Audiology Students Demonstrate Excellence in Research

BY JASON GALSTER
In 2014, five students were selected from a highly competitive pool of applicants to present their research projects at the Student Research Forum at AudiologyNOW! Their work covered a broad range of topics: vestibular assessment, use of electrophysiological measures for outcome assessment following hearing aid fitting, physiology of tinnitus, attitudes of audiologists regarding individuals with disabilities, and hair cell regeneration in zebrafish.

All of these students developed ambitious research projects, asked challenging questions, and completed complex protocols to answer their questions. The following article includes summaries of their projects and findings.

These students and their projects are great models for other students interested in hearing-science research. The AudiologyNOW! Student Research Forum is right around the corner!

CVEMP Measures in Adolescents
Student Researcher: Reaghan Albert
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Currently, there is a lack of research evaluating vestibular-evoked myogenic potential (VEMP) parameters in the adolescent population. VEMP research has been completed on neonates and children aged 3 to 11 (Kelsch et al, 2006; Sheykholesam et al, 2005). Since hearing loss and the loss of vestibular function can co-occur, vestibular function should be monitored periodically if a child is diagnosed with a congenital or acquired hearing loss (Angeli, 2003). There has been a strong push in previous research to construct a universal VEMP protocol so that it can be used across clinics with normative data. Documented latency, amplitude, and optimal testing conditions for the adolescent population is lacking. It is important that research include the adolescent population while constructing clinical protocols. This research aimed to evaluate VEMP measures in the adolescent population.

A total of 23 participants, or 46 ears, from adolescent males and females, aged 11 to 18, were recruited for participation in this study. Participants with clear canals and Jerger Type A tympanograms on the day of testing were allowed to continue with the study. Using a standard tape measure, the participant’s neck length was measured from the mastoid tip to the perpendicular point on the clavicle. Measurements were taken to the closest centimeter.
Participants were asked to complete the VEMP in two positions; a one-channel recording where they were seated and completed a head turn and a two-channel recording where they were in a supine position and completed a head raise. Each measurement was recorded twice to confirm repeatability. Ear and position were counterbalanced to account for potential neck muscle fatigue.

A multivariate regression analysis of the relationship between P1, age, and neck length revealed a significant relationship [F (2, 37)=3.284, p=.049]. Analysis of the coefficients revealed that the relationship between P1 and age was not significant [t=.471, p=.64]. However, the relationship between P1 and neck length was significant [t=-2.055, p=.047]. As neck length increased, P1 latency decreased. Statistical analysis of the relationship between N1, age, and neck length was not significant. A significant difference in asymmetry ratio means was found [t (19)=2.473, p=.023].

The current study indicates that normative values of VEMP latencies in the adolescent population should be based on the neck length rather than an age category. Within the adolescent population, there is a high variability of growth rate. This variability likely yields the non-significant relationship between age and VEMP latencies. The age of the adolescent in clinical practice is readily available; however, obtaining a neck length adds very little time to the test protocol and has shown to be a more accurate predictor for this age group.

Structural variance in the adolescent population has a significant factor on VEMP latency values. These structural variances should be accounted for when recording the VEMP in this population. Bilateral VEMP recording without the use of an EMG control is appropriate and efficacious in the adolescent population.

References


Speech-Evoked Envelope Following Responses as an Objective Aided Outcome Measure

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Objective outcome measures using auditory-evoked potentials could improve evaluation of hearing aid fittings in young infants. Several auditory-evoked potential methods have been proposed for use as an aided outcome measure. However, there have been concerns about accurate representation of hearing aid function in certain stimulus protocols. A test paradigm based on a speech-evoked envelope following responses (EFRs) was developed for use as an objective aided outcome measure. EFRs are neural responses phase-locked to the stimulus envelope and are elicited at the fundamental frequency of the voice, when elicited by a vowel. The test paradigm uses a naturally spoken speech token (/susa∫i/) that resembles running speech in temporal characteristics. The vowels and fricatives were modified to enable recording of EFRs from low, mid, and high frequency spectral regions.

In our validation studies, we evaluated the sensitivity of the test paradigm to changes in stimulus level, bandwidth, and use of amplification in adults with normal hearing (NH) and hearing loss (HL). Additionally, we evaluated the relationship between EFRs and behavioral measures such as speech discrimination and sound quality in multiple bandwidth conditions.

To evaluate the protocol’s sensitivity to level and amplification, EFRs were recorded in 20 adults with NH and 21 adults with HL at stimulus levels of 50 and 65 dB SPL. Adults with NH were tested unaided, and adults with HL were tested unaided and aided using individually verified hearing aids. As hypothesized, the number of EFRs detected and the amplitudes of the majority of EFRs increased with the increase in level and use of amplification, consistent with improved audibility.

To evaluate the protocol’s sensitivity to bandwidth, EFRs also were recorded in three low-pass filtered conditions with cut-off frequencies of 1, 2, and 4 kHz at 65 dB SPL. Adults with NH were tested unaided and adults with HL were tested aided. A consonant-recognition test and sound-quality rating were completed in the three low-pass filtered conditions and the full bandwidth condition. The number of detected EFRs and the combined response amplitude of EFRs increased as the stimulus bandwidth increased. The bandwidth-related changes in the EFR parameters (number detected and response amplitude) were significantly correlated with bandwidth-related trends observed in behavioral tests. In agreement with...
previous studies, consonant recognition scores and sound-quality rating improved with increases in stimulus bandwidth in both groups.

Our validation studies in adults suggest that the speech-evoked EFR test paradigm demonstrates sensitivity to improved audibility due to stimulus level, bandwidth, and amplification. The protocol also demonstrates convergent validity when compared with bandwidth-dependent psychophysical measures of hearing aid outcome. Average response detection times of significant EFRs were about 6 ± 2 minutes in adults with NH and about 8 ± 3 minutes in adults with HL tested aided. These short test times favor clinical feasibility to evaluate encoding of multiple spectral regions important for speech understanding. In summary, this new procedure may be useful in validation of hearing aid fittings. Further studies evaluating the protocol in children are necessary.

Onset-Offset N1-P2 Response Comparisons: A Possible Index for Tinnitus Verification

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Tinnitus traditionally has been conceptualized as a phenomenon generated from within the peripheral auditory system (i.e., the cochlea). Evidence has emerged supporting central auditory nervous system (CANS) origins and mediators for tinnitus, including the auditory cortical sites in the temporal lobe. It is hypothesized that tinnitus in some individuals with normal hearing sensitivity may be generated at the level of the CANS (Eggermont, 2005; Saunders, 2007). The onset-offset N1-P2 auditory evoked response is an exogenous potential generated in the auditory cortex in response to stimuli long enough in duration to evoke two N1-P2 responses, one to stimulus onset and one to stimulus offset. It is recommended that stimuli longer than 1000 milliseconds in duration with at least 4000 millisecond gaps between stimuli be used to evoke the response (Hillyard and Picton, 1978).
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In a sister study conducted in the Neuroaudiology Lab at the University of Connecticut that examined onset-offset response changes resulting from stimulus alterations, 17 individuals were evaluated, three of whom had chronic tinnitus. These three individuals exhibited notable differences in onset-offset N1-P2 morphology compared to the 14 individuals without tinnitus, especially for broadband stimuli 2000 milliseconds in duration presented at 70 dB SL.

The present study is an extension of the aforementioned study. Two normal hearing samples of 6 subjects each were recruited, one with tinnitus and one without tinnitus. Hearing sensitivity and central auditory processing function were screened, and the sample with tinnitus completed a pitch and loudness matching procedure and the Tinnitus Handicap Inventory.

All participants accepted were assessed using the onset-offset N1-P2 through the NeuroScan Stim2 evoked response system. Broadband stimuli of 2000 milliseconds duration in 4500 millisecond gaps at 70 dB SL were presented to each subject. Three stimulus presentation conditions were used: right ear, left ear, and both ears (binaural). Two waveforms were obtained and averaged for each condition using Cz as the active electrode site referenced to the inion of the skull.

The N1 response was a focus of data analysis, as it is the sole exogenous electrophysiologic component that diminishes in amplitude with binaural stimulation (Lavikainen et al, 1997).

The right and left ear averaged waveforms were added together (R+L), and the N1 amplitude differences between the onset and offset components of the binaural waveform as well as the R+L waveform were computed. The binaural calculation was then subtracted from the R+L calculation to yield a “binaural N1 amplitude suppression” value.

Using this waveform analysis procedure, the tinnitus group’s values were significantly smaller than those calculated for the non-tinnitus group (P = 0.0016) using a two-tailed independent samples t-test. When a comparison of onset-only N1 [(R+L) - B] was performed, the groups differed significantly (P = 0.014). A comparison of offset-only N1 [(R+L) - B] was performed as well, and, even though these amplitude values did not reach statistical significance at the 0.05 alpha level (P = 0.26), the tinnitus group showed a trend of increased suppression values for the offset-only comparison.

Therefore, individuals without tinnitus exhibited increased binaural N1 amplitude suppression for the onset compared to the offset, while individuals with tinnitus exhibited increased binaural N1 amplitude suppression for the offset compared to the onset, at least for the participants recruited for this study.

References


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Attitudes of Audiologists Toward Individuals with Multiple Disabilities
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The purpose of the study was to investigate attitudes of audiologists toward individuals with multiple disabilities. Due to advancements in technology to better diagnose disabilities, deinstitutionalization and inclusion of people with disabilities into society, and health-care advances that allow adults to live longer, the number of individuals with multiple disabilities is growing.

Previous literature has indicated that negative attitudes of health-care professionals may negatively impact the quality of patient care (Satchidanand et al, 2012). Researchers have also found through pre- and post-test measures that including an educational program for health-care providers about people with disabilities can help create more positive attitudes (Loiacono et al, 1996; Oermann and Lindgren, 1995). The Interactions with Disabled Persons Scale (IDP) (Gething, 1991) has been used to assess attitudes of different populations, but research on the attitudes of audiologists is lacking. Having a better understanding of audiologists’ attitudes may help determine if continuing education opportunities and/or extra coursework in academic training programs may be beneficial. Therefore, the primary goals of the study were to determine if the overall attitudes are consistent with normative data from the IDP, and to determine which demographic and within-subject factors would have the greatest effect on IDP scores.

Survey results from 473 audiologists were analyzed. The mean IDP score of audiologists (M=61.86) was within one standard deviation of the normative sample mean IDP score (M=64.14). In the current sample, mean IDP scores were significantly different across age groups (p=.003); specifically, IDP scores were lower for the oldest (>55) group when compared to the youngest (18–35) group. The most influential factors in predicting IDP scores were identified as job setting, age, level of contact, and academic degree. Audiologists with jobs settings rated as “other,” those older than 55 years of age, and those with an AuD degree were predicted to have more positive attitudes than audiologists not meeting those criteria. Audiologists who were ages 18–35 and who reported only monthly contact with people with multiple disabilities were predicted to have the least positive attitudes. Finally, in the sample of audiologists assessed, IDP scores were significantly different between audiologists with “daily” versus “less than monthly” contact, and between audiologists with “weekly” versus “less than monthly” contact.
Therefore, increased contact may improve comfort; however, future research is warranted to investigate the effects of quantity and quality of interactions on attitude scores. Additional variables also may be explored to help account for more variance in IDP scores. One-hundred ninety-one audiologists had IDP scores that were poorer than the mean score from the normative sample, suggesting that continuing education efforts could be pursued to potentially improve attitudes of audiologists. Professionals who are responsible for continuing education should consider providing opportunities for audiologists to learn about individuals with multiple disabilities in various contexts, and audiologists should seek experiences to engage in social interaction with individuals with multiple disabilities. These efforts may improve attitudes of audiologists and improve quality of care for this unique population now, and in the future.

References

Proliferation Patterns in Zebrafish Neuromasts Following Cisplatin Toxicity
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The development of hair cell regeneration therapies is of interest to clinicians and patients alike. Additional research in animal models is required to unlock the molecular processes underlying hair cell regeneration and to uncover the limitations these potential therapies may have in treating persons with hearing and vestibular deficits.

Unlike mammals, fish can regenerate hair cells following ototoxic drug exposure (Oesterle and Stone, 2008). Hair cells in lateral line neuromasts are physiologically akin to inner ear hair cells, but are used by fish to detect vibrations in the surrounding water (Dambly-Chaudière et al., 2003). When extensive hair cell damage occurs, nearby internal supporting cells can divide and differentiate into new hair cells (Ma et al., 2008). Although near complete restoration of lateral line hair cells is observed 2-3 days post-aminoglycoside exposure (Mackenzie and Raible, 2012), recovery from cisplatin toxicity is incomplete even after 10 days (Genuaidi, 2012). Unlike aminoglycosides, cisplatin is both ototoxic and antimitotic ( Rybak et al, 2009).

The purpose of the present study was to uncover why hair cell regeneration in zebrafish is impaired following cisplatin exposure. Five day post-fertilization zebrafish were incubated for four hours in 1000 µM cisplatin (N=42) or embryo medium (N=51) and then permitted to recover for 24-96 hours. We hypothesized that fewer regenerated hair cells are observed in cisplatin-treated fish because dividing supporting cells (i.e., hair cell progenitors) are damaged by cisplatin’s antimitotic properties. In order to quantify the number of supporting cells undergoing division each day after treatment, fish were incubated in 5 µM BrdU during the last 24 hours of their survival. Since BrdU is a nucleotide analog incorporated into the DNA of dividing cells, it is an ideal marker for identifying mitotically active progenitor cells and any progeny resulting from progenitor divisions. To determine the number of progeny surviving in the “long term” after cisplatin (N=123) or mock (N=80) treatment, fish were allowed to recover for 12 hours, incubated in 5 µM BrdU for four hours, and then permitted to recover for an additional 0–72 hours. Upon completion of both experiments, the fish were sacrificed and fixed for preservation. Cell nuclei were stained blue using DAPI, and BrdU analogs were stained green using anti-BrdU and Alexa-488 antibodies. Finally, confocal microscopy was used to image the three most posterior neuromasts of each fish, and BrdU+ cell counts were performed for each neuromast. Two-tailed t-tests were conducted to identify statistical differences.

Compared to control animals, experimental animals exhibited a significant increase in the mean number of BrdU+ cells counted between 48–72 hours post-treatment. Although increased supporting cell proliferation was observed in experimental fish, long-term survival of internal supporting cell progeny was not. These findings indicate that the robust regenerative response typically
observed in zebrafish neuromasts following ototoxic drug exposure is impaired by cisplatin’s lingering toxic effects on dividing progenitors. So long as these toxic effects remain, a mitotic replacement approach to hair cell regeneration is an unlikely treatment option for hearing loss secondary to cisplatin exposure.

References


