

Hearing Review™

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Issue 22 - 2010

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Welcome to the twenty-second issue of Hearing Review.

Our first paper in this issue of Hearing Review looks at a different approach to Auditory Brainstem Response Audiometry by using complex, everyday sounds. We also look at some clinical issues related to non-organic hearing loss in childhood, adult sudden sensorineural hearing loss, and cochlear implantation in children with auditory neuropathy spectrum disorder.

I hope you find the range of papers in this issue interesting and useful, and I welcome your comments and feedback

Kind regards,

Valerie Looi

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Auditory brain stem response to complex sounds: a tutorial

Authors: Skoe E, Kraus N

Summary: This tutorial review describes the collecting and analysing of speech-evoked auditory brain stem responses to complex sounds (cABRs) and gives an overview of the rationale and historical perspective for a range of recording and stimulus parameters that can be used to assess auditory brainstem responses to more realistic, everyday stimuli. They explain how clinicians and researchers can incorporate cABRs into their clinical or research programmes. For example, cABRs can be used to assess specific impairments in auditory processing, or to objectively and noninvasively examine cognitive function and experience-dependent processes in sensory activity. These qualities render cABRs very useful in the study of populations where auditory function is of interest (e.g., auditory experts such as musicians, and persons with hearing loss, auditory processing, and language disorders).

Comment: The application of click-evoked ABR for determining auditory thresholds and detecting neuropathologies is well known. However, these stimuli are poor representations of real-world stimuli such as music, speech and environmental sounds. cABR emerged in the 1980s, where researchers showed that responses to speech sounds could be observed in the resulting waveform. cABRs are recorded several milliseconds post-stimulus onset and reflect a neural response. Most commonly used cABR stimuli have been the consonant-vowel syllable /da/ and lexical tones, but have also included words, phrases, environmental sounds, non-speech vocal sounds and music. cABRs have shown our plasticity in the subcortical processing of these sounds, and that this is associated with experience and linked to cognitive processes involving language and music. cABR responses are sensitive to auditory training effects and may allow for the early identification of auditory processing deficits linked to learning or language disorders. For example, it has been shown that cABR abnormalities are linked to poorer speech-in-noise perception.

This interesting review article outlines some clinical applications of cABR, how to select appropriate stimuli, the presentation of these stimuli, collection parameters, and how to analyse the resulting waveforms.

Reference: *Ear Hear.* 2010;**31(3):302-24.**

http://www.soc.northwestern.edu/brainvolts/documents/Skoe_Kraus_EH2010.pdf

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Interaural attenuation for Sennheiser HDA 200 circumaural earphones

Authors: Brännström KJ, Lantz J

Summary: This study sought to establish the interaural attenuation (IA) for pure tones (frequency range 125 to 16,000 Hz) using the Sennheiser HDA 200 circumaural earphones and compare them with those recorded using Telephonics TDH-39P supra-aural earphones in nine unilaterally deaf subjects. Amongst all subjects and at all tested frequencies, the lowest IA value recorded for the HDA 200 was 42 dB. The HDA 200 earphones provided more IA than the TDH-39P on average, especially at the low and high frequencies.

Comment: Three factors tend to contribute to the IA of air conduction earphones: vibration via the bone conduction mechanism, acoustic radiation from air conduction leakage from the transducer, and vibration of the mechanical connection between the earphones. Despite tending to provide better external sound attenuation than supra-aural earphones, circumaural earphones have generally provided less IA, probably due to one (or more) of three factors: air leakage from back venting, poorer vibration-insulation of the transducer itself, and/or that it provides more bone conduction. The IA values provided by the Sennheiser HDA 200 circumaural earphones in this study were better (higher) than those for the usual TDH-39 supra-aural earphones used in many clinics, particularly at the low and high frequencies, with little difference for 1000, 1500 & 2000 Hz. Its design is based on a hearing protector and thus provides more sound attenuation than the conventional TDH-39 earphones. This may also result in less acoustic radiation. The IA values of this circumaural earphone are significantly (~25dB) higher than for the previous Koss circumaural earphones, possibly as the HDA 200 earphones have no back venting and closer coupling between the earphone and the skull. The greater sound attenuation may be useful if testing in noisy environments, such as hearing screening in a school or work situation.

Of interest to clinicians may also be that the TDH-39 earphones provided an average IA of 58 dB (125 Hz: 40 dB; 250 Hz: 54 dB; 500 Hz: 58 dB; 1000 Hz: 65 dB; 2000 Hz: 55 dB; 4000 Hz: 64 dB; 8000 Hz: 69 dB).

Reference: *Int J Audiol.* 2010;49(6):467-71.

<http://www.ingentaconnect.com/content/apl/tija/2010/0000049/0000006/art00008>

Non-organic hearing loss in childhood

Authors: Morita S et al

Summary: These researchers sought to determine the aetiology, symptoms, diagnosis and prognosis of paediatric patients with non-organic hearing loss (NOHL), and to heighten awareness of this disorder among physicians. Medical records were retrospectively reviewed from 47 pediatric patients (aged 6–18 years of age) diagnosed with NOHL. Eighteen patients presented with unilateral hearing loss and 29 with bilateral hearing loss. Five patients received steroid treatment before the correct diagnosis was made, and six patients had secretory otitis media and underwent tympanostomy tube placement.

Comment: NOHL is a well recognised consideration in adults, but less so in children. It is defined in this article as “a conversion disorder whereby an unconscious psychological need is translated into a physical defect”. The presentation is a sudden idiopathic sensorineural hearing loss in one, or both, ears. This article differentiates between NOHL as researched in this study where the derivation is unconscious, as opposed to consciously faking a hearing loss for psychological, financial, or personal gain (i.e. pseudohypacusis or malingering). The former is usually attributable to a subconscious psychological defense mechanism triggered by conflict or stress.

In this study, NOHL was diagnosed when the child passed a DPOAE test along with recording a normal ABR or a Wave V evoked by a stimulus intensity of <10 dB nHL of the puretone audiometry threshold. Of the children in this study, the average hearing level provided being 65 dB at the initial appointment. More than a quarter had spontaneous recovery within a week, with over half within 2 weeks, and three-quarters within a month. Ninety-five percent had recovered within 2 months. It is suggested that clinicians avoid statements such as ‘there is nothing wrong with your hearing’, and instead, retest the child as soon as is practical in a supportive environment.

Reference: *Int J Pediatr Otorhinolaryngol.* 2010;74(5):441-6.

<http://www.ijporonline.com/article/S0165-5876%2810%2900006-6/abstract>

Independent commentary by Dr Valerie Looi, a Senior Lecturer in Audiology for the Department of Communication Disorders at the University of Canterbury. Her primary areas of research are in the field of cochlear implants, along with the music perception of those with a hearing impairment. She is particularly interested in developing a music training programme for cochlear implant users.

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Effects of universal newborn hearing screening on an early intervention program for children with hearing loss, birth to 3 yr of age

Authors: Halpin KS et al

Summary: This paper describes changes in the local early intervention (EI) programme for young children with hearing loss, following the introduction of the Universal Newborn Hearing Screening (UNHS) in Kansas in 1999. Data were retrospectively analysed from the charts of 145 children enrolled in the EI programme from 1999 to the last reporting year in the study (academic year 2005–2006). The percentage of the caseload identified in the newborn period had increased from about 25% before UNHS to over 80% after its implementation. After UNHS, the EI caseload included as many children with mild and moderate hearing loss as with severe and profound loss. At the time of the final study analysis, all children with profound hearing losses had cochlear implants.

Comment: This study provides some outcome data that may be of interest to early EI programs in NZ, with regard to the potential impact of UNHS on caseloads and patient demographics. As one would expect, the introduction of UNHS would result in changes for EI programs, such as an increase in caseload, a lower age of diagnosis of HL and amplification fitting for children, and an earlier age of enrolment in the EI program. Specifically, post-UNHS, enrolments nearly doubled, the mean age of HL diagnosis dropped to 3.7 months from 1 year pre-UNHS, with the age of amplification fitting changing from 18 months to between 6–10 months. Additionally, this programme found that the range of HL levels changed from being predominantly severe-to-profound, to an equal distribution of losses from mild through to profound. That is, significantly more children with lesser degrees of HL were being identified. One would view all of these changes as positive outcomes of UNHS, and verification that the UNHS was having an impact on the identification and remediation of infants with HL. The EI program in this study was home-based, and free to families.

Reference: *J Am Acad Audiol.* 2010;21(3):169-75.

<http://tinyurl.com/25zqucd>

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Threshold prediction in children with sensorineural hearing loss using the auditory steady-state responses and tone-evoked auditory brain stem response

Authors: Rodrigues GR, Lewis DR

Summary: Auditory steady-state responses (ASSRs) were compared to tone-burst auditory brain stem response (TB-ABR) and to behavioural thresholds obtained on follow-up audiometry at 500, 1000, 2000, and 4000 Hz in 17 infants and young children aged between 2 months and 3 years, with sensorineural hearing loss. Correlations of tone-evoked ABR and ASSRs thresholds at 500, 1000, 2000 and 4000 Hz were 0.91, 0.76, 0.81 and 0.89, respectively. On follow-up audiometry, strong correlations were observed between ASSRs and behavioural hearing thresholds; Pearson r values exceeded 0.94 at each test frequency.

Comment: One advantage that ASSR has to TB-ABR is that the latter requires subjective judgment in analysing the waveform and hence audiological experience is critical. ASSR, on the other hand, is detected by the computer using statistical tests, allowing for multiple responses to be simultaneously recorded, reducing test time. In this study, the comparison of TB-ABR, ASSR and BOA/VRA behavioural thresholds showed strong positive correlations between the 3 assessments at the analysed frequencies. ASSRs were able to be recorded at higher levels than TB-ABRs; however, it was cautioned that at high intensities there is the potential for these responses to reflect vestibular, rather than auditory, responses. Behavioural thresholds were approximately 5 dB higher than TB-ABR thresholds, and 2 dB higher than ASSR thresholds. These higher behavioural thresholds are to be expected, considering that in infants, behavioural assessments are more an evaluation of minimum response levels than true hearing thresholds. Overall, the results suggest that TB-ABR and ASSR tests can be used to predict puretone hearing thresholds in infants with sensorineural hearing losses.

Reference: *Int J Pediatr Otorhinolaryngol.* 2010;74(5):540-6.

<http://tinyurl.com/2dbvwd4>

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Disclaimer: This publication is not intended as a replacement for regular medical education but to assist in the process. The reviews are a summarised interpretation of the published study and reflect the opinion of the writer rather than those of the research group or scientific journal. It is suggested readers review the full trial data before forming a final conclusion on its merits.

How is the children's implant profile used in the Cochlear Implant Candidacy Process?

Authors: Lazaridis E et al

Summary: These researchers analysed the use of a modified version of the Children's Implant Profile (mChIP) in the candidacy process at The Children's Hospital of Philadelphia Cochlear Implant Program. Those cases in which the recommendation regarding implantation appeared inconsistent with the mChIP score were further analysed to understand the real-life decision processes. Outcomes were examined for 121 children assessed for cochlear implant (CI) candidacy at the hospital over a 2-year period. Eighty-seven were considered suitable for CI; implantation was not recommended for 20. Another 14 cases in which one or more of the mChIP had not been completed were excluded from analysis. The mChIP ratings of No Concern, Some Concern and Great Concern were assigned values of 1, 2 and 3, respectively. When the scores for the recommended and not-recommended groups were plotted to show the effect of adjusting a criterion mChIP score for recommending implantation, using a mean score of ≤ 1.55 as a criterion would correctly predict 75% of the team's recommendations to implant and 75% of recommendations not to implant. Examination of the cases where implantation was not recommended illuminated the decision-making process.

Comment: The Children's Implant Profile (ChIP) was developed in the early 1990s as an 11-item evaluation to be completed by a multidisciplinary team when considering a child's suitability for a CI using a 3-point response scale. The tool was found to help facilitate interdisciplinary collaboration and to identify families requiring additional support. In the last two decades, the ChIP has been modified, including the 31-item version in this study (mChIP) with sections to be completed by ENTs, audiologists, speech pathologists, social workers and education staff. A copy of the mChIP is provided in the article. Each item is scored, and a mean score can be calculated for the mChIP. Although the study was not able to identify a criterion score that could predict a team's recommendation, the tool as a whole could be used to assess areas of potential concern. Chronological age and duration of deafness were the only identified factors to impact on CI outcome.

Reference: *Int J Pediatr Otorhinolaryngol.* 2010;74(4):412-5.

<http://www.ijporonline.com/article/S0165-5876%2810%2900044-3/abstract>

Cochlear implantation in children with auditory neuropathy spectrum disorder

Authors: Teagle HF et al

Summary: Patient characteristics, preoperative audiological profiles, surgical outcomes, and postoperative performance are reported for children with auditory neuropathy spectrum disorder (ANSD), 52 (37%) of whom received cochlear implants (CIs) in their affected ears (mean duration of use of 41 months). A variety of medical comorbidities impacted on these children; over one-third had abnormal findings on preoperative magnetic resonance imaging (MRI) of the brain and inner ear, and 81% had a greater than severe (>70 dB HL) degree of hearing loss before implantation. Although 50% of the implanted children with ANSD demonstrated open-set speech perception abilities after implantation, nearly 30% of them with >6 months of implant experience were unable to participate in this type of testing because of their young age or developmental delays. No child with cochlear nerve deficiency in their implanted ear achieved open-set speech perception abilities.

Comment: Research into the epidemiology and diagnosis of ANSD has been discussed in previous issues of HRR. The habilitation of, and use of an assistive device (e.g. HA, CI), is still subject to much debate and must obviously be individualised for the child, given the heterogeneity of the condition. The clinic in this study incorporated diagnostic imaging, including MRIs as routine part of the diagnostic process, in addition to immittance, ABR, behavioural testing, OAEs and speech perception tests where possible. After diagnosis, a 3- to 6-month trial of HAs was instigated, and if the child did not make progress in their auditory or spoken language skills at a rate similar to their non-ANSD peers (with a hearing loss), a CI was considered.

Some of the interesting findings from the 140 children with ANSD in this study were that 28% used no assistive device, 31% used unilateral or bilateral HAs, 35% had unilateral or bilateral CIs, and 6% had a CI with a HA. Forty-two percent of the children were prematurely born, and 38% had abnormal findings on the MRIs. Of the 52 children who had received CIs, half achieved some open-set speech perception abilities, with 76% of these scoring $>30\%$ correct on word recognition tests, suggesting that ANSD itself should not be a contraindication to implantation. The study also demonstrated the predictive value of preoperative MRIs for children with ANSD getting a CI. Abnormal MRI and/or atypical/absent ECAP responses were associated with poor CI performance.

Reference: *Ear Hear.* 2010;31(3):325-35.

http://journals.lww.com/ear-hearing/Abstract/2010/06000/Cochlear_Implantation_in_Children_with_Auditory.3.aspx

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Systematic review of the evidence for the etiology of adult sudden sensorineural hearing loss

Authors: Chau JK et al

Summary: This systematic review of the literature found 23 studies reporting evidence regarding different aetiologies of sudden sensorineural hearing loss (SSNHL) as identified by clinical diagnostic tests in the adult population. Multiple aetiologies were identified.

Comment: SSNHL is the rapid progression of hearing impairment over a short period of time. It has been estimated that the incidence of SSNHL ranges from 5–20 per 100,000 persons p/year, with the peak incidence being in the 5th – 6th decade of life. The most common symptomatology is a unilateral hearing loss upon waking or attempting to use the affected ear. The loss may be sudden and stable, or rapidly progressive, affecting any (or a range of) frequencies. Tinnitus, vertigo and/or aural fullness may be present, although pain or facial numbness is rare.

This comprehensive literature review found that 71% of SSNHL cases are idiopathic, with the most common identifiable cause of SSNHL being infection (13%). The article includes a comprehensive table summarising articles which test for a specific SSNHL aetiology. Suspected aetiologies include viral inner ear infection (e.g. herpes simplex, cytomegalovirus, rubella), autoimmune disease (as seen by elevations in various inflammatory markers with significant changes in autoantibodies and cellular changes), vascular impairment (interruption of vascular flow to the cochlea), inner ear anomaly, and CNS abnormalities such as tumours, trauma, haemorrhage, infarctions, etc. A few of the studies found significantly higher rates of vestibular schwannomas in SSNHL patients, suggesting that MRIs should be conducted for patients presenting with SSNHL.

Reference: *Laryngoscope*. 2010;120(5):1011-21.

<http://www3.interscience.wiley.com/journal/123352270/abstract>

Survey on hearing aid outcome in Switzerland: associations with type of fitting (bilateral/unilateral), level of hearing aid signal processing, and hearing loss

Authors: Bertoli S et al

Summary: This investigation aimed to determine the individual and technological factors related to hearing aid (HA) outcome among 6027 HA users with symmetrical hearing loss. Evaluations focused on associations of hearing loss, level of signal processing, and fitting type (bilateral versus unilateral fitting) with HA use, satisfaction with and management of the aid.

Comment: The largely positive findings from this survey in part reflect the different HA provision system used in Switzerland. HA candidacy is not solely based on the audiogram, but also accounts for the resulting degree of social and emotional handicap. An ENT determines the need for and type of fitting to be provided. Subsequently, a private dispenser provides the HAs, which includes comparative fittings, trials of different types of devices, and ongoing post-fitting counselling. The Swiss social security system covers the total costs of bilateral HAs for those still working, but only 75% of the costs of a unilateral aid being covered for those who have retired. As a result, satisfaction rates with bilateral fittings were high, as were rates of regular bilateral HA use and HA satisfaction overall. Factors that most strongly affected outcomes were use, satisfaction and management. The main reasons for non-use were issues with noisy situations, unpleasant side effects and poor fit/comfort. Degree of hearing loss was the strongest determinant of successful HA outcome (moderate and severe HL decreased the risk of non-regular use). In a somewhat contradictory finding, advanced signal processing was associated with higher durations of use; however, satisfaction rates were higher for devices with simpler technology. Maybe those with complex devices had higher, less realistic expectations of their device?

Reference: *Int J Audiol*. 2010;49(5):333-46.

<http://informahealthcare.com/doi/abs/10.3109/14992020903473431>

Acoustic neuroma surgery for preservation of hearing: technique and experience in the Chinese PLA General Hospital

Authors: Han DY et al

Summary: This paper examined techniques to preserve hearing during acoustic neuroma resection in a series of 18 patients undergoing surgery for an acoustic neuroma who had preoperative hearing. All patients underwent continuous intraoperative auditory monitoring using auditory brainstem response (ABR) and electrocochleography (EcochG). The retrosigmoid approach was used for 16 complete resections and 2 patients underwent partial resections. Assisted endoscopic surgery was conducted for 10 ears.

Comment: An acoustic neuroma (or vestibular schwannoma) is a tumour on the vestibular nerve branch of the eighth cranial nerve. The use of endoscopy and intraoperative monitoring has led to high rates of preservation of facial nerve function. However, the preservation of hearing remains a challenge, and depends on a range of factors including the integrity and function of the internal auditory artery, the inner ear structure, and preservation of the cochlear nerve. Tumour size (and site) and preoperative hearing thresholds have the strongest association with hearing preservation results. In this study, hearing was monitored intraoperatively using ABR and EcochG. Sixty-one percent of patients had preserved post-surgery hearing; for tumours larger than 20 mm, hearing preservation rates were 40%, and nearly 70% for tumours <20mm. The article provides descriptions of cases where hearing was, and was not, preserved.

The use of ABR and EcochG is also discussed. Predicting hearing preservation from ABR results was possible. The presence of Waves I, III and V indicates the likelihood of hearing preservation. If there is no Wave V during surgery (with Waves I & III remaining), it is possible that Wave V could reappear during the recovery process, also suggestive of hearing preservation. However, if only Wave I is present post-surgery, prognosis is mixed, and if no Wave I is present, hearing is usually lost.

Reference: *Acta Otolaryngol*. 2010;130(5):583-92.

<http://informahealthcare.com/doi/abs/10.3109/00016480903402999>



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