

Pediatric Hearing Assessment

This booklet is designed to supplement the Phonak Video Focus “Pediatric Hearing Assessment”. The figures and references contained were selected to further clarify and/or direct interested readers to pertinent literature concerning appropriate screening and assessment procedures for infants and young children that are overviewed in the videotape.

The booklet has been organized according to four basic audiologic screening and assessment topics reviewed; namely, hearing loss identification in the newborn period, physiologic tests of middle ear and cochlear function, electrophysiologic (frequency-specific) auditory brain-stem response (ABR) procedures, and behavioral audiometry techniques. In addition, references are provided on the development of a pediatric evaluation protocol (test battery) and on the family-centered approach to hearing screening, assessment and management.

Screening and the comprehensive evaluation of hearing are important components of the early habilitation process. The accurate and timely detection and delineation of hearing loss allows appropriate amplification to be provided to the infant or young child. The use of prescriptive hearing aid fitting procedures is addressed in the companion videotape “Pediatric Hearing Instrument Fittings” in this Phonak Video Focus Series.

Newborn and Infant Hearing Screening

Due to pre- or perinatal complications or to family history, certain newborns are at higher risk for hearing loss than other babies born without such backgrounds. Moreover, other factors that occur early in childhood place some children who experienced typical birth histories at risk for later onset, progressive or acquired hearing loss.

High risk indicators for hearing loss proffered by the U.S. Joint Committee on Infant Hearing (JCIH, 1994) are delineated in **Table 1**. Risk indicators are provided for the age periods:

1. birth to 28 days,
2. 29 days to 2 years, and
3. 29 days to 3 years for infants requiring monitoring for progressive, late-onset, and acquired, hearing loss.

The JCIH 1994 Position Statement also recommends early detection of hearing loss throughout childhood and comprehensive assessment and follow-up.

Table 1

Indicators Associated with Hearing Loss JCIH 1994
Birth to 28 days
<ul style="list-style-type: none"> ● Family history of hereditary childhood sensorineural hearing loss. ● In-utero infection (e.g., TORCH). ● Craniofacial anomalies. ● Birthweight < 1500 g. ● Hyperbilirubinemia at serum level requiring exchange transfusion. ● Ototoxic medications including but not limited to the aminoglycosides used in multiple courses or in combination with loop diuretics. ● Bacterial meningitis. ● Apgar scores of 0–4 at 1 minute or 0–6 at 5 minutes. ● Mechanical ventilation ≥ 5 days. ● Stigmata or other findings associated with a syndrome known to include sensorineural and/or conductive hearing loss.
29 days to 2 years
<ul style="list-style-type: none"> ● Parent/caregiver concern regarding hearing, speech, language, and/or developmental delay. ● Bacterial meningitis and other infections associated with hearing loss. ● Head trauma with loss of consciousness or skull fracture. ● Stigmata associated with syndromes known to include hearing loss. ● Ototoxic medications including but not limited to the aminoglycosides used in multiple courses or in combination with loop diuretics. ● Recurrent or persistent Otitis Media with Effusion (OME) for a period of at least 3 months.

In Need of Monitoring: 29 days to 3 years
<ul style="list-style-type: none">● Family History of hereditary childhood hearing loss.● In-utero infections: CMV, rubella, syphilis, herpes or toxoplasmosis.● Neurofibromatosis Type II and neurodegenerative disorders.● Conductive hearing loss indicators: OME, anatomic deformities, neurodegenerative disorders.

Hearing loss is often identified late in childhood. The first three years of life is a period important for oral/aural speech and language acquisition. In response to this problem, in 1993, a panel formed by the U.S. National Institutes of Health (NIH) developed a Consensus Statement titled *Early Identification of Hearing Impairment in Infants and Young Children*. In the Statement, the NIH recommended screening for hearing loss be completed before the newborn is discharged from the hospital or within the first 3 months of life. Follow-up recommendations and research goals were also provided. **Table 2** highlights the primary points made in the 1993 NIH Consensus Statement.

Table 2

NIH Consensus Statement 1993
<ul style="list-style-type: none">● All infants admitted to the Neonatal Intensive Care Unit (NICU) should be screened for hearing loss prior to discharge from the hospital.● Universal screening should be implemented for all infants within the first 3 months of life, preferably before discharge from the hospital.● Hearing screening techniques should be rapid, reliable, highly sensitive, specific, and easy to administer by trained and supervised personnel.● A two-stage screening process should be used. Evoked Otoacoustic Emissions (EOAE) should be used for the initial screening. Babies failing EOAE should be rescreened using the Auditory Brainstem Response (ABR). (Those passing ABR rescreen should return for rescreen at 3–6 months of age.)● Babies failing ABR rescreen should be referred for diagnostic audiologic evaluation to:<ul style="list-style-type: none">– verify the existence of a hearing loss and to determine the type and severity of the impairment;– to initiate a remediation program for the infant and family.

Selected References:

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Eilers, R., Ordanar, O., & Steffins, M.L. (1993). Classification of audiograms by sequential testing: Reliability and validity of an automated behavioral hearing screening algorithm. *Journal of the American Academy of Audiology*; 4,172-181.

Hermann, B.S., Thornton, A.R., & Joseph, J.M. (1995). Automated infant hearing screening using the ABR: Development and validation. *American Journal of Audiology*, 4, 6-14.

Joint Committee on Infant Hearing 1994 Position Statement. *Asha*, 1994 (Dec): 38-41.

Kurman, B. & Spivak, L. Test equipment for newborn hearing screening. In: L. Spivak (ed), *Universal Newborn Hearing Screening: A Practical Guide*. Thieme Publishers, New York (in press).

NIH Consensus Statement. (1993) *Early Identification of Hearing Impairment in Infants and Young Children*. March 1-3; 11(1): 1-24. (Copies may be obtained from the Office of Medical Applications of Research, National Institutes of Health, Federal Building, Room 618, Bethesda, MD 20892.)

Meyer, D.M. & Gravel, J.S. Screening for hearing loss in infants and young children: An examination of the CAST procedure. *Journal of the American Academy of Audiology* (in press).

Spivak, L. (Ed). *Universal Newborn Hearing Screening: A Practical Guide*. Thieme Publishers, New York (in press).

White, K. (Ed). The Rhode Island Hearing Assessment Project (RIHAP). *Seminars in Hearing*, 1993.

Physiologic Assessment Procedures

Selected References:

Glatke, T.J., Pafitis, L.A., Cumiskey, C. & Herrer, G.R. (1995). Identification of hearing loss in children and young adults using measures of transient otoacoustic emission reproducibility. *American Journal of Audiology*, 4, 71-86.

Prieve, B. (1992). Otoacoustic emissions in infants and children: Basic characteristics and clinical application. *Seminars in Hearing* 13 (1) 37-52.

Marchant, C.D., et al. (1986). Objective diagnosis of otitis media in early infancy by tympanometry and ipsilateral acoustic reflex thresholds. *Journal of Pediatrics*, 109, 590-595.

Norton, S.J. (1993). Application of transient evoked otoacoustic emissions to pediatric populations. *Ear and Hearing*, 14, 64-73.

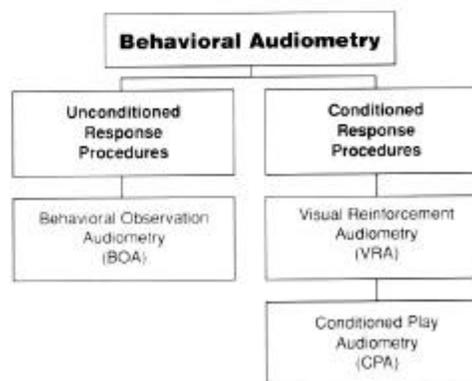
Nozza, R.J., Bluestone, C., Kardatzke, D., Bachman, R. (1994). Identification of middle ear effusion by aural acoustic admittance and otoscopy. *Ear and Hearing*, 15, 310-323.

Smurzynski, J., Jung, M.D., Lafreniere, D., et al. (1993). Distortion-product and click-evoked otoacoustic emissions of pre-term and full-term infants. *Ear and Hearing* 14, 258-274.

Behavioral Tests

Behavioral audiologic test techniques for infants and young children can be divided into two general categories: those that rely on observations of behavior (unconditioned response procedures) versus those that use operant conditioning techniques (conditioned response procedures) to maintain responding over repeated test trials. The outline provided in **Figure 1** classifies the behavioral techniques reviewed in the videotape.

Figure 1



Visual reinforcement audiometry (VRA) is a very useful test technique for infants beginning at 5 to 6 months of age. The availability of visual reinforcement for correct head-turn responding is critical to the success of operant audiometry. Practice of VRA is not restricted to the test suite arrangement depicted in the videotape. In the **figures below**, alternative arrangements for VRA testing are provided. (S = Loudspeaker; A = Audiologist, P = Parent; I = Infant, TA = Test Assistant; HC = High Chair; T = Table; VR = Visual Reinforcer unit.)

Figure 2

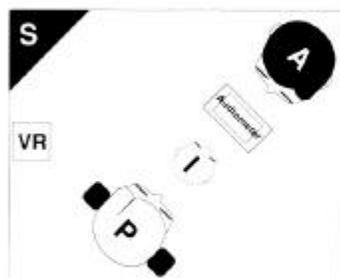


Figure 3

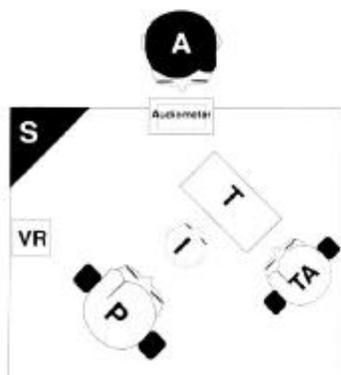


Figure 4

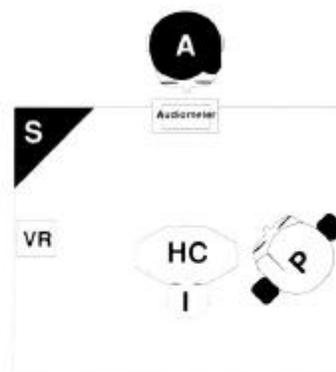
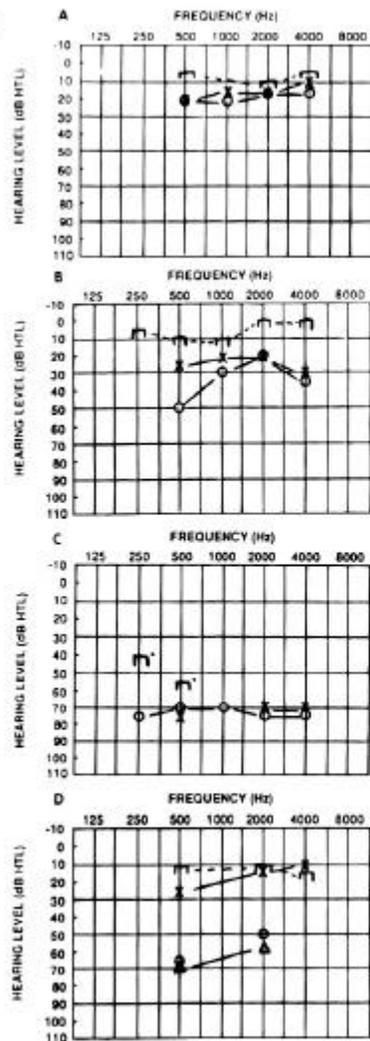


Figure 5 depicts four audiograms obtained from four 9-month-old infants using the VRA technique. Note that ear-specific and frequency-specific responses were obtained by air-conduction and that information from unmasked bone conduction was also obtained. Audiogram A – normal hearing; Audiogram B – conductive hearing loss secondary to otitis media; Audiogram C – severe cochlear hearing loss bilaterally; Audiogram D – unilateral hearing loss.

Figure 5



Gravel, J.S. (1989). Behavioral assessment of auditory function. *Seminars in Hearing* 10(3), 222. Reprinted with permission.

Table 3 provides mean sound field threshold data (in dB HL rounded to the nearest 5-dB audiometric step) obtained using a computerized VRA procedure. Thresholds are provided at 500, 1000, 2000 and 4000 Hz. Data are displayed for infants ages 5, 7, 10 and 12 months of age. Babies had normal tympanograms at the time of test. The data of between 40 and 49 babies were considered in each age category and for each frequency. Numbers in parentheses refer to variability (standard deviation) again, rounded to the nearest 5 dB. (Data based on Gravel and Wallace, 1997).

Table 3

	500 Hz	1000 Hz	2000 Hz	4000 Hz
5 months	20 dB HL (15)	25 dB HL (15)	25 dB HL (15)	25 dB HL (15)
7 months	10 dB HL (10)			
10 months	10 dB HL (5)	10 dB HL (10)	10 dB HL (10)	10 dB HL (5)
12 months	15 dB HL (5)	15 dB HL (10)	15 dB HL (10)	10 dB HL (10)

Selected References:

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Wilson, W. & Thompson, G. Behavioral audiometry. In: J. Jerger (Ed), *Pediatric Audiology*, (pp. 1-44) San Diego, CA: College-Hill Press, 1984.

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Selected References:

Oates, P. & Stapells, D.R. Auditory brainstem response estimates of the pure-tone audiogram: Current status. *Seminars in Hearing* (in press).

Purdy, S.C. & Abbas, P.J. (1989). Auditory brainstem response audiometry using linearly and Blackman-gated tone bursts. *ASHA*, 31, 115-116.

Stapells, D.R. Auditory brainstem response assessment of infants and children. *Seminars in Hearing*, 10(3); 229-251, 1989.

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Stapells, D.R. & Ruben, R.J. (1989). Auditory brainstem responses to bone-conducted tones in infants. *Annals of Otolaryngology, Rhinology and Laryngology*, 98, 941-949.

Yang, E.Y., Rubert, A.L., Moushegian, G. (1987). A developmental study of the bone conduction auditory brain stem response in infants. *Ear and Hearing*, 8, 244-251.

Test Battery in Pediatric Assessment

When assessing the hearing of infants and young children, it is important to adopt a test-battery approach. Such an assessment protocol is in keeping with the principles delineated by Jerger and Hayes (1976) that supported use of a "cross-check approach" to pediatric assessment. Figure 6 presents test protocols that are useful in the assessment of infants and young children. The protocols are modeled after those recommended by ASHA (1991), Chase et al. (in press), and Chase and Gravel (1996).

Selected References:

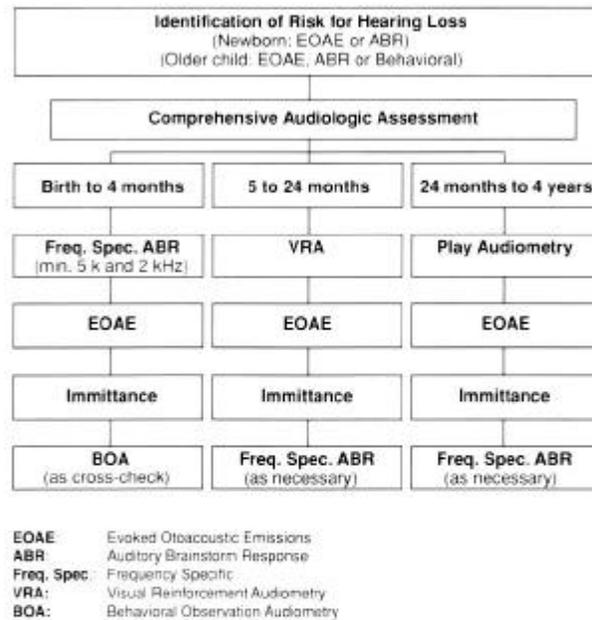
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Chase, P.A., Hall, J.W. & Werkhaven, J.A. (in press). Medical and audiologic assessment and management of sensorineural hearing loss children. In: Martin, F. & Clark, J. (Eds), *Pediatric Audiology*. New York: Allen & Bacon.

Jerger, J. & Hayes, D. (1976). The cross-check principle in pediatric audiometry. *Archives of Otolaryngology*, 102, 614-620.

Figure 6: Example of Pediatric Protocol



Family-Based Approach

Selected Reference:

Roush, J. & Matkin, N.D. (Eds). *Infants and Toddlers with Hearing Loss. Family-Centered Assessment and Intervention*. Baltimore MD: York Press, 1994.