The Role of Oxidative Stress in Noise-Induced Hearing Loss.
Donald Henderson; Eric C. Bielefeld; Kelly Carney Harris; Bo Hua Hu

Abstract:
Modern research has provided new insights into the biological mechanisms of noise-induced hearing loss, and with these new insights comes hope for possible prevention or treatment. Underlying the classic set of cochlear pathologies that occur as a result of noise exposure are increased levels of reactive oxygen species (ROS) that play a significant role in noise-induced hair cell death. Both necrotic and apoptotic cell death have been identified in the cochlea. Included in the current review is a brief review of ROS, along with a description of sources of cochlear ROS generation and how ROS can damage cochlear tissue. The pathways of necrotic and apoptotic cell death are also reviewed. Interventions are discussed that target the prevention of noise-induced hair cell death: the use of antioxidants to scavenge and eliminate the damaging ROS, pharmacological interventions to limit the damage resulting from ROS, and new techniques aimed at interrupting the apoptotic biochemical cascade that results in the death of irreplaceable hair cells.

Maturation of Auditory Steady-State Responses in Normal Babies.
Gary Rance; Dani Tomlin

Abstract:
Objective: To track the development of the auditory steady-state response (ASSR) through the neonatal and early infant periods in a group of normal-hearing babies.

Design: This longitudinal study involved assessment at four data collection points. ASSR thresholds to modulated 500 Hz and 4 kHz tones were established in 20 full-term subjects at 0, 2, 4, and 6 wks of age.

Results: Significant developmental changes were observed for both test frequencies. Mean ASSR threshold levels decreased by approximately 10 dB between the week 0 and week 6 data collection points.

Conclusions: The results of this study indicate that ASSR threshold levels in normal-hearing neonates and young infants are different from those observed in older subjects. Clinical application of the ASSR procedure in this population will need to take into account developmental changes occurring in the first weeks of life. Furthermore, the findings indicate that ASSR thresholds in normal-hearing babies at 6 wks of age are not yet mature.

Development and Evaluation of the Listening in Spatialized Noise Test.
Sharon Cameron; Harvey Dillon; Philip Newall

Abstract:
Objective: The goal of this study was to design and develop an audiological test that provides an ecologically valid measure of speech understanding in background noise while minimizing the effects of between-listener variation in factors such as linguistic skills and attention on test performance. The Listening in Spatialized Noise Test (LISN(R)) creates a three-dimensional auditory environment under headphones and was designed to be totally software driven, so that it can be delivered in any audiology clinic with the use of only a PC and an audiometer. The
extent to which the LISN was able to simulate free-field conditions and the effect of learning on the test were also examined.

Design: In a three-alternative forced choice adaptive procedure, 20 adults with normal hearing were required to indicate the intelligibility level of target continuous discourse presented at 0[degrees] azimuth in the presence of distracter sentences simultaneously presented at either 0[degrees] azimuth (0[degrees] condition) or at both +90[degrees] and -90[degrees] azimuth (+/-90[degrees] condition). The target story was always spoken by female 1, whereas there were three conditions of speaker for the distractor sentences: the “same female speaker” as the target (same voice condition); two “different female speakers” (different female voices condition); and a “male speaker” (male voice condition). In a separate study, 16 adults with normal hearing who had not participated in the first study were assessed on the same voice and different female voices conditions, which were presented and then retested in the same order and test session to determine the effect of practice on performance on the LISN.

Results: The 20 adults were able to understand the target story at a significantly lower threshold in the +/-90[degrees] condition than the 0[degrees] condition. The degree of this spatial separation advantage (SSA) decreased significantly as the vocal quality of speakers of the target and the distracter sentences became more different (10.4 dB in the same voice condition, compared with 5.6 dB in the different female voices condition, and only 3.3 dB in the male voice condition). The SSA for the different female voices and male voice conditions were comparable to measurements previously reported in a free-field environment. There was no significant difference in SSA between the first and second presentations for either the same voice condition (at 10.3 dB and 10.2 dB) or the different female voices condition (at 4.7 and 5.7 dB).

Conclusions: For adults with normal hearing, the ability to comprehend the story in the separate condition was facilitated by the use of binaural cues, such as interaural time differences, to distinguish the target from the spatially separated distracters. When a target and masker are distinguishable on the basis of features of the various speakers’ voices (such as large differences in fundamental frequency), listeners are less reliant on spatial cues to recognize the target, and the SSA in dB is reduced. The stability of test scores with practice, the comparable levels of performance to those achieved in free-field environments, and the ability of the test to utilize difference scores to assess binaural processing while minimizing differences between participants in variables such as linguistic skills make the LISN a potentially valuable tool for assessing auditory processing disorders.

Ruth Y. Litovsky; Patti M. Johnstone; Shelly Godar; Smita Agrawal; Aaron Parkinson; Robert Peters; Jennifer Lake

Abstract:
Objective: To evaluate sound localization acuity in a group of children who received bilateral (BI) cochlear implants in sequential procedures and to determine the extent to which BI auditory experience affects sound localization acuity. In addition, to investigate the extent to which a hearing aid in the nonimplanted ear can also provide benefits on this task.

Design: Two groups of children participated, 13 with BI cochlear implants (cochlear implant + cochlear implant), ranging in age from 3 to 16 yrs, and six with a hearing aid in the nonimplanted ear (cochlear implant + hearing aid), ages 4 to 14 yrs. Testing was conducted in large sound-treated booths with loudspeakers positioned on a horizontal arc with a radius of 1.5 m. Stimuli were spondaic words recorded with a male voice. Stimulus levels typically averaged 60 dB SPL and were randomly roved between 56 and 64 dB SPL (+/-4 dB rove); in a few instances, levels were held fixed (60 dB SPL). Testing was conducted by using a "listening game" platform via computerized interactive software, and the ability of each child to discriminate sounds presented to the right or left was measured for loudspeakers subtending
various angular separations. Minimum audible angle thresholds were measured in the BI (cochlear implant + cochlear implant or cochlear implant + hearing aid) listening mode and under monaural conditions.

Results: Approximately 70% (9/13) of children in the cochlear implant + cochlear implant group discriminated left/right for source separations of <=20[degrees], and, of those, 77% (7/9) performed better when listening bilaterally than with either cochlear implant alone. Several children were also able to perform the task when using a single cochlear implant, under some conditions. Minimum audible angle thresholds were better in the first cochlear implant than the second cochlear implant listening mode for nearly all (8/9) subjects. Repeated testing of a few individual subjects over a 2-yr period suggests that robust improvements in performance occurred with increased auditory experience. Children who wore hearing aids in the nonimplanted ear were at times also able to perform the task. Average group performance was worse than that of the children with BI cochlear implants when both ears were activated (cochlear implant + hearing aid versus cochlear implant + cochlear implant) but not significantly different when listening with a single cochlear implant.

Conclusions: Children with sequential BI cochlear implants represent a unique population of individuals who have undergone variable amounts of auditory deprivation in each ear. Our findings suggest that many but not all of these children perform better on measures of localization acuity with two cochlear implants compared with one and are better at the task than children using the cochlear implant + hearing aid. These results must be interpreted with caution, because benefits on other tasks as well as the long-term benefits of BI cochlear implants are yet to be fully understood. The factors that might contribute to such benefits must be carefully evaluated in large populations of children using a variety of measures.

Using a Combination of Click- and Tone Burst-Evoked Auditory Brain Stem Response Measurements to Estimate Pure-Tone Thresholds.

Michael P. Gorga; Tiffany A. Johnson; Jan R. Kaminski; Kathryn L. Beauchaine; Cassie A. Garner; Stephen T. Neely

Abstract:
Design: A retrospective medical record review of evoked potential and audiometric data were used to determine the accuracy with which click-evoked and tone burst-evoked auditory brain stem response (ABR) thresholds predict pure-tone audiometric thresholds.

Methods: The medical records were reviewed of a consecutive group of patients who were referred for ABR testing for audiometric purposes over the past 4 yrs. ABR thresholds were measured for clicks and for several tone bursts, including a single-cycle, Blackman-windowed, 250-Hz tone burst, which has a broad spectrum with little energy above 600 Hz. Typically, the ABR data were collected because the patients were unable to provide reliable estimates of hearing sensitivity, based on behavioral test techniques, due to developmental level. Data were included only if subsequently obtained behavioral audiometric data were available to which the ABR data could be compared. Almost invariably, the behavioral data were collected after the ABR results were obtained. Because of this, data were included on only those ears for which middle ear tests (tympanometry, otoscopic examination, pure-tone air- and bone-conduction thresholds) indicated that middle ear status was similar at the times of both tests. With these inclusion criteria, data were available on 140 ears of 77 subjects.

Results: Correlation was 0.94 between click-evoked ABR thresholds and the average pure-tone threshold at 2 and 4 kHz. Correlations exceeded 0.92 between ABR thresholds for the 250-Hz tone burst and low-frequency behavioral thresholds (250 Hz, 500 Hz, and the average pure-tone thresholds at 250 and 500 Hz). Similar or higher correlations were observed when ABR thresholds at other frequencies were compared with the pure-tone thresholds at corresponding frequencies. Differences between ABR and behavioral threshold depended on behavioral threshold, with ABR thresholds overestimating behavioral threshold in cases of normal hearing and underestimating behavioral threshold in cases of hearing loss.
Conclusions: These results suggest that ABR thresholds can be used to predict pure-tone behavioral thresholds for a wide range of frequencies. Although controversial, the data reviewed in this paper suggest that click-evoked ABR thresholds result in reasonable predictions of the average behavioral thresholds at 2 and 4 kHz. However, there were cases for which click-evoked ABR thresholds underestimated hearing loss at these frequencies. There are several other reasons why click-evoked ABR measurements were made, including that they (1) generally result in well-formed responses, (2) assist in determining whether auditory neuropathy exists, and (3) can be obtained in a relatively brief amount of time. Low-frequency thresholds were predicted well by ABR thresholds to a single-cycle, 250-Hz tone burst. In combination, click-evoked and low-frequency tone burst-evoked ABR threshold measurements might be used to quickly provide important clinical information for both ends of the audiogram. These measurements could be supplemented by ABR threshold measurements at other frequencies, if time permits. However, it may be possible to plan initial intervention strategies based on data for these two stimuli.

Standard and Multifrequency Tympanometric Norms for Caucasian and Chinese Young Adults.
Navid Shahnaz; Dreena Davies

Abstract:
Objective: This study examined differences between a group of normal-hearing Caucasian and Chinese young adults on six tympanometric parameters. The goal of this study was to determine if the Chinese group had different low and multifrequency tympanometry results than the Caucasian group.

Design: There were a total of 159 subjects (303 ears) between the ages of 18 and 34 years, with 76 subjects in the Caucasian group and 83 subjects in the Chinese group. Tympanometric data were gathered on a clinical immittance machine, the Virtual 310 equipped with a high frequency option. Four of the parameters-static admittance (SA), tympanometric width (TW), tympanometric peak pressure (TPP), and ear-canal volume (ECV)—were measured automatically at a standard 226 Hz frequency. The remaining two parameters—resonant frequency (RF) and SA up to 1200 Hz—were measured by multifrequency, multicomponent tympanometry, using a mathematical approach.

Results: The Chinese group had significantly lower SA, wider TW, more positive TPP, and lower ECV than their Caucasian counterparts. The parameter of SA up to 1200 Hz showed a significant group effect (Caucasian versus Chinese) until 900 Hz in the male group and up to 1120 Hz in the female group. The Chinese group had significantly higher RF than the Caucasian group. Once the effect of body size was compensated by adjusting for the ear canal and the middle ear volumes, the differences observed between the Caucasian and the Chinese groups were no longer significant for tympanometric parameters obtained at standard probe tone frequency of 226 Hz; however, the effect was still significant for SA obtained at higher probe tone frequencies (560, 630, 710, 800, and 900 Hz) and for RF. Applying the Caucasian norms to a group of mainly Caucasian adults with surgically confirmed otosclerosis resulted in improved overall test performance when compared with the combined Caucasian and Chinese norms and the Chinese only norms.

Conclusions: It seems that the body size plays a crucial factor in the observed differences between the Caucasian group and Chinese groups at a standard probe tone frequency of 226 Hz; however, other mechano-acoustical properties of the middle ear may contribute to these differences at higher probe tone frequencies. Findings of this study suggest that further research is needed to investigate the effects of body size on immittance measures with other ethnic groups. In the meantime, overall test performance may be improved by using a more homogenous norm when testing the Caucasian or Chinese individuals.

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