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# CHILDHOOD AUDIOLOGICAL ASSESSMENT (PART II): RECOMMENDED PROCEDURES IN THE FIRST TWO YEARS OF LIFE

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# CHILDHOOD AUDIOLOGICAL ASSESSMENT (PART II): RECOMMENDED PROCEDURES IN THE FIRST TWO YEARS OF LIFE

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This month's bulletin discusses audiological procedures recommended for assessing a child's hearing in the first two years of life. We suggest the reader refer first to part 1 of our bulletin on Child Audiological Assessment, as the material is complementary. We invite you to accompany us on this journey into Child Audiological Assessment.

Concern about hearing has been growing, as the number of people with hearing impairment increases. According to the World Health Organization (WHO), deafness and hearing loss are found in all regions and countries. Currently, more than 1.5 billion people (almost 20% of the world's population) live with hearing loss; 430 million of them have disabling hearing loss and it is expected that by 2050 there could be more than 700 million people with the condition.

When considering the pediatric population,

**AROUND 34 MILLION CHILDREN HAVE SOME DEGREE OF HEARING LOSS**

and about 60% of cases are due to causes that can be avoided simply and at low-cost, such as:

- Immunisation to prevent disease
- Improved maternal and child health
- Early screening and treatment of ear infections and earwax buildup.

**HEARING LOSS CAN NEGATIVELY IMPACT QUALITY OF LIFE, DUE TO CHANGES IN SOCIAL, PERSONAL, AND CULTURAL INTERACTIONS.**

When hearing loss affects children, there can be delays in speech and language development and poorer academic performance.

To identify congenital hearing disorders early on, audiological tests can be applied soon after the baby is born. Such procedures, called Neonatal Hearing Screening (NHS), were covered in a previous bulletin (see Soares et al, 2023). If for some reason a baby failed to have NHS in a hospital, assessment procedures (otoacoustic emissions, OAEs) and automated Auditory Brainstem Response (aABR) will need to be done in an outpatient facility. The general recommendation for hearing screening is to use OAEs, but for children with a risk indicator for hearing impairment – and so having greater risk of neural impairment – the screening should be complemented with aABR.

**Regardless of the results of the hearing screening, if there is any suspicion on the part of parents, caregivers, health professionals, or educators about a child's hearing, an immediate medical and speech therapy evaluation is recommended.**

To make an accurate diagnosis in children, the audiologist must have the skills, knowledge, and access to equipment required for diagnosing babies, infants, and children. If a professional doesn't have the appropriate training or access, they will need to refer the patient to a specialised audiology center.


*Figure 1: A 4-month-old baby seeking out the source of his mother's voice. Image from the authors' personal collection.*

The following paragraphs present the main recommended assessments up to 24 months of age.

**Pediatric audiological diagnosis aims to identify hearing loss early and it needs to be done based on the principle of cross-checking, meaning that all the assessments (behavioral, physiological, and electrophysiological) need to agree. No audiological evaluation is complete unless more than a single test has been done.**

Consistent with the cross-check principle, different national and international bodies have established guidelines and recommendations on audiological screening, diagnosis, and monitoring of children. Pediatric audiologists should use protocols based on scientific evidence and according to the criteria recommended by these bodies, remembering that the protocols will need to consider the socioeconomic and cultural context of where they will be applied. Regardless of the protocol adopted, visual inspection of the external auditory canal (meatoscopy) is recommended for all children referred for audiological evaluation.

# UP TO 5 MONTHS OF AGE:

In this age group the gold standard in audiological investigation is the Auditory Brainstem Response (ABR), both for checking the integrity of the auditory pathway (click-ABR) and for researching auditory thresholds [specific frequency ABR (SF-ABR)]. The use of the Auditory Steady-State Response (ASSR) may be an alternative to correlate with psychoacoustic thresholds; however, in cases of suspected auditory neuropathy spectrum disorder (ANSD) it should be used with caution. Electrophysiological assessments are best carried out with the child sleeping naturally, with sedation reserved for children who are otherwise unable to perform the examination. Sedation carries risks and should only be used with caution. To test the tympanic ossicular system, acoustic immittance measurements must be carried out to analyse the mobility of the tympanic membrane (tympanometry). Similarly, the response of the auditory system and brainstem to strong sounds (ipsilateral and contralateral acoustic reflexes) should be tested. In this age group, tympanometry with a 1000 Hz probe tone or using a broadband stimulus is recommended.

**To test the integrity of cochlear function, specifically the outer hair cells (OHCs), otoacoustic emissions (OAEs) can be used. Either transient stimuli (TEOAEs) or distortion product (DPOAEs) are possible. These tests are extremely important for the differential diagnosis of ANSD.**


*Image 2: Baby tracking to the left in response to a sound from the coconut instrument. Image from the authors' personal collection*

The tests mentioned above enable a diagnosis of hearing loss, which is the first step in beginning auditory rehabilitation. However, such procedures do not provide any information on the child's auditory behavior, and this aspect requires observation and behavioral assessments.

Behavioral assessment makes it possible to investigate the development and maturation of auditory skills and to assess the responses in terms of speech and language development. For children less than two years of age, the assessment can be done by observing auditory behavior in response to uncalibrated sound instruments or with visual reinforcement audiometry. Several studies have set out normative values for behavioral assessment using linguistic and non-linguistic sounds.

# FROM 6 MONTHS TO 2 YEARS OF AGE:

VRA uses the operant conditioning technique in which a sound stimulus becomes associated with positive reinforcement presented visually (lights, animated toys, videos, etc.). The stimulus must be attractive, but it cannot be so stimulating that the child becomes distracted.

In some cases, children refuse to allow earphones to be placed over their ears, or not for long enough to analyse each ear separately. In these situations, it is possible to carry out assessments in a free field or by using a bone vibrator. Responses obtained in free field or with a bone vibrator, without contralateral masking, provide information about the performance of the better ear (in cases of auditory asymmetry).

To confirm the results obtained in RVA, speech detection thresholds can be tested, which can be obtained with earphones, a bone vibrator, or in free field. From 9 months of age onwards, in addition to the speech detection threshold, responses to the six Ling sounds and the recognition of verbal commands of various complexity can be verified. Both procedures are presented hands-free.

**In addition to a behavioral assessment, it is necessary to check the mobility of the tympanic-ossicular system. For babies up to 9 months of age, it is recommended to use tympanometry with a 1000 Hz probe tone or a broadband source; from 10 months of age, a conventional probe tone (226 Hz) can be used. In all cases it is necessary to test acoustic reflexes.**

In cases where the tympanic-ossicular system is intact, evoked otoacoustic emissions can be performed to complement audiological assessment or to make a differential diagnosis in cases where the child doesn't give reliable responses to behavioral assessments. The robust amplitude of evoked otoacoustic emissions in infants and children facilitates OAE detection, although one should note that the presence of TEOAE responses does not exclude the possibility that there is mild hearing loss. However, the presence of DPOAE responses ensures that the baby's hearing thresholds are better than 45–50 dB.

**For children who give reproducible responses only with physiological methods (acoustic immittance measurements and evoked otoacoustic emissions), it is necessary to complement the assessment with electrophysiological procedures (click ABR, SF-ABR, and ASSR).**

Although we have already mentioned the matter, it never hurts to reinforce the need for crosschecking when making audiological assessments in children. For ages 6 to 24 months, there are several audiological procedures that can be used to make an accurate and reliable diagnosis. Whenever possible, behavioral audiological assessment combined with physiological assessment should be the priority, and, if necessary, additional electrophysiological techniques.

Due to the complexity of the peripheral and central auditory system, the choice of diagnostic method depends on the expertise of the specialist audiologist as well as the peculiarities of each infant. In summary, there are several possibilities and strategies which can be employed, but the choice will depend on the evidence and the needs of each case.

We have presented a little more about the audiological procedures used in children, and we now invite you to continue with us on this journey of exploring children's audiological assessment by reading our forthcoming bulletins.


*Image 3: Baby locating the evaluator's voice. Image from the authors' personal collection.*

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