02
An Illustrative Approach To The Auditory Vertebral Basilar System
Mallory Brown; Frank Musiek, PhD, University of Connecticut, Storrs, CT

The vertebral basilar system is the basis for the blood supply to the auditory brainstem, the internal auditory meatus and the cochlea. This poster will use sequenced illustrations to demonstrate the location and common course of these arteries, and attempt to simplify this complex system. This poster also will address the origin, number and size of the arteries. Key is the fact that vertebral basilar blood supply to the auditory system is crucial for proper auditory function and its compromise is a major factor in hearing and balance problems. Despite the significant role in auditory function, the vascular anatomy is often neglected in the field of audiology. This study consisted of a literature review as well as direct observation of three human cadaver brains at the University of Connecticut Health Center. Illustrations and pictures of key structures of the vertebral basilar system were systematically collected to provide an illustrative depiction of this anatomy. Many of our direct observations matched the findings of the reviewed studies.

DISEASES / SYNDROMES / DNA REPAIR

Poster #107 – DIS01
Comprehensive Auditory Phenotype of Alstrom Syndrome
Carmen Brewer, PhD; Christopher Zalewski; Kelly King, PhD, NIDCD/NIH, Hyattsville, MD
Meral Gunay-aygun, MD, NHGRI/NIH and Johns Hopkins University

H. Jeffrey Kim, MD, NIDCD/NIH and Georgetown University Hospital

Alstrom syndrome is a rare ciliopathy characterized by severe vision loss over the first decade of life secondary to atypical retinal degeneration, hepatorenal and pulmonary disease, childhood obesity, cardiomyopathy, insulin resistance, hyperlipidemia, normal intelligence and postlingual, progressive sensorineural hearing loss (SNHL). Mouse studies have shown abnormalities of the sterocilliary bundles and loss of outer hair cells. While pure-tone thresholds have been evaluated in humans, the auditory profile for Alstrom syndrome remains incomplete. OAEs and ABRs, which are critical assessments for description of sensory versus neural hearing loss, have not been reported.
Here we report the audiology findings for 29 patients (12 females, 17 males) with Alstrom syndrome, aged 1.6-39 years. Age of hearing loss identification ranged from 3-11 years, and for those with known NBHS results, all passed (n=12). Cross sectional analysis showed progression of pure-tone average at a rate of 12 dB/decade. OAEs, acoustic reflexes and word recognition ability were commensurate with degree of hearing loss. ABR waveforms were remarkably robust, and latencies were normal or consistent with the degree of hearing loss for all but three patients with interpeak latency prolongations. These novel, comprehensive data provide overwhelming evidence for cochlear dysfunction, although concomitant retrocochlear involvement remains a consideration.

Poster #108 – DIS02
Cortical Auditory Evoked Potentials in Pelizaeus-Merzbacher Disease
Thierry Morlet, PhD; Kyoko Nagao, PhD; L. Ashleigh Greenwood, AuD; Mora Sara, PhD; Stacey Koletty; Grace Hobson, PhD, Nemours/Alfred I Dupont Hospital for Children, Wilmington, DE

Pelizaeus Merzbacher disease (PMD) is a recessively inherited X-linked leukodystrophy. Previous reports reveal a spectrum of hearing abilities, while most auditory brainstem response (ABR) studies indicate that absence of later components after wave I or II is a common finding. Results of hearing testing in 11 PMD patients (ages 1 to 33) were as follows. Middle ear muscle reflex thresholds were normal in all but 3 ears. Otoacoustic emissions were present and of normal amplitude in all tested ears. ABR were absent in 4 ears of 3 subjects and abnormal in all remaining ears. Wave I was observed bilaterally in 4 subjects and unilaterally in 3 others, sometimes in conjunction with waves II and III. Very questionable synchrony was observed in 5 ears of 4 subjects. Cortical auditory evoked potentials (CAEP) were present in at least one ear in all patients. Latencies were normal in 4 ears of 3 patients. In all remaining ears, CAEP were of abnormal morphology and latencies were delayed. The present findings suggest that PMD patients present with central auditory neuropathy and that CAEP could be used as a better clinical tool than ABRs to assess their hearing function and participate in their management.

Poster #109 – DIS03
Inducible DNA Repair Enzymes in the Mammalian Cochlea
O'neil Guthrie, PhD, Loma Linda Va Medical Center, Loma Linda, CA

The ability of cells to repair damaged genes is directly dependent on their capacity to effectively mobilize DNA repair enzymes. Three independent experimental approaches to increase the capacity of the cochlea to mobilize DNA repair enzymes are reported. In one approach a synthetic molecule with a tandem telomere sequence (TTAGGGn), called T-oligo, was used to increase ($p < 0.05$) the expression of rate-limiting DNA repair enzymes above control levels. Furthermore, t-oligo treatment limited the magnitude of noise induced auditory impairment as revealed by brainstem and cortical electrophysiologic recordings. In a second approach, antisense oligonucleotides (ASO) that are

structurally tuned with 2'-O,4'-C-methylene-¬ø-D-ribofuranosyl nucleosides and designed to increase the expression of DNA repair genes by ¬øknocking-down¬ø specific microRNAs (miR-24, miR-210, and miR-295) could also increase ($p < 0.05$) the expression of DNA repair enzymes. In a third approach, carboxy alkyl esters (CAEs) that have been standardized to increase DNA repair activity were able to increase the repair of trauma induced DNA double-strand breaks in the cochlea. Furthermore, this increase in DNA repair was associated with regeneration of cochlear function after injury. Combined the results suggest that inducible DNA repair enzymes exist in the mammalian cochlea and these enzymes could be therapeutically optimized.

Poster #110 – DIS04 **Mentored Student Research Poster Award**

Auditory Phenotype of Patients with Isolated Methylmalonic Acidemia (MMA)

D. Rudyard Nast; Chris Zalewski, PhD; Kelly A. King, PhD; Carmen C. Brewer, PhD, National Institute on Deafness and Other Communication Disorders, Bethesda, MD
Irini Manoli, MD; Jennifer Sloan, PhD; Charles P. Venditti, MD, National Human Genome Research Institute

Isolated methylmalonic acidemia (MMA) is a clinically and genetically heterogenous group of disorders most commonly caused by deficiency of the mitochondrial enzyme methylmalonyl-CoA mutase (MUT). MMA patients display multisystemic manifestations including neurologic complications, such as metabolic strokes of the basal ganglia, optic neuropathy and intellectual impairment. The auditory phenotype of isolated MMA has remained unexplored.
We evaluated auditory function of 39 patients (20 males, 19 females) with isolated MMA (subtypes: mut, cblB, cblA), age range 2-33 years (median=10.6) enrolled in a dedicated natural history study. Twenty-three percent had hearing loss (0.5/1/2/4 kHz pure-tone average or speech threshold >20 dB HL). Three and six patients had unilateral or bilateral hearing loss, respectively. For ears with hearing loss (n=15), the degree was mild (n=5), moderate (n=4), or profound (n=6). Hearing loss type was most often sensorineural, although two ears had evidence of a conductive component. Word recognition was commensurate with pure-tone averages, and OAE testing supported a cochlear origin of the hearing loss in all ears with normal middle ear function. Hearing loss occured in mut and cblB patients but not in those with the milder cblA subtype. Audiologic surveillance should be included in the management of vitamin B12 nonresponsive MMA patients.

Poster #123 – DIS05

Bmitochondrial DNA (MTDNA) Haplotypes and Dysfunctions in Presbyacusis

Hossam Mostafa; Amal El-attar, MD; Gamal Ahmed, Assiut University Hospital, Assiut
Stefano Berrettini; Francesca Forli; Gabriele Siciliano; Michelangelo Mancuso, University of Pisa, Italy

Presbyacusis is defined as a disorder, often quantified by a certain degree of hearing loss.In genetic terms, any study uses only ¬øone¬ø phenotype, to define the presence/ absence of hearing impairment due to ageing, and to determine possible risk factors or causes.Most patients with presbyacusis have mild (28.5%) or moderate (32.8%) SNHL, and the ¬øflat-configuration¬ø was most dominantly represented (35.7%), followed by HFSS (32.8%), and that ¬øLFA¬ø, ¬øMFU¬ø and ¬øMFRU¬ø configurations were very rare (together less than 1%). These data agree with previous studies evaluating audiometric data of presbyacusis. It has well been documented that mutations of 12S rRNA gene are the hot spots related to the antibiotics-induced and/ or presbyacusis, and several deafness-associated mtDNA mutations have been identified in this gene. The most common mutations in 12S rRNA gene causing presbyacusis are A1555G, A3243G, and A7445G. In our study, these mutations were not detected in any patient. Recent studies indicate that the phenotypic expression of mtDNA mutations is highly variable which indicates

that these mutations may not be present, and some differences in either the nuclear gene content or activity appears to contribute significantly to the biochemical defect. Because of heteroplasmy, the proportion of mutant mtDNA varies in cells/tissues of an individual, and affected organs can be variable in patients with the 12S rRNA gene mutation. We found a significantly higher prevalence of presbyacusis in subjects with mtDNA haplogroups U,I in egyptian patients in comparison with egyptian controls, while haplogroup H was not statistically significant between egyptian patients and controls. The egyptian controls have significant high prevalence of haplogroups L,T in comparison to egyptian patients. In italian patients, haplogroup H is not statistically elevated, while haplogroup U were significantly higher in comparison to italian controls who have significant high prevalence of haplogroups H. Different mtDNA haplogroups may cause mild deleterious bioenergetic abnormalities. There is a growing body of evidence to suggest that presbyacusis may be associated with a reduction in mitochondrial function. In keeping with this, mutations in mtDNA and reduced mitochondrial function have been reported in human models of presbyacusis. So, our findings suggest that haplogroup U may be used as a genetic marker for presbyacusis susceptibility. Our results further support the concept that certain mtDNA haplogroups may cause mild deleterious bioenergetic abnormalities rather than merely representing the ¬øneutral¬ø polymorphisms reflecting different ethnic backgrounds. It is possible that genetic variants in specific mtDNA haplogroups may impair respiratory chain function within the cochlea to increase the risk of developing presbyacusis. In many population studies, prevalence of mtDNA haplogroup U, reported from studies of European and North American populations, were similar to our data, suggesting that our results would likely be applicable to other societies. In conclusion, our findings suggest that mtDNA haplogroups U are independent genetic markers for presbyacusis and may modify susceptibility associated with some known risk factors. Mitochondrial DNA may play a role in the pathogenesis of presbyacusis, but our findings need to be corroborated by future studies to confirm the prevalence of mtDNA haplogroups in other populations of individuals affected with presbyacusis. The precise mechanism underlying how mtDNA haplogroups increase genetic risk for presbyacusis remains to be clarified. If these findings are confirmed, introduction of preventive strategies to minimize environmental causes could be implemented to reduce the overall risk of a genetically susceptible individual of developing presbyacusis.

Poster #124 – DIS06

Increased Sensorineural Hearing Sensitivity in Children with Progeria During Lonafarnib Treatment

Homira Osman, University of Washington; Boston Children's Hospital, Seattle, WA
Brian Fligor, PhD, Boston Children's Hospital; Harvard Medical School, Boston, MA

Hutchinson-Gilford Progeria Syndrome (HGPS) is an autosomal dominant, rare, fatal pediatric premature aging disease, for which there is currently no FDA approved treatment. In 2007, the first prospective single-arm clinical drug trial was conducted at Boston Children's Hospital. As part of a multi-disciplinary approach, twenty-six children with HGPS from sixteen countries treated with lonafarnib underwent a myriad of clinical evaluations, including audiological evaluation. This presentation describes the following audiological outcomes in detail: pure-tone behavioral audiometry, speech audiometry, tympanometry, middle-ear muscle reflex, and distortion-product otoacoustic emissions. At end-of-therapy (two years after lonafarnib was started), air conduction hearing sensitivity remained stable, but low-frequency sensorineural hearing had a statistically significant increase in sensitivity. Tympanometric and middle-ear muscle reflex threshold measures suggested a stiffening of the middle-ear system, although tympanograms in ears that changed from ¬ønormal¬ø to ¬øabnormal¬ø from baseline to end-of-therapy did not correlate with decrease in hearing sensitivity. Whether or not these observed changes

were drug-related or a new finding of age-related changes in children with HGPS is unknown. These results imply diagnostic and medical and audiological management of conductive hearing loss in children with HGPS should be prioritized to enhance quality of life, given the potential for hearing loss to go undetected.

COCHLEAR IMPLANTS

Poster #111 – CI01 **T35 Research Trainee Poster**

Cue Integration In Question-Statement Identification by Hearing and Cochlear-Implanted Children

Alison Goren; Julie Christensen, AuD; Monita Chatterjee, PhD, Auditory Prosthesis and Perception Lab, Boys Town National Research Hospital, Omaha, NE, and The University of Maryland, College Park, MD
Brooke Burianek, Doane College In Crete, Ne
Shu-chen Peng, PhD, U.S. Food and Drug Administration, Silver Spring, MD
Nelson Lu, PhD, Division of Biostatistics, CDRH/FDA (Center for Devices and Radiological Health, Food and Drug Administration), Silver Spring, MD

Fundamental frequency (F0), intensity, and duration are important aspects of speech prosody. Listeners weight these cues to maximize the meaning derived from an utterance. For normally hearing (NH) adults listening to full-spectrum stimuli in a question-statement identification task, F0 contour, the most reliable acoustic cue, is weight most, while intensity and duration, less reliable cues, are weighted far less. Conversely, when listening through cochlear implants (CIs), or acoustic CI simulations in which the F0 cue is diminished, adult listeners rely more on intensity and duration. The present study investigated acoustic cue-weighting in school-aged NH children with full-spectrum and CI-simulated speech. Parallel data were obtained in a small group of CI children (full-spectrum speech only). The stimulus in the question/statement identification task was the word ¬øpopcorn¬ø, acoustically modified to have 360 combinations of F0 contour, F0 height, intensity, and duration. Results to date indicate that patterns of cue-weighting in NH and CI children are qualitatively consistent with those observed in NH and CI adults, but that NH children may need more training with CI-simulated speech than was provided in this study. This work has implications for CI speech processors and auditory (re)habilitation programs for children with CIs.

Poster #112 – CI02

An Assessment of Partial Tripolar Stimulation in Cochlear Implant Users

Melanie Gilbert, AuD; Leonid Litvak, PhD; Myles McLaughlin, PhD, Advanced Bionics LLC, Valencia, CA

Most cochlear implant (CI) speech processing strategies use monopolar stimulation, where current is delivered via an intra-cochlear electrode and returned via an extra-cochlear ground electrode. CI users achieve reasonable speech perception with monopolar strategies. However, the wide monopolar electric field limits the number of independent channels, potentially limiting speech perception. In partial tripolar stimulation a portion of the current is returned via two flanking intra-cochlear electrodes. This stimulation mode should produce a narrower electric field and increase the number of independent channels, improving spectral resolution and potentially improving speech perception. Here we investigated the effect of differing amounts of partial tripolar stimulation. Current spread in the cochlea was assessed using electric field imaging. Spectral resolution was assessed using pitch ranking and spectral ripple discrimination. Speech-in-noise understanding was assessed using AzBio sentences. Initial results indicate that for equal stimulation levels partial tripolar produces a significantly narrower electric

field than monopolar stimulation. However, partial tripolar requires higher M-levels to achieve equivalent loudness. When scaled to matched loudness differences between monopolar and partial tripolar electric field became more subtle. Partial tripolar stimulation improved spectral ripple discrimination and pitch ranking. Initial results indicated that partial tripolar may improve in speech-in-noise perception in some patients.

Poster #113 – CI03
Effect of Current Levels on Residual Hearing in EAS Subjects
Andrea Bucker, University Of North Carolina At Chapel Hill, Chapel Hill, NC
Margaret Dillon, AuD; Harold Pillsbury, MD; Craig Buchman, MD; Oliver Adunka, MD, UNC Department of Otolaryngology/Head And Neck Surgery, Chapel Hill, NC
Marcia Adunka, AuD; English King, AuD, UNC Department of Audiology, Chapel Hill, NC

Candidacy criteria for Electric-Acoustic Stimulation (EAS) targets a subset of hearing impaired people with steeply sloping severe-to-profound mid-to-high frequency hearing loss. Advances in electrode array designs and insertion techniques have allowed for post-operative hearing preservation, and thus the ability to utilize cochlear implant and hearing aid technology in the same ear. Though post-operative hearing preservation is possible, there has been variability in the amount of hearing preservation across subjects. Primary causes for the variable loss in residual hearing are relatively unknown. This study aims to examine the relationship between stimulation levels of EAS subjects and their post-operative residual hearing and speech perception abilities.
Subjects¬ø residual hearing and aided speech perception were assessed preoperatively, and at 3, 6, and 12 months post-initial EAS activation. Map parameters and current levels were also calculated at each interval. Interim results suggest there is not a causal relationship between current levels and postoperative hearing preservation or speech perception outcomes.

Poster #114 – CI04 **Mentored Student Research Poster Award**
Near-Infrared Spectroscopy Detects Brain Activity Differences Between CI Simulations
Sterling Sheffield, AuD; Rene Gifford, PhD, Vanderbilt University, Nashville, TN

Objective: Determine the utility of near-infrared spectroscopy (NIRS) in detecting auditory cortical activity differences between cochlear implant (CI) simulations.
Experiment: Auditory cortical activity was measured using NIRS and functional magnetic resonance imaging (fMRI) in normal hearing adults while listening to CI speech simulations. Conditions included unprocessed, unilateral CI (right), bilateral CIs, and bimodal hearing. Participants rated the intelligibility of each condition during testing. Speech recognition was tested behaviorally for CNC words, AzBio sentences, and BKB sentences.
Results: NIRS revealed differences in auditory cortical activity between conditions differing in site of sound stimulation (right vs. both ears) but not in intelligibility (bilateral CI vs. unprocessed). fMRI revealed significant differences in activation between conditions differing in site of sound stimulation and intelligibility.
Discussion: NIRS detected differences between simulation conditions consistent with literature showing effects of unilateral vs. bilateral sound stimulation but no intelligibility effects. fMRI showed significant effects of both intelligibility and unilateral vs. bilateral sound stimulation. Differences in NIRS and fMRI results might be due to fMRI scanner noise, different cortical areas tested, and differences in imaging methods. NIRS shows potential as an objective measure of the benefit of a hearing aid in the non-implanted ear or a second CI.

Poster #115 – CI05

Neural Correlates of Phonetic Learning in Adult Cochlear Implant Users

Sharon Miller, MA; Yang Zhang, PhD; Peggy Nelson, PhD, University of Minnesota, Minneapolis, MN

Auditory event-related potentials (ERPs) provide insight into the neural processing of complex speech and non-speech stimuli and are an attractive tool for assessing outcomes in cochlear implant (CI) listeners. The present study utilized ERPs to examine perceptual learning of /b/, /d/, /w/, and /j/ categories in 9 adult, post-lingually deafened, experienced cochlear implant (CI) users. A phoneme based auditory training software was developed that featured multi-talker variability and adaptive listening; the program was developed to help CI users attend to formant transitions required for phonemic categorization of /ba-da/ and /wa-ja/ stimuli. Subjects completed behavioral and electrophysiologic testing before and after 4 sessions of auditory training. The results indicate that training resulted in significant improvement in phoneme identification in the CI subjects. Consistent with the behavioral results, pre-post ERP measures showed enhanced MMN peak amplitudes to the /ba-da/ and /wa-ja/ distinctions after training. These data suggest that targeted auditory training can induce neural plasticity for phoneme perception in adult CI users.

Poster #116 – CI06 **New Investigator Poster Award**

Integration of Electrical Pulses by Listeners with Cochlear Implants

Ning Zhou, PhD, East Carolina University, Greenville, NC
Casey Kreft, MS; Bryan E. Pfingst, PhD; Deborah J. Colesa, MS, University of Michigan

Temporal integration (threshold versus stimulus duration functions) and multipulse integration (threshold versus pulse rate functions) were measured behaviorally in guinea pigs and humans with cochlear implants. Results showed that multipulse integration functions became steeper with increasing pulse rate reflecting a change in the integration mechanisms from long-term integration at low rates (< 300 pps) and short-term integration from 300 to 1000 pps, to residual charge summation on the cell membrane above 1000 pps. Slopes of multipulse integration were correlated with those of temporal integration suggesting a similar underlying mechanism. Histological analysis of the guinea pigs suggested that slopes of the multipulse integration functions below 1000 pps were dependent on neural health near the stimulation sites. In ears with great pathology, fiber demyelination or poor metabolic state of the neurons can result in prolonged refractoriness and reduced responsiveness for stimulation rates of as low as 100 pps. The reduced responsiveness could result in less effective multipulse integration for higher rate stimuli and thus shallower multipulse-integration slopes. The multipulse integration functions can be used as a non-invasive measure for identifying stimulation sites of poor neural health in humans and guide site-selection or rehabilitation strategies for improving speech recognition with the device.

Poster #117 – CI07

Factors Affecting Speech Outcomes in Hearing Preservation Cochlear Implantation

Sandra Prentiss, PhD, University Of Kansas Medical Center, Department Of Otolaryngology Head & Neck Surgery, Kansas City, KS

Introduction: Hearing preservation cochlear implantation has become commonplace and give patients who are poor hearing aid candidates but have significant residual hearing an opportunity to take part in the hearing world. Significant improvements have been noted with hearing preservation patients;

however, outcomes continue to vary. The purpose of this study was to look at variations in hearing preservation and performance based on insertion depth of the electrode and age of the patient. Initial studies with hearing preservation showed increased damage with deeply inserted electrodes, but the downfall of partial insertions is the inability to stimulate the entire cochlear partition, particularly the apical end. The audiologic configuration that makes the patient a candidate for hearing preservation implantation is common in the elderly. Outcomes may tend to vary more with the elderly as central processing disorders increase with age.
Subjects: Forty-one cochlear implant recipients with hearing preservation were evaluated. The change in the pure tone average were measure pre- and post-operatively. Outcomes were measured with CNC and AzBIO scores.
Results: Insertion depth was found to be independent of loss of hearing. No significant correlations are seen the change in PTA and age nor age and outcome measures.
Discussion: Other attempts to evaluate variations in outcomes may involve tests of neuronal survival, i.e., electrophysiologic measures. Furthermore, tests for dementia or other central processing deficits may be indicated for the elderly population. Cochlear implantation with hearing preservation shows many advantages; however, the elderly population may not consistently achieve the same benefits seen in younger adults.

Poster #119 – CI08 **T35 Research Trainee Poster**

Acoustic Bandwidth Required for Bimodal Benefit in Pediatric Cochlear Implantation

Michelle Simha, University of South Florida, Tampa, FL
Sterling Sheffield, AuD; Rene Gifford, PhD, Vanderbilt University, Nashville, TN

Objective: The primary aim was to determine the acoustic bandwidth required for pediatric implant recipients to attain bimodal benefit for speech perception in noise.
Experiment: Speech recognition was assessed for BabyBio sentences in noise (varying SNRs) for 20 children with normal hearing using acoustic low pass filtering and cochlear implant (CI) simulations with a 15-channel vocoder (Litvak et al., 2007). The following three conditions were assessed: 1) CI alone, 2) acoustic alone (low-pass filtered at 1500 Hz), and 3) CI with contralateral acoustic (bimodal). Acoustic stimuli for condition 3 were filtered as follows: <250 Hz, <500 Hz, <750 Hz, <1000 Hz, and <1500 Hz. The low-pass filter slopes incorporated 90 dB/oct roll-off to restrict energy to the intended passband.
Results: Significant bimodal benefit was observed with <250 Hz filter. Increasing benefit was observed through the <750 Hz filter. No significant benefit was observed for the addition of acoustic hearing beyond the <750 Hz filter.
Discussion: Results suggest that 1) pediatric CI recipients may benefit from minimal acoustic hearing (<250 Hz) in the non-implanted ear and 2) bimodal benefit increases with increasing bandwidth up to at least <750 Hz. Ongoing work is currently examining this research question with pediatric implant recipients.

Poster #120 – CI09 **Mentored Student Research Poster Award**

Exploring Relationships Among Electrophysiological Measures, Behavioral Thresholds and Electrode Position

Rachel Scheperle, PhD; Paul Abbas, PhD, University of Iowa, Iowa City, IA
Julie Bierer, PhD, University of Washington, Seattle, WA

Neural excitation patterns resulting from electrical stimulation by a cochlear implant (CI) are affected by a number of factors, including electrode position and neural survival. We evaluated the role of electrode

position on two measures used to evaluate neural excitation: behavioral thresholds using focused stimulation (e.g. Bierer, 2007; Bierer & Faulkner, 2010) and electrically evoked compound action potential (ECAP) channel interaction functions using broad stimulation (e.g. Cohen et al., 2003; Abbas et al., 2004). Four recipients of Advanced Bionics CI systems participated. Electrode position was determined from computerized tomography (CT) (Verbist et al., 2010). Behavioral thresholds for electrodes 2-15 were obtained using quadrupolar stimulation. ECAP channel interaction functions for probe electrodes 1-16 were obtained using monopolar stimulation. There was considerable variability in the relationships observed across participants; however, results suggest that ECAP measures are more sensitive to the proximity of the electrode to the modiolus than behavioral thresholds. We do not have evidence of broader neural excitation for electrodes with high behavioral thresholds. For one participant, ECAP amplitudes were relatively small for electrodes with high behavioral thresholds. Additional research is needed to more fully understand the implications of the results for each individual.

Poster #121 – CI10

Joint Attention in Children Obtaining Cochlear Implants: A Preliminary Report

Tina Grieco-Calub, PhD; Erin Ingvalson, PhD, Northwestern University, Evanston, IL
Nancy Young, MD, Northwestern University; Ann & Robert H. Lurie Children's Hospital of Chicago
Patrick Wong, PhD, The Chinese University of Hong Kong

Joint attention (JA) is the ability of two individuals to share attention on an object or event. In normal hearing children, JA emerges within the first year of life and is predictive of language abilities in later childhood. Children who are deaf also exhibit JA. Little is known, however, about how JA abilities relate to spoken language outcomes in the subset of children who receive cochlear implants. To address this issue, we have designed a longitudinal study to test the hypothesis that JA skills prior to cochlear implantation promote language acquisition in children following cochlear implant activation. To date, six children with severe-to-profound hearing loss who are between 10-21 months of age have participated in the pre-implantation JA measure. During the interval between cochlear implantation and activation, children are administered the Early Social-Communication Scales (ESCS, Mundy et al., 2003), a standardized JA measure that provides scores on six categories of social communication. As predicted, all children exhibit JA, thus validating the ESCS as a measure of JA in children with hearing loss. These data will be discussed in the context of normative data for the ESCS. Ongoing data collection and analyses examine links between ESCS and various language outcome measures.

Poster #122 – CI11

Speech Recognition Performance with PRESTO in Five Clinical Populations

Kathleen Faulkner, PhD; Terrin Tamati; Taylor Twiggs; David Pisoni, PhD, Indiana University, Bloomington, IN

There is a pressing clinical need for new theoretically-motivated robust assessment measures of speech recognition in addition to the conventional speech intelligibility tests that have been in continuous use since the end of WW II (Hirsh, 1947). PRESTO (Perceptually Robust English Sentence Test Open-set) is a new high-variability sentence recognition test designed to study individual differences in five clinical populations. In this presentation, we summarize results with PRESTO in five different clinical populations. Non-native speakers of English show much poorer performance when compared with native speakers of English. PRESTO performance declines with advancing age and is correlated with other measures of sentence recognition, cognitive processing measures, and self-reported hearing difficulties. PRESTO is also strongly associated with differences in rapid phonological coding in prelingual long-term

CI users. PRESTO is more sensitive to individual differences in noise when compared with HINT and AZBio in post-lingual adult CI users as well as NH listeners under acoustic simulation. PRESTO is a valuable addition to the ¬øclinical toolbox¬ø for determining CI candidacy and tracking performance following implantation. PRESTO is especially sensitive to individual differences and provides additional diagnostic information about the basic underlying sensory and neurocognitive processing mechanisms involved in speech recognition.

Poster #125 – CI12

Listening Effort in Bilateral Cochlear Implants and Bimodal Hearing

Matthew Fitzgerald, PhD; Katelyn Glassman, AuD; Keena Seward, AuD; Arlene Neuman, PhD, New York University School of Medicine, New York, NY
Sapna Mehta, City University of New York, New York, NY

Many users of bilateral cochlear implants, or of bimodal hearing, report, reduced listening effort when both devices are active relative to a single device. To quantify listening effort in these individuals, we used a dual-task paradigm. In such paradigms, the participant divides attention between a primary and secondary task. As the primary task becomes more difficult, fewer cognitive resources are available for the secondary task, resulting in poorer performance. The primary task was to repeat AzBio sentences in quiet, and in noise. The secondary task was to recall a digit string presented visually before a set of two sentences. As a control, both the primary and secondary tasks were tested alone in a single-task paradigm. Participants were tested unilaterally and bilaterally / bimodally. Relative to the single-task control, scores obtained in the dual-task paradigm were not affected in the primary sentence-recognition task, but were lower on the secondary digit-recall task. This suggests that a dual-task paradigm has potential to quantify listening effort. Some listeners who showed bilateral benefits to speech understanding had higher bilateral than unilateral digit-recall scores. However, there was considerable variability on the digit-recall task, which hinders our ability to draw clear conclusions.

Poster #126 – CI13

Objective and Subjective Measures of Listening Effort and Fatigue in Adult Cochlear Implant Recipients

Robert Dwyer; Rene Gifford, PhD, Vanderbilt University, Nashville, TN
Michael Dorman, PhD, Arizona State University
Tony Spahr, PhD, Advanced Bionics and Vanderbilt University

Objective: The primary objective was to determine whether adults with cochlear implants are more physically and mentally fatigued than their normal hearing (NH) peers as a result of their day-to-day interactions with family, friends and colleagues and to examine the relationship between the cortisol awakening responses (CAR) and subjective measures of listening effort and fatigue.
Methods: A total of 7 salivary cortisol samples were collected from 10 adults currently enrolled in audiology programs: 5 adults with hearing loss (3 CI and 2 hearing aid users with severe to profound hearing loss) and from 5 adults with NH. Subjective questionnaires were administered to investigate the relationship between the CAR and the perceived stress and fatigue of each participant.
Result: No significant differences in the CAR were observed between those with hearing loss and NH controls. Analysis of subjective reports revealed significant differences between groups for daily listening effort, but not for fatigue or vigor.

Conclusion: No relationship between the CAR and the subjective measures of listening effort and fatigue could be established. Limitations include the possibility that salivary cortisol changes may not be sensitive enough to capture changes in fatigue or stress related to listening and current sample size.

Poster #127 – CI14
Listening Effort: Bilateral and Bimodal Cochlear Implant Listeners
Douglas Sladen, PhD, Mayo Clinic, Rochester, MN
Yingjiu Nie, PhD, James Madison University, Harrisonburg, VA

Cochlear implant (CI) users often use a contralateral hearing aid (HA), have a second side CI, or leave the ear unaided. Adding the contralateral ear in noisy conditions may result in a binaural advantage or binaural confusion. For this study, bilateral and bimodal listeners were tested using a dual task paradigm. This approach measures speech understanding performance in addition to mental effort needed to process speech. Monosyllabic words were presented in multi-talker babble in an R-SPACE speaker array at +5 and +15 dB signal-to-noise ratios (SNR) in unilateral and bilateral conditions. While repeating words, listeners pushed a button in response to a light flashing at random intervals. Correctness of word recognition and reaction time were recorded. Overall, preliminary data show listeners recognized more words in the bilateral condition, but presented similar reaction times. Bilateral-unilateral-difference (BUD) in word recognition score was negatively correlated with BUD in reaction time, suggesting improved word recognition resulted from bilateral hearing associates with less listening effort. Correlations between SNR-induced differences in word recognition were not clear, though preliminary positive correlations suggest listeners may exert more listening effort to improve word recognition in lower SNR.
Work supported by St. Mary's Research grant and JMU faculty start-up fund.

Poster #128 – CI15
Speech Understanding Using a Roving Target with Spatially Separated Maskers
Louise Loiselle, PhD; Michael Dorman, PhD; William Yost, PhD; Sarah Cook, Arizona State University, Tempe, AZ

A new test paradigm was designed to determine if a dynamic listening environment with a roving target in a background of multiple spatially separated maskers captured more accurately 1) the benefit of bilateral cochlear implants (CI) compared to the better CI ear and 2) the benefit of a second acoustic ear, e.g. the benefit of preserving hearing in the implanted ear, compared to the bimodal condition for hearing preservation (HP) listeners. The ¬øRoving Cocktail¬ø test was designed to mimic a more realistic and dynamic listening environment. RSpace¬ø was used for the test environment and creates a virtual restaurant setting with the listener surrounded by an eight loudspeaker array. Target sentences were roved in the frontal horizontal plane amid a background of restaurant noise emanating from all eight loudspeakers. Results for the Roving Cocktail test demonstrated a mean of 28 percentage points for bilateral CIs compared to the better CI ear alone. The HP listeners gained a mean of 13 percentage points in the combined condition (bilateral acoustic hearing + a single CI) when compared to the bimodal condition. The benefit of having bilateral hearing in both ears, either electric or acoustic, is beneficial for listening in complex noisy environments.

Poster #129 – CI16 **Mentored Student Research Poster Award**
Effects of Spectral Shift on Dichotic Speech Recognition
Rebecca Berger; Li Xu, PhD, Ohio University, Athens, OH

Yitao Mao, Central South University

In bilateral cochlear implantation, the information delivered to the two ears is usually different due to differences in electrode insertion depth, frequency allocation, and local pathology in the cochleae. This frequency mismatch between the two ears and relative to the original cochlear map in bilateral implant users may be so great that speech understanding is adversely affected. The goal of the present study is to determine the effects of this mismatch on speech recognition in order to better understand how the brain integrates dichotic speech signals as well as the problems that bilateral implant users are facing. Ten normal-hearing listeners were tested on vowel and consonant recognition of vocoder processed speech. The speech information was frequency shifted by various amounts ranging from 0 to 6 mm in the two cochleae. Results showed that when there was a great amount of shift in both ears, phoneme recognition performance greatly decreased. However, if the frequency shift is only varied in one ear, speech recognition was not affected. Thus, it is likely that the brain attends to the better ear for speech recognition under spectral shift conditions. Implications for bilateral cochlear implantation will be discussed in light of findings from the present study.

Poster #130 – CI17

Short-Time Temporal Fine Structure Processing Improves Speech Perception

Limmin Hou, PhD; Kyle Brown; Li Xu, PhD, Ohio University, Athens, OH
Yanmei Feng, MD; Shankai Yin, MD, Shanghai Jiaotong University

The role of temporal fine structure (TFS) in speech perception is still under debate. Sentence recognition using TFS extracted with Hilbert transform has been shown very poor. In the present study, TFS of English sentences was extracted in short-time segments (50, 100, 150, 200, 250, and 300 ms) with the amplitude of each segment determined by the mean amplitude of the envelope. The bandwidths used were 1, 2, and 4 ERBs. The concatenated TFS sentences were presented to 5 normal-hearing, native English-speaking listeners. Sentence recognition results showed that (1) performance with segments ¬ø 100 ms in 1- and 2-ERB conditions was approximated 90% correct; (2) performance declined sharply as segments was ¬ø 150 ms; and (3) performance with 4 ERBs maintained as high as 90% correct across all segment conditions. Therefore, providing short-time amplitude cues (10 to 20 Hz) might account for the improved sentence recognition performance in TFS speech. Good sentence recognition with 4 ERBs might be attributed to the recovered envelope cues from wider bandwidth. These results might have important implications for speech processing strategies in cochlear implants.

Poster #131 – CI18

Linguistic Cues vs. Acoustic-Visual Coherence in Auditoy-Visual Benefit

Shuai Wang; Julie Liss, PhD; Visar Berisha, PhD; Xuan Zhong, MS; Sarah J. Cook; Michael F. Dorman, PhD, Arizona State University, Tempe, AZ

Recent studies have found that seeing faces enhanced auditory neural activities that were linked to selective envelope tracking (2-7 Hz) in a cocktail party like environment (Golumbic et al., 2013). Given statistical evidence of a correlation between visual lip movements and acoustic envelope information, some neuroscientists have claimed that ¬øcontinuity¬ø of visual cues was critical for listeners to receive the benefits of adding vision to acoustic information (Scarborough et al., 2009). However, it is unclear whether non-linguistic cues such as coherence between lip movements and acoustic envelope, or linguistic cues such as place of articulation from vision, underlie the benefits. The present study tested ten normal hearing listeners in audiovisual sentence recognition in noise by proportionally preserving

linguistic cues from vision while no continuous visual information was maintained for tracking. Results indicated benefits were robustly proportional to the amount of residual linguistic cues from vision. Additionally, little correlation was observed between the amount of residual non-linguistic cues such as envelope information from vision and percent correct of that corresponding sentence in the post-hoc sentence-by-sentence analysis among subjects.

Poster #132 – CI19
Exploring the Source of Neural Responses in Cochlear Implant Users
Akinori Kashio, PhD; Viral Tejani, AuD; Rachel Scheperle, PhD; Carolyn Brown, PhD; Paul Abbas, PhD, University of Iowa Hospitals And Clinics, Iowa City, IA

In some individuals the electrically evoked compound action potential (ECAP) is observed to have shorter N1 latencies using recording electrodes further from the stimulation site compared to electrodes closer to the stimulation site. A proposed explanation is that different neural populations (peripheral vs modiolar, or ectopic, stimulation) dominate the response as the recording electrode changes from near the stimulating electrode to further away (Finley et al., 2013, Conference of Implantable Auditory Prostheses,). We hypothesized that if different neural populations were responding, channel interaction functions measured using a two-pulse subtraction paradigm (Abbas et al., 2004, Audiol. Neurotol,) should reflect those differences. This study evaluated ECAP latencies measured with different recording electrodes and channel interaction functions recorded using both near and far recording electrodes. Nine CI patients participated, some with probe electrodes at both basal and apical positions. Six out of 18 probes had shorter ECAP latencies at far recording electrodes compared to electrodes closer to the probe. However, no difference in the pattern of the channel interaction functions recorded from far and near recording electrodes was evident. These preliminary findings suggest that similar neural populations contribute to ECAPs measured from different recording electrode.

Poster #133 – CI20 **T35 Research Trainee Poster**
Is Visual Temporal Processing Related to Speech Perception after Cochlear-implantation?
Kelly Jahn; Ryan Stevenson, PhD; Juliane Krueger; Mark Wallace, PhD, Vanderbit University, Nashville, TN

Objective: The primary aim was to examine the relationship between visual temporal order judgment (vTOJ) task performance and scores on clinical audiological measures in cochlear implant (CI) recipients.
Experiment: Forty-three cochlear implant recipients originally completed six multisensory tasks and two unisensory control tasks, including vTOJ. Clinical data was compiled for 31 participants including age of implantation, duration of hearing loss, audiometric configurations, and scores on several speech perception tests including AzBio, HINT, BKB-SIN, and CNC words. Correlations between performance on multisensory and unisensory tasks and clinical measures were obtained.
Results: Performance on the vTOJ tasks was related to several clinical measures. Better visual temporal processing abilities were associated with better performance on various speech recognition tasks. Better audiometric thresholds between 4000-8000 Hz correlated with better vTOJ performance and better thresholds for 150-1500 Hz correlated with worse vTOJ performance. Shorter duration of hearing loss was also associated with better vTOJ performance.
Discussion: Results suggest: 1) Better visual timing abilities may improve an individual's ability to learn speech after cochlear implantation, 2) There is potential for vTOJ scores to predict performance on clinical speech measures, and 3) In general, better speech perception abilities are related to better visual temporal processing abilities.

Poster #134 – CI21

Visual Contributions to Reverberant Speech Perception for Cochlear Implant Users

Brianna Boles; Nathaniel Whitmal, PhD; Sarah Poissant, PhD, University of Massachusetts Amherst, Amherst, MA

Many cochlear implant (CI) users understand speech well in reverberant rooms, despite the presence of reflected sounds that can interfere with speech envelope temporal cues. Visual contributions from speechreading may account for this good performance. Previous research suggests that listeners experiencing a period of profound hearing loss rely on speechreading more than listeners with normal hearing and thereby become more proficient at it. However, the extent of this reliance is unknown, as previous studies of audio-visual benefit for CI users have focused exclusively on anechoic listening. The present study investigated visual contributions to perception of CI-processed speech in simulated reverberation. Six CI users and eighteen CI-simulation users (with normal hearing) performed a speech recognition task with sentence recordings presented in audio-only, visual-only, and combined audio-visual modalities. Results from both groups showed that visual contributions were negatively associated with anechoic audio-only performance and positively associated with reverberation time. Half of the CI users performed nearly as well as simulation users in all conditions. The other CI users (all pre-lingually deafened for at least 20 years) achieved audio-visual scores that were only slightly lower, despite poor audio-only performance. Implications of these results for assistive technology and rehabilitation will be discussed.

Poster #135 – CI22

Auditory Enhancement in Cochlear-Implant Users with Simultaneous and Forward Masking

Heather Kreft, MA; Ningyuan Wang; Andrew Oxenham, PhD, University of Minnesota, Minneapolis, MN

Auditory enhancement and context effects ¬ø similar to the negative afterimage in vision ¬ø have been observed in auditory and speech perception in acoustic hearing. These effects may help ¬ønormalize¬ø the incoming sound and produce perceptual invariance in the face of the variable acoustics produced by different rooms, talkers, and backgrounds. Little is known about whether cochlear-implant (CI) users experience similar context effects. If enhancement effects are found with CI users, then that would argue against a cochlear basis for the effect, as the cochlea is bypassed in CI stimulation. On the other hand, if enhancement is not found in CI users, it may point to a potentially important aspect of hearing that is not currently captured by CI processors. This study examined basic psychophysical auditory enhancement using simultaneous and forward masking. Stimuli were presented to CI via direct stimulation. The results suggest some, but often reduced, enhancement in CI users for both simultaneous and forward masking. Understanding more about how auditory enhancement effects differ in CI users should help inform potential new algorithms to reintroduce these effects, thereby potentially contributing to restoring perceptual invariance for CI users. [Work supported by NIH grant R01 DC012262 and Advanced Bionics.]

Poster #136 – CI23

Psychophysical Measures Show Treatment Effects in Cochlear Implant Mapping

Nancy McIntosh, AuD; Jay Rubinstein, MD; Ward Drennan, PhD, VM Bloedel Hearing Research Center, Seattle, WA

Psychophysical tests such as the spectral ripple discrimination test or temporal modulation detection might be useful for rapidly evaluating different maps in CI users. The aim of this study was to determine if basic psychophysical tests reflect mapping changes in CI users. Nine experienced cochlear implant users,

6 unilateral and 3 bilateral (12 ears), were recruited to evaluate the effects of programming changes on hearing ability. Optimal mapping of the sound processor was completed to the subjects¬ø and audiologist's satisfaction, then several plausible 'bad' maps were created by reducing the maps' comfortable loudness levels. The objective was to determine how changes which reduced speech understanding influenced psychophysical measures.

Mapping changes resulted in poorer scores for both speech and non-speech tests. For all tests completed, the differences in scores observed between the Good and Bad maps were statistically significant. These results demonstrate that programming changes that affect speech perception also affect spectral and temporal discrimination. Thus, the non-linguistic tests are sensitive to treatment effects (mapping) and might be useful as a surrogate measure for speech understanding. These non-linguistic measures could expedite the process of finding optimal maps, because they exhibit less acclimization than speech tests.

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