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Audiometric Assessment for Children aged 6 to 60 months

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Audiometric Assessment for Children aged 6 to 60 months.



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SECTION 1: INTRODUCTION

This protocol addresses procedures for audiometric assessment of hearing thresholds in infants and young children using behavioural measures of threshold and associated measures in a test battery. The scope of this document includes these assessments as funded by MCCSS for the Ontario Infant Hearing Program (IHP).

In infants and young children, modified operant conditioning is used to obtain systematic behavioural responses to sound from older infants and young children. These conditioned responses are used as the basis of behavioural audiometry until the child is developmentally able to complete standard audiometry, at about 3 to 5 years of age in typically developing children (Sabo et al., 2003). Specific procedures are used depending upon the developmental stage and motor abilities of the child. Visual Reinforcement Audiometry (VRA) is used for infants aged 6-24 months developmental age, or older (corrected age), who have sufficient vision to see the reinforcers, and who have sufficient trunk and neck control to turn toward the reinforcers voluntarily. As infants grow older, they are transitioned into Conditioned Play Audiometry (CPA). These two procedures are modified for use with children who do not have the visual, cognitive, or developmental ability to participate in these tasks using a range of strategies that are described here as Individualized Reinforcement Audiometry (IRA).

This document includes: (i) Key procedures that are mandatory (***bold italics***); (ii) Supplementary details on rationale, challenges, and solutions; (iii) Technical appendices; and (iv) key references.

1.1 VERSION HISTORY

The IHP Assessment Protocol (2008) has now been split into two protocols: Auditory Brainstem Response Assessment (ABRA; 2018) and the Audiometric Assessment in Children aged 6 to 60 months (Audiometric Assessment; 2018). This Audiometric Assessment protocol supersedes all previous versions. Notable revisions/additional protocol elements and dates are listed below.

Version Date	Document Title	Previous Version
October 2018 March 2019	Audiometric Assessment for Children aged 6 to 60 months, 2018.01 was released for clinician review. Following review, an updated version is now released for use in clinical practice as 2019.01.	IHP Audiologic Assessment Protocol, January 2008
October 2018	Protocol for Auditory Brainstem Response-Based Audiological Assessment 2018.01	Protocol for Auditory Brainstem Response-Based Audiological Assessment 2016.02

1.2 REVISION SUMMARY

With the recent amendments, several topics were added or expanded for this protocol based on current evidence and clinical practice. A summary is provided below.

Topic	Description	Section
Scope	Policy and procedural revisions as directed by the MCCSS. Corresponds to other IHP protocols so this can be a stand-alone document.	Various in Section 2: Scope
MRL and Minimum Test Levels	A normal MRL for this protocol is defined as 25 dB HL. Testing to 20 dB HL is supported, with reduction to adult-like test levels as the child progresses from VRA to CPA to standard testing. Normative ranges are provided.	3.7, 4.1
Mandatory Test Frequencies	Added high frequency thresholds in the minimum frequency set along with 500 and 2000 Hz.	2.15
Updated normative data for tympanometry.	Added new normative data with varying requirements by age.	Appendix C
Updated equipment options and new stimuli	Added options to use computer-assisted reinforcement and/or updated test signals at clinician's discretion. Specific additions of new, calibrated stimuli (F.R.E.S.H. noise and Pediatric noise) for use as audiometric stimuli.	2.26; 3.4
Follow up testing schedule	Added requirement to test frequently for children who have not yet completed a hearing evaluation, or those with transient conductive overlay, fluctuating hearing loss, or progressive loss.	4.1, 4.4
Continuous quality improvement and Key Performance Indicators	New.	2.19, Appendix E
VRA Worksheet.	Keeping a worksheet record is still mandatory, but the type of worksheet and symbol system used is at the clinician's discretion as long as key items are tracked.	2.27, Appendix A1 and 2
Restructured Document	Some protocol information within Appendices is now moved to main body of document.	Throughout
General edits	For clarity and to update relevant literature.	Throughout

SECTION 2: SCOPE

2.1 IHP CORE PRINCIPLES

Audiometric assessment, using behavioural measures with or without conditioning as required, shall be provided in accordance with the IHP core principles of informed family/caregiver choice and consent, timely provision of unbiased information based on the best available scientific evidence, and sensitivity to family culture and values.

2.2 BEHAVIOURAL HEARING ASSESSMENT PROCEDURES IN YOUNG CHILDREN

In older infants, toddlers, and children younger than approximately 36 months developmental age (Sabo et al., 2003), behavioral audiometry is performed with a modified operant conditioning technique, so that the child will provide enough responses to measure a partial audiogram. Responses may be Minimum Response Levels (MRL) or thresholds (depending upon the developmental stage of the child). This protocol includes Visual Reinforcement Audiometry (VRA), Conditioned Play Audiometry (CPA), and Individualized Reinforcement Audiometry (IRA) procedures that are used to test children for whom VRA and CPA are not appropriate. These procedures are embedded within a larger test battery that adheres to the cross-check principle (for children younger than 3 years developmental age (AAA; 2012) and for children older than this as required) and includes, at minimum:

1. Case history, including IHP screening history and any previous ABRA or behavioural assessments conducted with the child;
2. Otitic examination for both ears, which should be completed prior to inserting phones or eartips;
3. Assessment of otoacoustic emissions for both ears;
4. Assessment of middle ear status using immittance or reflectance measurements for both ears; and
5. Behavioural thresholds or MRLs by air and bone conduction for both ears as per this protocol.

2.3 WHO CAN CONDUCT BEHAVIOURAL AUDIOMETRY?

Only Audiologists registered with College of Audiologists and Speech Language Pathologists of Ontario (CASLPO) who are trained and authorized by the IHP to conduct this protocol may offer hearing assessment services with IHP funding. The IHP Audiologist must personally conduct the testing and interpret the results. The IHP Audiologist must not delegate the testing of CBA fully to a test assistant or student. A test assistant or student can be involved in the testing, including the administration of test stimuli and/or reinforcers or serving as a distractor, at the discretion of the audiologist and providing that the success of the test session is not compromised.

If an IHP Audiologist has been inactive in this protocol for six months or more, the re-training review procedures in the IHP Guidance document may apply.

Authorization for Assessment may be withdrawn at the discretion of the MCCSS.

2.4 PROTOCOL ADHERENCE IS A REQUIREMENT

All IHP hearing assessments must be conducted in adherence to this protocol; such adherence is an expectation for continued authorization to provide IHP services. Sufficient documentation of protocol adherence must be kept on file to support clinical decision support and/or standard practice reviews when necessary.

2.5 LEGITIMATE DEPARTURE FROM PROTOCOL

It is acknowledged that case-specific situations that justify departure from protocol elements can arise. Such departures must be noted in the records with a brief explanation. All such notes must be accessible to IHP standard practice review or case audits (see later).

2.6 CHANGES TO THE PROTOCOL

Prior approval by the MCCSS is required in order to change substantively any element of this protocol. Program-wide changes can occur only through MCCSS directive. If any IHP Audiologist has a substantial concern about the rationale or procedure of any element of this protocol, the issue should be identified to their regional IHP coordinator or discussed directly with a DTC.

2.7 NON-IHP SERVICES

Hearing assessment services conducted by any person who is not an Audiologist authorized by the IHP shall not be funded by the IHP and shall not be deemed to provide a sufficient basis for subsequent management within the IHP. For this reason, and because of the prevalence of progressive losses and/or conductive overlays in the pediatric population, IHP Audiologists shall re-test a child prior to making inferences about hearing status and/or candidacy for ongoing management.

2.8 POPULATIONS TARGETED

The target populations for procedures in this protocol are infants or young children within the eligible age range of IHP services who are either being seen for follow-up assessments after ABRA assessment or who:

1. Referred on IHP Universal Newborn Hearing Screening (UNHS) or who have confirmed permanent hearing loss from ABRA assessment and are in the developmental range of 6 months or older; or
2. Bypassed screening in accordance with IHP protocol and are in the developmental range of 6 months or older; or
3. Are otherwise designated as candidates by an IHP Regional Lead Agency or by a Designated Training Centre (DTC).

2.9 TARGET DISORDERS

The IHP target disorder set includes permanent hearing loss (PHL) of ≥ 30 dB HL at 0.5, 1, 2 or 4 kHz in any ear, auditory neuropathy spectrum disorder (ANS) and auditory brainstem pathway disorders that may be detectable using auditory brainstem response (ABR) techniques (see IHP ABRA Protocol). The target PHL includes conductive impairment associated with structural anomalies of the ear but does NOT include impairment attributable to minor, non-structural middle ear conditions.

2.10 CONDUCTIVE HEARING LOSS (CHL)

Purely conductive hearing loss is not an IHP target unless obviously or presumptively structural, such as in congenital atresia or if a syndrome associated with structural, conductive anomalies is identified or suspected.

For children referred from UNHS, the Audiologist performing ABRA must demonstrate presence of hearing loss of severity and frequency within the target disorder range. If a sensory/neural component is ruled out, primarily by bone conduction testing, the loss is deemed to be conductive. Absence or complete closure of the external auditory canal automatically confers permanence, but in all other cases, presence of conductive loss must be established audiometrically. If a syndrome that is known to be associated with conductive loss is already documented or is suspected by the Audiologist, the CHL may be presumed to be permanent. The same is true if a non-syndromic anomaly or external or middle-ear structure has been identified or is suspected.

Where there is no sensory/neural hearing loss and a relevant syndrome or anomaly are not suspected, classification of permanence is presumptive and is at the Audiologist's discretion, based mainly on tympanometry and audiometric assessment. For example, if the tympanogram is flat (Rosenfeld et al., 2016) and the threshold elevation is only at 0.5 kHz and less than about 45 dB HL, it is reasonable to infer that the loss is likely to be attributable to a transient middle-ear disorder.

The significance of the provisional classification of CHL permanence is that the IHP is not a systemic replacement for Ontario's medically-driven Ontario Health Insurance Plan (OHIP) system for pediatric hearing health care but, rather, is complementary to it. The management of middle-ear disorders is a medical/surgical matter that should normally fall under the OHIP system, as should associated diagnostic audiologic assessment. The usual course of events, given detection of minor, conductive hearing loss that is audiologically suggestive of middle-ear disease and asymptomatic, is to discharge the affected infant from the IHP, with appropriate caregiver information and counselling concerning self-referral to a physician if signs or symptoms of active middle-ear disorder occur. Such discharge does not preclude the infants from re-entering the IHP if and when external audiometric or otologic evidence suggesting a structural conductive or sensory/neural hearing loss component emerges and is confirmed by IHP audiologic assessment.

With discretionary exception of minor, conductive losses isolated at 0.5 kHz and accompanied by a flat tympanogram, detection of clinically significant conductive hearing loss may indicate the need for evaluation and/or treatment by a physician. While local protocols may vary, recent clinical guidance for the assessment and management of acute otitis media and otitis media with effusion are available (Lieberthal et al., 2013; Rosenfeld et al., 2016). These guidelines suggest medical treatment when the physician assesses that the child has ear pain and/or a bulging tympanic membrane (acute otitis media). They also suggest a period of watchful waiting for non-acute otitis media with effusion; watchful waiting monitors the child after three months, but also considers whether the child is considered at risk for a speech and language delay. The identification of significant hearing loss as a result of otitis media with effusion that has persisted for more than 3 months of watchful waiting is considered reason for re-evaluation by a physician (Rosenfeld et al., 2016). Physician follow-up every three to six months is recommended for non-acute otitis media.

2.11 OBJECTIVES OF HEARING ASSESSMENT

The main objectives of hearing assessment through conditioned procedures are to:

1. Determine the presence or absence of the target disorder;
2. Quantify hearing loss laterality, component types, severities and configuration with sufficient accuracy and efficiency to inform and facilitate timely, appropriate provision of IHP intervention services elected by the family;
3. Achieve (a) and (b) by eight to ten months corrected or developmental age for children who enter caseload prior to this age;
4. Achieve (a) and (b) within ideally 1 month and at most 3 months for children who enter caseload from referrals into the program from outside Ontario or due to late-onset hearing losses¹;
5. Provide ongoing assessment of the child's hearing status in follow-up to an identification; and
6. Provide opportunity to discuss test results with families in such a manner as to facilitate understanding, acceptance and positive engagement to the greatest extent feasible.

Objective (4) reflects the fact that in many cases, assessments will provide ongoing information to the family about the hearing status of the child, by being used in combination with screening history, case history, and any previous ABRA results. Accurate and efficient assessment is ineffective unless it leads to prompt and appropriate action by the family. Therefore, supporting successful intervention is considered a key component of hearing assessment that is primarily the responsibility of the Audiologist conducting the assessment.

2.12 AGE AT FIRST CONDITIONED HEARING ASSESSMENT

Conditioned hearing assessment must be targeted to begin no later than:

1. Six to eight months corrected age for children who enter caseload prior to this age; or
2. When the child's medical, cognitive and developmental status can support learning a conditioned response, whether that is a head-turn or any other observable voluntary response.

2.13 IHP DESIGNATED TRAINING CENTRES (DTC)

DTCs are authorized by the MCCSS to provide IHP support, including advanced training, consultative and Amplification referral services, protocol support and clinical decision support to IHP Audiologists. DTCs also conduct standard IHP practice reviews and implement audits of services as directed by the MCCSS.

The DTCs are the CHEO (Ottawa) for ABRA and Audiometric Assessment including VRA, Humber River Hospital (Toronto) for ABRA and VRA, and the National Centre for Audiology (NCA; Western University, London) for Amplification and Outcome Measurement.

2.14 AGE AT COMPLETION OF FIRST CONDITIONED HEARING ASSESSMENT

¹ This protocol does not provide specific timelines related to audiological surveillance practices. For this information please consult surveillance protocols as specified in the Guidance Document.

Assessment must be targeted to be completed no later than ten months corrected age. The challenge arises when PHL may be present, especially with concurrent CHL or if the child takes more than one session to condition and to accept insert earphones for ear-specific assessment. Several sessions may be required, sometimes including referral to a DTC.

It is the responsibility of the Regional Lead Agency to put in place staffing, policies and procedures that facilitate the earliest possible access to hearing assessments consistent with these target timelines.

2.15 WHAT IS A COMPLETE HEARING ASSESSMENT?

A 'substantially completed' hearing assessment means that enough information has been obtained to determine whether physiological results and behavioural hearing assessment results agree, and to form the basis for ongoing management and amplification requirements, where amplification is indicated and elected.

INITIAL ASSESSMENTS

If the assessment is an initial behavioural response (either in follow-up from ABRA or as an initial evaluation within IHP), a substantially completed audiometric assessment must include all of the following in both ears:

1. **Otoscopy:**

Cursory otoscopy shall be conducted at the start of any IHP Assessment appointment. Its main purpose is to detect foreign bodies, canal occlusion and any physical condition of the ear that indicates referral to physician. For children with atresia include notes on external ear.

2. **Middle Ear Analysis (MEA):**

Immittance with 226 Hz tone for children 6 months corrected age and older unless contraindicated. Common contraindications may include atresia, visible inflammation, PE tube, perforation, impacted wax, or foreign objects in the ear canal (Swanepoel et al., 2014). If wideband reflectance measurement is used to assess middle ear status, comparison to criteria at the measurement frequency of 226 Hz is recommended. Measurement of middle ear muscle reflexes may be informative when Auditory Neuropathy Spectrum Disorder (ANSD) is suspected: if reflexes are present, ANSD is less likely.

3. **The Cross-check principle and Distortion Product Otoacoustic Emissions (DPOAE):**

In order to fulfill the cross-check principle (see Norrix, 2015 for full discussion) of having at least one behavioural measurement of hearing compared to at least one objective measure, DPOAEs take a higher priority in this protocol than in the ABRA protocol. Accordingly, the clinician shall pursue cross-check of behavioural test results with either (a) previous ABRA if still relevant; or (b) ongoing assessment of DPOAE as indicated. DPOAE levels and noise thresholds at nominal F2 values of 1.5, 2, 3 & 4 kHz. If tympanograms are flat, absent DPOAEs may have little or no value for differential diagnosis but may provide useful cross-check.

4. **Air Conduction (AC) MRLs:**

Reliable MRLs obtained for 500, 2000 and 4000 Hz per ear. At the clinician's discretion, further testing is strongly recommended: (1) interoctaves (750, 1000 or 3000 Hz) if there is a difference of 20 dB HL or greater between any 2 adjacent octaves; (2) 3000 or 6000 Hz at the clinician's discretion if 4000 Hz threshold is elevated (≥ 30 dB HL).

5. **Bone Conduction (BC) MRLs:**

Reliable MRLs obtained for any frequency which AC MRL is greater than 25 dB HL. For children with stenosis, microtia, or atresia include BC MRLs at 500, 2000 and 4000 Hz whenever the ear structures are such that air conduction testing cannot be performed. If possible, masking of the non-test ear is recommended as it would be for any test. Some studies have demonstrated the feasibility of masking even for children in the VRA age range (Nozza & Henson, 1999). Skull maturation increased transmission across the skull after about 10 months of age (Mackey, Hodgetts, & Small, 2017).

These tests may provide information that is useful in the interpretation of audiometric test results and/or insight into the site of lesion. The order of performance of the three tests may be left to the discretion of the audiologist as testing prior to audiometric assessment may provide useful information to guide assessment procedures yet it may irritate the child leaving him/her less cooperative for the remaining tests.

FOLLOW-UP ASSESSMENTS

If the assessment is a follow-up evaluation, and where previous complete and valid CBA results exist, the main purposes of the ongoing assessment are to (a) determine whether hearing remains stable from previous results and (b) to continue to fill in assessment data for a more complete audiogram. A loss is considered stable if all thresholds remain within <15 dB at each frequency or within <10 dB at three consecutive frequencies. In this case, a substantially completed audiometric assessment must include all of the following in both ears:

1. **Otoscopy (as above)**

2. **Middle Ear Analysis (MEA):**

May be completed, or omitted at the audiologist's discretion if (a) air conduction thresholds fall within the range of normal hearing; or if (b) air and bone conduction thresholds continue to indicate ear-specific stable sensorineural hearing loss. Otherwise, MEA is indicated. MEA is strongly recommended in either case whenever feasible.

3. **Distortion Product Otoacoustic Emissions (DPOAE):**

May be completed, or omitted at the audiologists' discretion if ongoing CBA indicates stable sensorineural hearing loss and prior valid measurement of DPOAE (present or absent) that agrees with CBA and MEA. Otherwise, DPOAE evaluation is indicated. Regardless of discretionary omission one specific appointment, retesting of DPOAE annually is recommended. Routine retesting of DPOAE for cases with ANSD is also recommended to track the presence or absence of DPOAE over time.

4. **Air Conduction (AC) MRLs (as above)**

5. **Bone Conduction (BC) MRLs:**

If air conduction thresholds and MEA are stable, bone conduction testing is at the audiologist's discretion, provided that it is remeasured at least annually.

2.16 PROTOCOL SUPPORT BY DTC

Audiologists who have any questions or concerns about any aspect of this protocol, or would like to seek expert opinion are recommended to contact a DTC. This is also a mechanism for protocol clarification and improvement.

2.17 CLINICAL DECISION SUPPORT

IHP Audiologists are encouraged to consult a DTC if they wish to discuss assessment procedures, interpretation or next steps in any specific child. Real-time support during testing is not feasible. Records sent for review must be de-identified.

In an infant or young child with a bilateral Refer result from AABR, suspected PHL from case history, caregiver concern, who are within IHP surveillance, or who have previous ABRA results that have identified PHL, if the initial assessment is NOT substantially completed within THREE attended sessions, clinical decision support should be sought. In such cases, scheduling of appointments should be prioritized such as sequential appointments are closely spaced so as not to delay behavioural confirmation of the hearing loss.

2.18 CLINICAL DECISION SUPPORT AND REVIEW

Support or review may be requested by an IHP Audiologist, the parents or another IHP service provider if they believe that such a review may materially improve the accuracy of the overall CBA outcome. Specific procedures for initiating this request and the procedures that follow are outlined in the IHP Guidance Document.

2.19 CONTINUOUS QUALITY IMPROVEMENT (CQI)

MCCSS implements quality assurance and quality management in IHP on an ongoing basis, and for funding accountability. This is being done through a CQI program that targets all EHDI service components, including audiometric assessment. See Appendix D for Key Performance Indicators.

2.20 IHP STANDARD PRACTICE REVIEWS

CBA providers must participate in document-based practice review. A streamlined process specified by the MCCSS will be implemented through DTCs. Practice review is a routine, support-oriented procedure aimed at verification and improvement of quality of care.

2.21 ADVERSE EVENT REVIEWS & AUDITS

MCCSS reviews instances of possible shortfall in quality of care for individual children and families in IHP. Irrespective of how such events come to light, if an adverse event is verified, case-specific clinical remedy will be sought and, depending on the nature of the event, the service involved may be subject to detailed review by a DTC, where directed by MCCSS.

2.22 IHP PROTOCOLS & CASLPO GUIDELINES

All IHP Audiologists shall practice CBA procedures in full compliance with the requirements of both CASLPO and this protocol. IHP protocols may be more specific than CASLPO guidelines. Effort is made to ensure that IHP

protocols do not conflict with CASLPO guidelines. Such conflicts may arise inadvertently and if any IHP Audiologist perceives such a conflict, the Audiologist shall notify the DTC promptly and the IHP will act to resolve the issue.

2.23 PROCEDURAL CONCERNS

IHP Protocols are evidence-based to the extent possible. Evidence is reviewed by the DTCs on an ongoing basis. This may result in specification of procedures that differ from opinions in published journals. Every IHP Audiologist shall bring significant procedural concerns to the attention of the relevant DTC. Substantive issues will be addressed by new evidence review, re-examination of existing evidence, and/or provincial consensus development. Changes to IHP protocols are outside the mandate of regional management and shall be authorized ONLY by modification of the relevant IHP protocol document (such as this document), which shall govern IHP CBA services throughout Ontario.

2.24 INFECTION CONTROL STANDARDS

Infection control practices are typically governed by site-specific, institutional or agency protocols and are outside the purview of this document. Generally accepted standards must be applied (CASLPO, 2010).

2.25 PERSONAL HEALTH INFORMATION

Management of all personal health information arising from the assessment process shall comply with local site requirements and those of the College of Audiologists and Speech-Language Pathologists of Ontario. Information communicated for approved monitoring and review procedures must be de-identified and code-referenced. All transmission of personally-identifiable information shall be consented by the appropriate family member or authorized caregiver.

2.26 INSTRUMENTATION, CALIBRATION & SUPPLIES

TEST ENVIRONMENT & CALIBRATION

CBA must be conducted only using an audiometer that meets current ANSI S3.6 specifications (2010), functioning within tolerances of standards for all transducers, and approved equipment for completion of the test battery.

The audiometer shall be capable of presenting pure tone and FM warbled-tone stimuli through insert earphones, supra-aural earphones, and a bone conduction oscillator. Loudspeakers should also be available for those children who will not tolerate earphones initially. A bone vibrator with a plain circular tip “with a nominal area of 175 ± 25 mm²”, as specified by the ANSI S3.6 Specification for Audiometers, is required. Stimuli shall be presented with 1-2 seconds duration. The new, more powerful, B-81 bone oscillator may be used at the clinician’s discretion.

Audiometers should offer at least warbled tones as test stimuli in sound field, and FRESH noise may be used at the clinician’s discretion. The audiometer, including its associated transducers and sound field, must be re-calibrated at least annually and calibration records and equipment monitoring practices must meet CASLPO requirements.

The ambient noise in the test room must meet the ANSI S3.1-2003 criteria for Maximum Permissible Ambient Noise Level. Test environments that exceed maximum permissible ambient noise levels should be re-evaluated to address and minimize lighting noise, HVAC noise, equipment noise, and to replace (if necessary) the sealing gasket

around the doors of the sound booth. Audiometric calibration is required when the audiometer is installed (or moved), and then annually thereafter.

The test environment should provide enough room to house test transducers, reinforcement equipment, appropriate and safe seating for the child and caregiver, and enough space to support sound field setup requirements (0.6 metres from walls, 1 metre from loudspeakers, 90 degrees azimuth). The room shall be adequately ventilated and equipped with fire alarms. It is recommended that the room lights be provided with a dimmer switch.

VISUAL REINFORCERS: TOYS AND COMPUTER-ASSISTED SYSTEMS

At minimum, clinics shall be equipped with button-operated VRA toys. A VRA toy is located in a smoked Plexiglas box that can be illuminated and animated. At least two such toys are required; four toys are preferable.

The reinforcing toys shall be placed at 90 degrees to the infant's right and/or left side as the preferred orientation, to maximize the size of head-turns and thereby promote clear judgement of responses. The reinforcing toys should be at the child's eye-level, to maximize their visibility and simplify the head-turn response. (See diagram below). The location of reinforcers may be modified to accommodate a child's abilities, such as if the child is not physically able to turn their head to a 90 degree angle. This may be done by changing the location of the child or the reinforcers. Reinforcers can be all on one side of the child or on both sides of the room.

The toy in the box should not be clearly visible to the child unless the box is illuminated. A switch in the observation room controls the animation and bright illumination of each individual toy. The reinforcement toys should be non-aversive to the child. It is recommended that the animation and the illumination of the toys be independently controllable, as some children are afraid of the animation, and thus are more relaxed if only the illumination is provided when the reinforcement is presented. Clinics may supplement physical VRA toys with computer-assisted reinforcers at their discretion. Computer-assisted reinforcers can be home-made using the setup in Figure 2. This may be useful for reinforcing children at the older end of the VRA test range, for the transition between VRA and CPA, and for CPA itself. Sample slide shows are provided in the IHP OWL site.

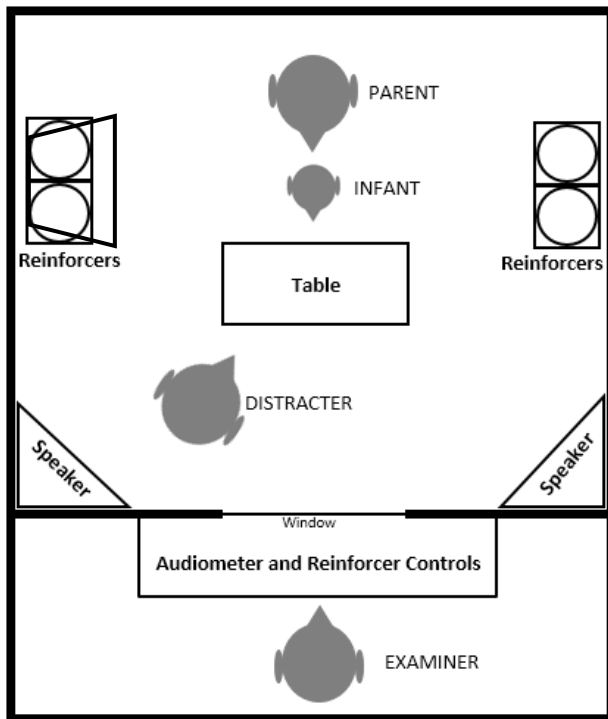


Figure 1. Example of VRA setup. Table is optional. Speakers are shown at 45 degrees, a 90 degree orientation is preferable. If sound field is used for preliminary testing, see text for details of room setup including distances from walls to speaker/child.

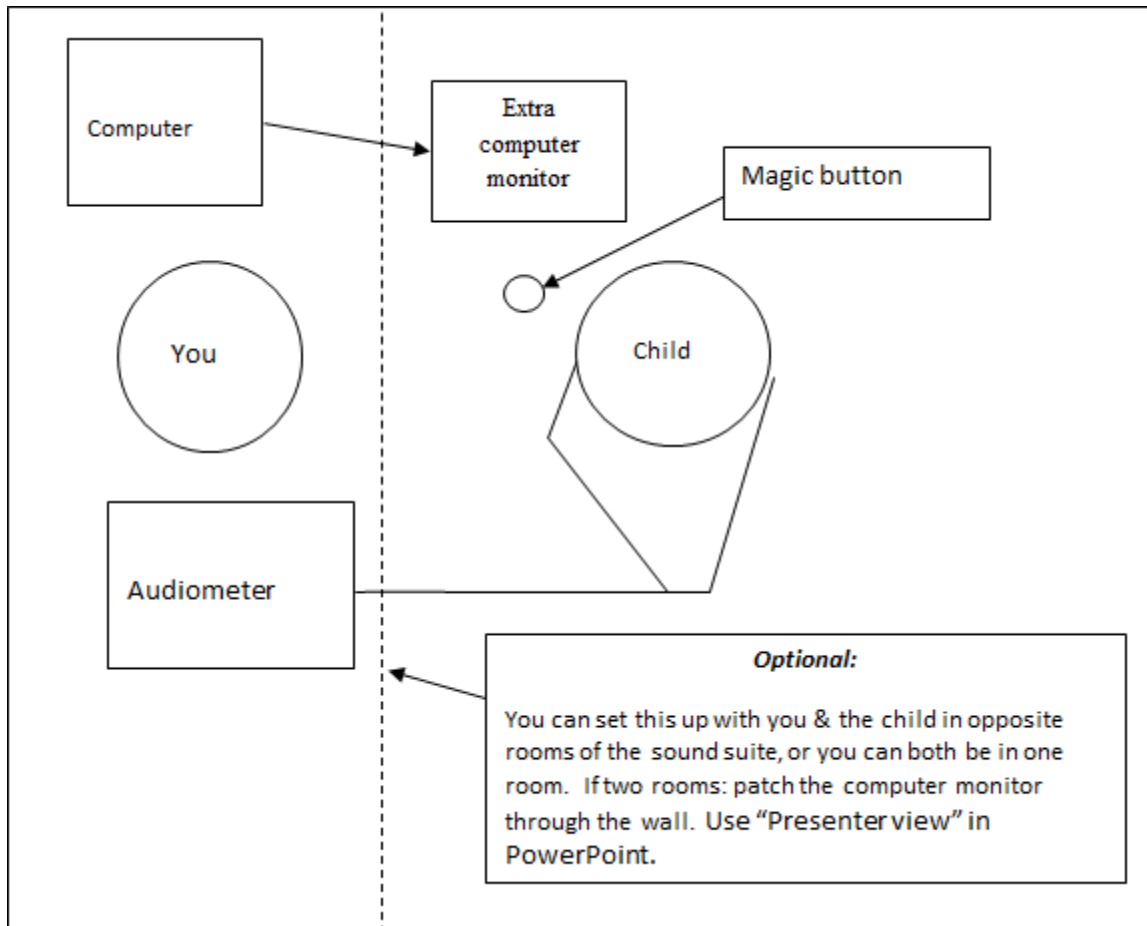


Figure 2. Setup for using homemade computer images as a low-cost video reinforcer. Images can be controlled via PowerPoint or similar software, and can be used to reinforce children for performing CPA, or for transition between VRA and CPA. The "Magic Button" can be any button that does not control the image advancement, such as a disabled mouse or a toy button.

TOYS FOR DISTRACTING DURING VRA AND FOR PLAYING DURING CPA

A large supply of different toys is needed to distract the child and/or for play tasks. These should be toys that can be manipulated quietly, can be effectively cleaned and/or disinfected as necessary, and are not similar to the reinforcement toys. Toys for VRA distraction should be significantly less interesting and appealing to the child than the reinforcement toys. Examples of distracting toys are plastic-covered soft blocks, stacking toys, and sparkle sticks.

Toys for playing should include simple games that are easily framed in tasks of 5 to 30 objects, such as puzzles, stacking, or peg toys in the toddler to preschooler developmental range, or collections of small objects that can be dropped in a bucket. Inventiveness and game variation are encouraged. Computer game-based reinforcement for game playing or appropriate computer games may be used at the clinician's discretion so long as testing compliance with ANSI standards is not compromised.

STIMULUS TRANSDUCERS

In the absence of specific contraindications, insert earphones (ER-3A) are the **required** transducers for air-conduction CBA testing. Insert earphones have several advantages over supra-aural earphones for this test method, including reduced acoustic crossover (increased inter-aural attenuation), decreased likelihood of collapsed external ear canals, accurate location of sound delivery, increased comfort and reduced interference with head-turn response. Research has shown that tolerance of insert earphones by infants is generally good once the earphones have been placed in the ears (Widen, 2000) and that more ear-specific thresholds are obtained with insert phones versus circumaural phones (Davis, 2012). Beginning a test session with insert phones, if possible, will result in the most efficient use of time.

Disposable foam tips may be used to couple the insert earphones to the child's ear. These foam tips are single use and should be discarded after one test session (CASLPO, 2010). If the child being tested has been fitted with hearing aids, his/her own earmolds, attached to the insert tubing, may be used instead of the foam tip. This modification should be noted on the audiometric record.



Figure 3. Coupling the child's earmold to the ER-3A can be more securely achieved by cutting the black insert tubing which can be used to connect the earmold to the earphone tubing.

The insert phone transducers may be clipped to the back of the infant's clothing to keep them out of the way of the baby's hands. The foam tips or earmolds should be placed in the ears, taking care to ensure proper placement. If the baby tries to take them out, it might be advisable to have an earphone in only one ear at a time during testing. One method of keeping the infant from pulling the earphones out is to have him/her hold a small toy in each hand, or use other methods of distraction.

Supra-aural earphones (TDH 49/50) are to be used only in rare cases when insert phones are contra-indicated, such as when the ear canals are very small or stenotic or when the infant does not tolerate the insert phones. Careful attention to achieve accurate placement of a TDH earphone is especially important to ensure appropriate stimulus levels and to avoid collapsing ear canals. Soft padding between the headband and the top of the infant's head shall be used to ensure comfort and proper placement. Similar considerations should be in place if circumaural (HDA-200 or equivalent) headphones are used.

The Audiologist may determine that, in some cases, presenting the stimuli in sound-field is helpful in conditioning a child who is initially reluctant to wear insert earphones. In this context, sound-field stimulation has a role to play in the VRA process. However, because sound-field testing does not provide ear-specific information, sound-field results are not considered a sufficient basis for ear-specific audiometry or a basis for the prescription or verification of assistive technology. If testing to rule out hearing loss, it may be sufficient to plug the non-test ear and test in sound field. A child who has not yet received ear-specific assessment should be re-scheduled to complete this, with ear-specific results being the highest priority for the next appointment.

Bone conduction thresholds are needed to identify and quantify conductive and sensorineural components of a hearing impairment. Establishment of these thresholds requires accurate and stable placement of the bone oscillator. Soft padding under the headband or a band of elastic fabric with Velcro attachments may be used if stable placement of the bone conductor cannot be achieved with the standard headband.

2.27 CLINICAL RECORDS & REPORTS

All audiometric records shall be maintained in a manner satisfying both CASLPO and the IHP. The records shall be maintained in hardcopy and, if electronic medical records are used, in secure data files. The infant's audiological record should include an audiogram as well as details of the procedure used to condition the child for VRA, the administration of control trials, the infant's rate of correct responses on control trials, and a worksheet showing the administration of VRA including control trial administration. Examples of appropriate worksheets are provided in Appendix A. Records detailing interpretation of the child's hearing status using the complete test battery and reporting of any necessary information to ISCS should also be available.

SECTION 3: PROTOCOLS FOR CONDITIONED TESTS

Within the IHP, an infant previously identified as having a permanent childhood hearing impairment (PCHI) on the basis of the ABRA protocol requires behavioural audiometric assessment as follow up to ABRA. The following protocol is a detailed description of audiometric assessment with use of Visual Reinforcement Audiometry (VRA), Conditioned Play Audiometry (CPA) and Individualized Reinforcement Audiometry (IRA).

VISUAL REINFORCEMENT AUDIOMETRY (VRA)

VRA is a technique used for measurement of detection of sound in infants and young children. It uses modified operant conditioning of the child to respond to an auditory stimulus by turning his/her head to look at a visual reinforcer. The lowest intensity level at which a reliable response is obtained is considered the Minimum Response Level (MRL) and can be frequency- and ear- specific. This measure is used for on-going audiological assessment of infants registered with the IHP and provides valuable audiological information for hearing aid fitting.

The objective of VRA assessment is to establish MRLs which are required to be obtained at a minimum of three frequencies (500, 2000 and 4000 Hz) per ear by air conduction (AC), and of at least one frequency by bone conduction (BC) if AC MRL >25 dB HL. Further frequencies shall be included over time at the Audiologist's discretion. Hearing sensitivity is considered to be within normal limits if the MRL is 25 dB HL or less.

3.1 TARGET POPULATION

Infants aged 6 months developmental age up to approximately 24-35 months of age who possess sufficient vision to see reinforcers and sufficient trunk and neck control to turn towards reinforcers are considered candidates for VRA (Sabo et al., 2003). Widen et al. (2000) found that, at 8 to 12 months of age, 95% of infants could perform the test reliably. For premature infants, Moore, Thompson, Folsom (1992) suggested that "a corrected age of 8 months and/or a mental age of 6 months is typically required for acceptable performance using VRA". Infants with developmental delay may not be ready for behavioural testing using VRA at 8 to 12 months of age, so information about an infant's visual, cognitive, and motor developmental status may be useful in deciding when to schedule the infant for this test. For example, if the baby, at 8 months, is unable to sit up or turn his/her head, VRA should probably not be attempted until s/he has better motor control. In typically developing infants, VRA testing at a corrected age of 9 to 10 months for most infants is often the age associated with completion of the first full, reliable VRA assessment in IHP program records. VRA may be successful with children with developmental or cognitive delay when the children reach a mental age of 10 months (Greenberg et al., 1978; Thompson, Wilson, Moore, 1979).

3.2 REFERRAL SOURCES

Infants may be referred for hearing assessment through the following routes or in the following circumstances:

1. From IHP screening and assessment, where ABRA results indicated a permanent hearing impairment of >25dB eHL at any frequency in the range of 0.5-4kHz, in either ear.
2. From IHP screening and assessment, where the infant has reached the corrected age of 8 months, but ABR results have been incomplete, inconclusive or unreliable, and a hearing loss has not yet been confirmed or ruled out.

3. As part of the hearing aid evaluation and follow-up process for infants identified with PCHI.
4. From referral of children who have acquired or who demonstrate any of the IHP risk indicators for PCHI. Children who are being referred outside of the Universal Newborn Hearing Screening or Surveillance services of the IHP should receive OHIP-funded hearing assessment services prior to referral to the OIHP whenever possible, to rule out medically-treatable conditions such as conductive hearing loss.
5. Children whose audiological assessment results and/or risk factors from a community Audiologist suggest possible hearing impairment and permanent conductive and/or sensorineural components have not been ruled out. Risk factors are outlined in more detail in the Surveillance protocols of the Ontario Infant Hearing Program.

3.3 TEST PERSONNEL

TESTING ASSISTANT

An assistant acts as the distractor during VRA testing while the IHP Audiologist presents the stimuli and visual reinforcement and records the infant's responses. The testing assistant can be a non-Audiologist (e.g. assistant, student, communication disorders assistant, or parent) who has been instructed on the correct distraction procedures by the IHP clinician. The IHP Audiologist is responsible for monitoring the distractor and provide feedback as needed to maintain a successful test.

The role of the distractor during VRA is to keep the infant in an appropriate state of listening to the presented stimuli by drawing the child's gaze toward the midline before trials. This allows for a full head-turn response which can be easily seen by the Audiologist. An example of a distractor is available at <http://www.youtube.com/watch?v=LK5ExH4KwBI>.

IHP AUDIOLOGIST

The role of the Audiologist during VRA is to control the presentation of stimuli/reinforcement and observe the infant's head turn, play, or other response chosen for conditioning, to judge if the infant has responded or not. The Audiologist records these judgements on the VRA worksheet. S/he may also guide the testing assistant in keeping the infant in the appropriate state for testing.

SINGLE TESTER VRA

In situations where a testing assistant is not available, the IHP Audiologist can act as both the examiner and distractor. For this to be achieved, it is usually recommended that the tester, the child, the audiometer, and the reinforcer controls should be in the same test room, or in a setup that permits adequate equipment control and observation and reinforcement of responses.

3.4 STIMULI

Pure tones should not be used in sound field due to standing waves; warble tones are appropriate for use in sound field (Barry & Resnick 1978; Lundeen 1987; Orchik & Rintelmann 1978; Sabo, Paradise, Kurs-Lasky, & Smith, 2003; Stephens & Rintelmann 1978; Widen et al., 2005). F.R.E.S.H. noise has recently been reported to provide

frequency-specific thresholds similar to that of pure tones, unlike narrowband masking signals (Norrix & Anderson, 2015). The F.R.E.S.H. noise stimulus is implemented in Otometrics products; the GSI brand uses a similar signal called Pediatric Noise. Both of these are intended for use as audiometric test signals because they are narrower in bandwidth than traditional narrowband noise stimuli, and are based on recommendations from Walker, Dillon, and Byrne (1984) (Moore & Violetto, 2016; Prigge, 2019). The older narrowband noises were originally developed as masking signals, and are not recommended for thresholds estimation because they may underestimate audiometric slope (Norrix & Anderson, 2015).

Clinicians may use either pure tones (if using insert phones), warbled tones or F.R.E.S.H. or Pediatric noise (in sound field or with phones) at their discretion. If other stimuli (e.g., live voice, Ling6(HL) stimuli, narrowband noise) are used to maintain attention or when troubleshooting a child's ability to condition, this should be documented, and effort shall be made in follow-up to retest with standard, calibrated, warbled tones or F.R.E.S.H. noise.

3.5 CONSIDERATIONS PRIOR TO TESTING

DISCUSSION WITH PARENT OR GUARDIAN

In preparation for testing with VRA, the nature of the testing should be explained to the parents/guardians. Prior to the appointment, parents/guardians should be informed that VRA requires that the infant be attentive so testing should be scheduled for a time when the infant is likely to be alert and that VRA may require more than one session. The audiologist should take specific measures to prevent the parents/guardians cueing the child to respond, such as indicating when a sound is presented. This can include careful instruction, seating the child in a high chair rather than a lap and/or providing a masking signal via phones or a consumer listening device (iPod or similar) to the parent/guardian so that they are not aware of sounds. Testing under insert phones helps to minimize parent/guardian awareness of sounds, while sound field testing facilitates parent/caregiver awareness of sound (depending on the hearing status of the parent/guardian). Finally, the parent/guardian should be asked of the status of the infant's vision. The audiologist should be aware of the differences between ocular and cortical visual impairment. For children who have suspected or confirmed blindness, low vision, or unassessed vision issues, referral to the Ministry's Blind-Low Vision Program is strongly recommended for follow-up services, and to obtain assistance with selecting appropriate test adaptations.

OTOSCOPY

It is recommended that, at the beginning of the test session, the Audiologist conduct a cursory otoscopic examination. It is recommended that cerumen be removed if the ear canal is occluded. However, successful testing can often be accomplished in the presence of substantial debris/cerumen. The decision to undertake testing with insert earphones under such conditions is at the discretion of the Audiologist. Partial occlusion is not uncommon, and usually does not interfere with accurate testing. VRA with insert earphones should be attempted in all but the most severe cases of apparent occlusion. Insertion of probe tips (for tympanometry, otoacoustic emissions, or insert phone audiometry) may be disallowed by local infection control requirements; cursory otoscope examination can identify drainage issues prior to these procedures.

If insert phones cannot be used, supra-aural earphones are an option, with the caveats noted earlier. It is also possible to undertake bone-conduction testing, but a return visit for ear-specific testing by air conduction is required to determine hearing sensitivity by air conduction.

3.6 TEST ORDER OF FREQUENCIES

During VRA assessment, consider the following when selecting a frequency to begin testing:

Start with 2000 Hz by air conduction in the better ear if:

- no previous assessment exists or;
- previous screening or assessment was normal or;
- previous assessment showed sensorineural hearing loss with measurable thresholds at 2000 Hz or;
- previous assessment resulted in the use of a BTE aid regardless of the nature of the loss or;
- previous assessment showed ANSD component.

Start with 500 Hz by air conduction in the better ear if:

- previous assessment showed no measurable threshold at 2kHz
- previous assessment showed sensorineural hearing loss with significant conductive component at 500 Hz.

Start with 2000 Hz by bone conduction if:

- the child has a full bilateral atresia or;
- previous assessment resulted in the use of BC hearing aid or;
- child is at risk for late onset sensorineural hearing loss and has significant middle ear dysfunction

These considerations may apply across the multiple visits that may be required to complete full VRA assessment. If the examiner has previous hearing threshold information about the infant, it is recommended that the testing begin with the better ear, and at a frequency which the hearing is the most sensitive, based on the previous assessments. This helps to ensure that the infant is conditioned to the VRA task as efficiently as possible.

Further considerations when choosing which frequencies to test depend on the goal of the appointment such as 1) Follow-up visits to obtain a full VRA assessment in which frequencies are selected based on those that remain to be tested; 2) Re-assessments begin at frequencies dictated by need, such as requiring high frequencies for amplification purposes or frequencies needed for monitoring of progression and; 3) Speech awareness MRLs are obtained at the Audiologist's discretion as long as it does not preclude frequency-specific testing.

3.7 TRAINING, CONDITIONING, AND MRL SEARCHES

This protocol is largely based on a large multi-site study by Widen et al., (2000). It places a priority on preventing or minimizing the chances of reinforcing stimulus presentations that are below threshold, and on minimizing the role of habituation. This is connected to the nature of the program: for many infants, they will enter the VRA process with a higher probability of threshold elevation than is found in the infants in the population who have passed a hearing screening. It is therefore possible that the few trials will be presented below threshold. Therefore, we begin testing by presenting sound and then looking for spontaneous head turns rather than starting with paired

stimuli as is often discussed in descriptions of VRA. This initial phase is “training trials”. We move to paired “conditioning trials” as a second step if this is not successful. These steps are outlined below.

INITIAL TRIALS LOOK FOR SPONTANEOUS RESPONSES

In initial trials, we first estimate a presentation level that is likely to be supra-threshold to the better ear (if known). A default starting level of 55 dB HL is recommended to align with the use of 20 dB step sizes and a final result at 25 dB HL for infant who have MRLs that are consistent with normal hearing. However, a different level may be chosen at the audiologist’s discretion if the infant’s history and previous test results provide evidence that another starting level should be used, and/or if the audiologist intends to use smaller step sizes and/or test to a lower HL value. This is done via an air-conducted stimulus presented through the insert earphone in the better ear (if known) at 50 dB HL, or at a comfortable level that is well above the previously-established ABR eHL threshold for that ear and frequency (if known), unless the structure of the ear prevents air conduction testing. If this is the case, bone conduction testing should form the basis of initial trials.

The first trial presents a warble-tone stimulus **without** any paired reinforcers. The tone is presented for 1-2 seconds and the infant is observed for a spontaneous head-turn. To be considered a response, the head-turn must occur within 4 seconds of the stimulus presentation; eye-shift or looking up at the distractor is not considered a response unless the audiologist has elected to use IRA. If the child responds by turning his/her head, the reinforcement should be presented. The visual reinforcement should be of sufficient duration for the infant to see it briefly (0.5 to 1.0 second); longer reinforcement may lead to extinguishing of the response, especially with infants who are approaching the upper age limit (24 months) of the target population (Culpepper and Thompson, 1994).

Once the infant has seen the reinforcer, the infant’s attention should be returned to midline by the distractor. On the second trial, the same stimulus should be presented again. If the infant responds again, the audiologist shall reinforce the response. These responses shall be recorded on a Worksheet that tracks trial-by-trial responses for stimulus trials and controls trials (Appendix B).

If the infant does not respond spontaneously to two presentations of the initial signal, the intensity is increased by 20 dB and the infant is observed for a spontaneous response. This may be repeated for a total of two trials prior to moving to either testing or to conditioning trials if no responses are observed (see flowchart below).

Stimulus-contingent responses and absence of responses are recorded on the worksheet using non-standard symbols. The specific symbol system to be used is at the clinician’s discretion so long as it is clear, interpretable, labelled, and consistent.

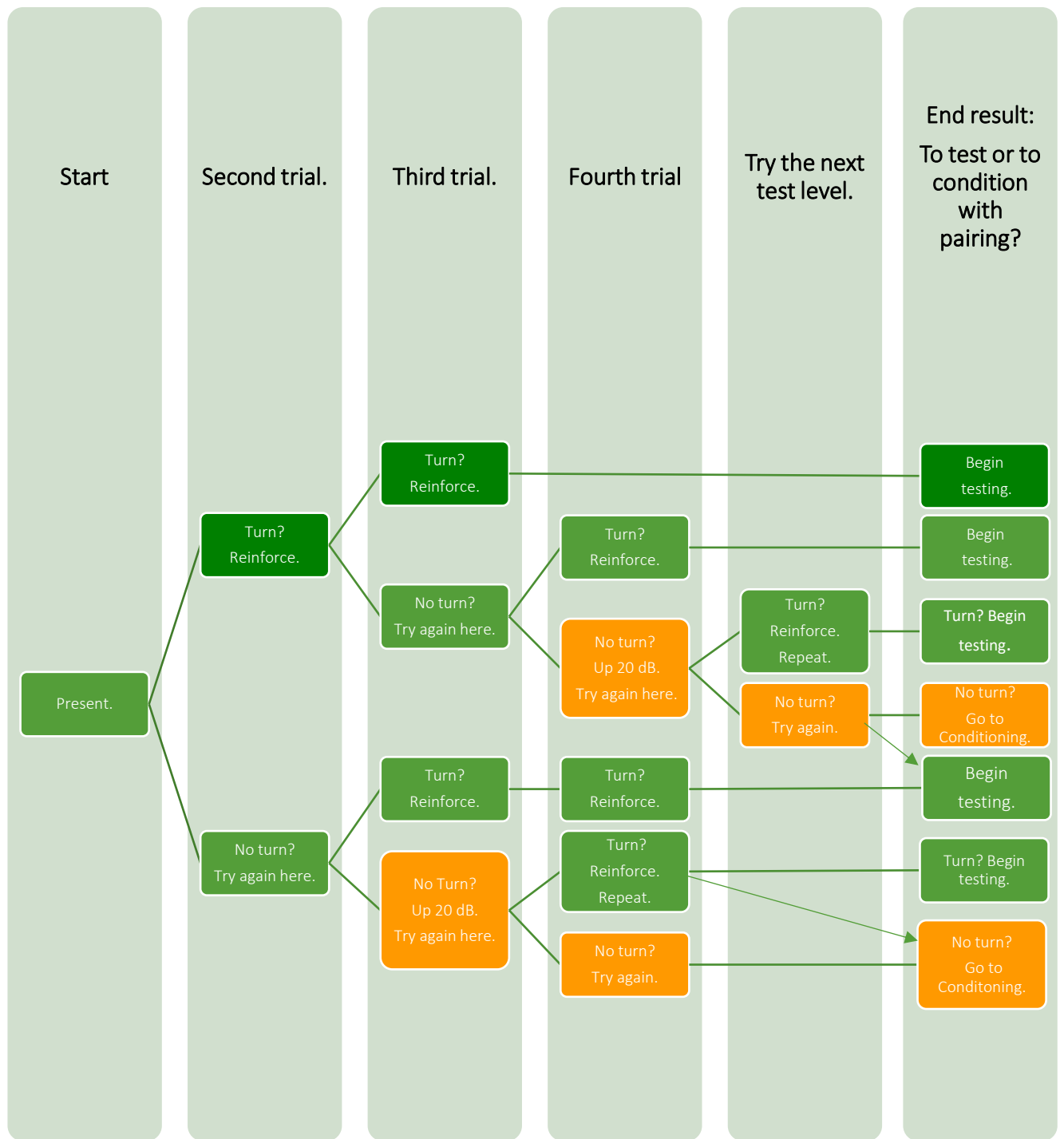


Figure 4. Workflow for establishing a conditioned response.

CONDITIONING TRIALS

Conditioning is the process of eliciting the desired head-turn response from the child who did not respond spontaneously during initial trials. The next signal should be paired with the presentation of the reinforcement (Conditioning Trials). If the infant does not turn to the reinforcement when it is activated, the distractor may have to direct the child to the reinforcer. This pairing of sound and reinforcement may be done twice, then the signal should be presented alone (Probe), to see if the infant responds to the sound. If s/he does, two consecutive reinforced responses are required to establish that the infant has been conditioned and the audiologist can move to the search for MRLs. If there is no response, a listening check of the equipment should be done. If there is no equipment problem, the intensity level may be increased, or the stimulus frequency or ear of presentation may be changed, and the conditioning repeated until a response is observed.

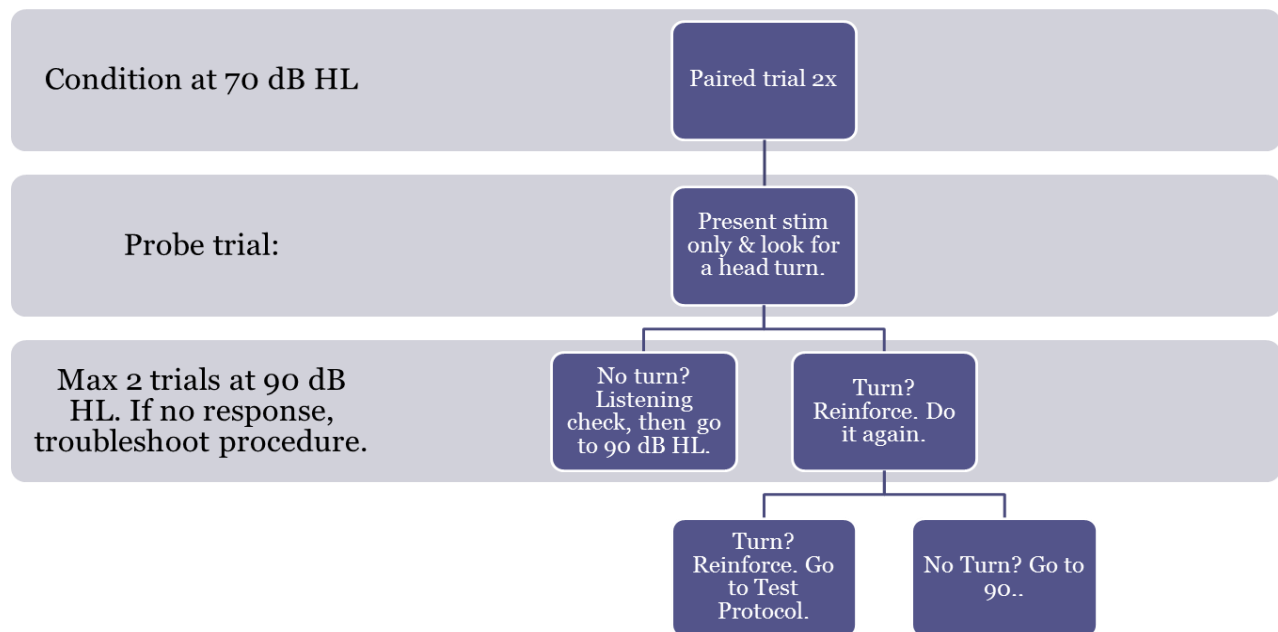


Figure 5. Workflow for Training Trials and Conditioning Trials to train infant on head-turn response to sound.

TROUBLESHOOTING FOR NO RESPONSE

It is important to avoid pairing the reinforcement with a sound that is inaudible to the infant. If no responses to sound have been observed after Training and Conditioning, but if the baby turns when the visual reward is presented, the test session risks reinforcement of false responses. In this case, the Audiologist will perform a visual and listening check on the equipment, address any equipment or setup issues and resume training trials if warranted. Otherwise, a short, live-voice speech signal, such as "Hello there!", "Ba-ba-ba" or saying the infant's name may be used during early trials if the infant does not respond well to tones. Voice can also be presented in sound field during conditioning (not during assessment since it is not ear-specific) if the infant is initially reluctant

to wear earphones. Alternatively, the audiologist can give the child a break (and perhaps complete other aspects of the test battery), or apply a vibrotactile stimulus in a repeated conditioning trial to determine if the infant can be conditioned to respond. A vibrotactile stimulus is chosen on the presumption that the infant, regardless of hearing impairment, should be able to perceive it. This procedure provides clarity as to whether the child's lack of response in previous trials may be due to inability to condition. To provide such a stimulus, place and hold the bone-conduction oscillator in the infant's hand or against his/her arm or leg, and present a 500 Hz bone-conducted tone of 55 dB HL (or 250 Hz BC at 40 dB HL) through the oscillator. Pair this vibrotactile stimulus with the reinforcement, directing the infant's attention to the reinforcement toy. Once the head-turn response to the vibrotactile signal has been established, remove the bone-conduction oscillator, and repeat attempts to elicit and reinforce responses to auditory stimuli, at increasingly higher intensities until responses are observed. As soon as the infant has given two consecutive responses at a particular level, a search for MRL may begin. If the infant shows no interest in the visual reinforcement, and will not turn to look at the reinforcement toys after 5 to 10 trials, further testing with the VRA technique may not be possible or useful on this occasion, and rescheduling is recommended.

BRACKETING FOR MRL

Minimum Response Level (MRL) is defined as the lowest intensity level that elicits two clear responses (out of three presentations). To achieve this, a 10-dB step size is used while bracketing 20 dB down, 10 dB up using a varied inter-stimulus interval (ISI). Present a stimulus at 20 dB below the level where the infant has just responded twice during the conditioning or training trials. If a clear response is noted at this lower level, reinforce and record the response, and lower the intensity by 20 dB for the next stimulus presentation. If there is no response, raise the intensity by 10 dB. A normal minimum response level for this test protocol is defined as 25 dB HL, and testing at a given frequency may be discontinued for the tested ear if the criterion for MRL is met at 25 dB HL. Where the MRL is greater than 25 dB HL, there must be at least two no-response trials at no more than 10 dB below the level reported as MRL. The Audiologist may, at his/her discretion, test at levels below 25 dB HL or with smaller step sizes, as long as this does not compromise completion of the audiogram at other required frequencies. When this is done, the recommended lowest test level for VRA testing is 20 dB HL. The MRL for each frequency and ear is recorded on the Summary of MRLs form (Appendix C) and on the Audiologic Assessment report form (Appendix D).

Note: When the test ear is changed, some infants may turn toward the side of the previous reinforcement. When this occurs, the Audiologist can continue to use this reinforcer for testing, even if it is not on the side of the test ear. If the infant turns in the direction of the new signal, the corresponding reinforcer may be activated. Any definite head-turn in response to a signal must be reinforced, and ear-by-ear lateralization is not judged as part of the response. However, the use of the left-side reinforcement for left-ear stimulation and the right-side reinforcement for right-side stimulation will likely maintain the infant's interest longer than the use of reinforcement on a single side. Therefore, when the test ear is changed and the stimulus is presented, if the infant turns to the side of the previous reinforcement, the examiner could illuminate the reinforcer on the side of the stimulus and the distractor could point out the new reinforcer to the infant.

3.8 RELIABILITY AND VALIDITY

Infants who are not making responses contingent on having heard a stimulus will likely either show very few responses overall, or will show many false responses during a test session. The impact of false responses, if they are not apparent to the clinician, is typically to invalidate the session and possibly to result in erroneous MRL estimates. In order to have a measure of the reliability and validity of the test session, the Audiologist shall subjectively rate the infant's response test-retest reliability, and objectively assess the validity of responses by tracking control trials in which no stimulus is delivered and the infant's response is noted on the Worksheet. Control trials are administered at regular intervals across the test session. Control trials must be administered at a rate of at least one per MRL, and should be administered during the process of bracketing the MRL (not only during known sub-threshold trials). Control trial responses are summed across the test session to determine the infant's False Positive Rate for the test session as a whole.

The protocol for the control trial is the same as that for a stimulus trial, except that no tone is presented, and no reinforcement is provided if the baby turns his/her head. The control trial is carried out when the infant is in the appropriate state for a test stimulus presentation: attentive and facing forward. The Audiologist informs the distractor of the beginning of the control trial, and the infant's behaviour is observed for the next four seconds to determine if a head-turn response occurs. The Audiologist records the presence or absence of a response on the worksheet beside the indication for a control trial (C). If the infant responds during a control trial, the Audiologist must administer an additional control trial to reassess response validity.

RELIABILITY

Reliability, in this protocol, refers to consistency of the infant's response across trials presented at the same test frequency and level (Norrix, 2015). If the child responds with uniform consistency and provides repeatable responses across trials throughout test trials, then the reliability can be rated as "good". If the child responds with consistency most but not all of the time, then the reliability can be rated as "fair". If the child's responses were inconsistent and not repeatable at any level, then the reliability can be rated as "poor". These ratings are derived from methods used in a large-scale study of VRA and CPA MRLs obtained from children seen in audiology clinics (Sabo et al., 2003).

VALIDITY

Validity, in this protocol, refers to the ability of the test session's results to distinguish true from false responses (Norrix, 2015). For the test results to be considered valid, the infant must demonstrate absence of response in at least 70% of the control trials (Norrix, 2015; Widen et al., 2000). The number of control trials in which the child gave no head-turn response is expressed as a percentage of the total number of control trials, and is recorded on the Worksheet as ____% correct control trials. Without formal control trials to determine the response validity, and the results cannot be used with confidence to plan the individual pattern of communication development services. Worksheets shall be recorded and kept for all VRA test sessions.

3.9 VRA TESTING FREQUENCY SELECTION

VRA testing prioritizes obtaining low- and high-frequency thresholds per ear, and for air- and bone-conducted stimuli as appropriate: this is known as “blocking the audiogram”. This blocking strategy is intended to use the limited number of responses from a given baby to estimate the magnitude, configuration, and nature (mixed versus sensorineural) of the infant’s hearing. Therefore, priority frequencies of 500, 2000, and 4000 Hz should be obtained in both ears, and by bone if the child has atresia or elevated thresholds by air conduction. The order of testing of these test frequencies may be modified at the clinician’s discretion. Further testing at other frequencies is a second priority and may be completed at the clinician’s discretion. Decisions to test further frequencies may be influenced by the audiometric configuration, child test state, or the specifics of the child’s case.

CONDITIONED PLAY AUDIOMETRY (CPA)

CPA is a technique used for measurement of hearing acuity in infants and young children. This technique is used to obtain frequency- and ear-specific thresholds by air conduction and bone conduction. Evaluation of responses as Minimum Response Levels may be appropriate to a developmental age of approximately three years, with responses to about 10 dB HL typical for children with normal hearing, moving to standard audiometric thresholds over a developmental age of three years, for children with typical development (Sabo et al., 2003). Sound field thresholds shall not be considered as sufficient basis for intervention and are only acceptable if there is documentation of substantial failed efforts to obtain ear-specific thresholds.

3.10 TARGET POPULATION

Young children typically aged from 24 to 60 months (AAA, 2012) and/or older children with developmental delay may be candidates for audiometric assessment using CPA. A combination of VRA and CPA techniques may be used for younger CPA children transitioning between these two testing techniques. CPA assessment is used as follow-up for children with PCHI identified from prior IHP assessment (i.e. ABR and/or VRA), as surveillance of high-risk children and to assess children referred into IHP identified as at risk for PCHI.

3.11 TEST PERSONNEL AND ENVIRONMENT

TESTING ASSISTANT

Use of a test assistant during CPA is not required. If an assistant is used, s/he may act as the play partner during CPA testing while the IHP Audiologist presents the stimuli and records the child’s responses. The testing assistant can be a non-Audiologist (trained assistant, student, CDA or parent) who has been instructed on the correct play procedures by the IHP clinician. The IHP Audiologist is responsible for training and monitoring the testing assistant and provide feedback as needed to maintain a successful test.

IHP AUDIOLOGIST

The Audiologist must be registered with CASLPO and have completed training in the use of this protocol. In situations where a testing assistant is not available, the IHP Audiologist can act as both the examiner and play partner. For this to be achieved, the audiometer and play activity must be in the same test room as the child, or in a two-room setup that permits the tester to see and interact with the child. The role of the Audiologist during CPA is to control the presentation of stimuli and judge if the child has responded or not. The Audiologist records these

judgements on a worksheet (Appendix B). S/he may also guide the testing assistant in keeping the child in the appropriate state for testing.

TEST ENVIRONMENT SETUP

The room shall be of sufficient size to accommodate the child and play partner comfortably. If two rooms are used, two-way communication shall be available to the examiner and play partner.

In the test room, the child may be seated in a chair or in the parent's lap along-side the play partner, or in another configuration that is appropriate for the play task and booth configuration. A surface for the toy or activity may be placed in front of the child. The play partner will direct play and maintain the child's attention for the duration of the assessment.

The Audiologist will control the audiometer and have a clear view of the child and play partner to monitor activity and record responses. In instances where the Audiologist is acting as both the examiner and play partner, the test room must also include an audiometer at an accessible distance for the Audiologist to present stimuli and record responses.

3.12 CPA TESTING FREQUENCY SELECTION

CPA testing follows a similar testing procedure to that described for VRA, in that blocking of the audiogram is an appropriate strategy for younger children. For older children, the audiologist may move to a more standard order of testing by frequencies at his or her discretion. This is typically appropriate if the child can be reasonably expected to provide enough responses for a complete audiogram.

Air conduction and/or bone conduction thresholds for Speech Awareness (SAT) may be established at the discretion of the Audiologist, as long as it does not compromise the goal of establishing frequency-specific thresholds. The primary purpose of this testing is to crosscheck the pure tone average. Where developmentally feasible, a Speech Recognition Threshold (SRT) may be determined by identifying pictures of spondees or identification of objects or body parts (AAA, 2012). If SRT testing is not feasible, a Speech Awareness Threshold (SAT) may provide a useful alternative.

3.13 THRESHOLD/MRL DETERMINATION

The procedures recommended for threshold determination by CPA are closely analogous to those for IHP VRA. The reinforcement paradigm shifts from visual reinforcement to a play action such as dropping a ball into a bucket when the stimulus is presented. First, training trials are completed at a suprathreshold level and a correct response is reinforced with the play action. If no response is given during training trials, conditioning trials may be completed by pairing the stimulus to the play action. Use of the VRA worksheet and application of control trials is recommended for children in the younger CPA age range (age 18 months to 3 y) and are at the clinician's discretion for older children who are easily conditioned. The same criteria for test reliability and validity apply as are used for VRA.

For some children, either the response (head-turns, play behaviours), or the reinforcement (toys, specific games) of VRA and/or CPA may not be appropriate. This occurs whenever the response is not within the child's motor ability range (e.g., head-turns for a child with a motor disability) or within the child's cognitive range (e.g., CPA for some children with a developmental delay), or when the visual reinforcers are not compatible with the child's visual abilities. For these children, modification of the CBA paradigm is necessary to individualize the response, the reinforcer, or both to work within the child's abilities.

For children who have **blindness or low vision**, request for support from the Ontario Blind Low Vision (BLV) program is strongly recommended, including for those who have cortical blindness. A BLV consultant can work in conjunction with the IHP Audiologist to determine an appropriate test setup and response that is appropriate for an individual child. Determining what the child can see prior to using a visual reinforcer is essential. Modification of reinforcer, room lighting, or placement may allow the child to see the reinforcer. Common strategies include: using moving rather than stationary reinforcers; using a moving reinforcer that lights up in a dimmed room; placing the reinforcer closer to the child; using reinforcers that are specific colours that can be perceived by the child.

For children who have **motor disorders**, modification of the response type shall be made at the discretion of the Audiologist. For example, if a head-turn is not possible, an alternative motor response such as an eye blink, hand motion, or verbal response may be conditioned. Any simple voluntary behaviour is appropriate, so long as the child can produce it in response to test stimuli. If the Audiologist is not able to determine an appropriate behaviour, or if the child's cognitive status precludes conditioning even after two test sessions, consultation and test planning with their developmental team is strongly recommended. Common strategies include: using a smaller range of head turn azimuth, such as 45 degrees rather than 90 degrees if this is within the child's range of motor abilities; monitoring and documenting the role and impact of spastic movements that are not responses to sound; accepting and documenting the observation of slow head movements, eye movements in lieu of head movements. Using a response type that is within the child's voluntary control is essential.

For children who have **developmental delay**, assess using a behavioural task that is appropriate for their developmental, not chronological age. Screen for conditioning using a vibrotactile stimulus if ability to learn the task is in question. Use of speech stimuli that are frequency-specific (Ling sounds including calibrated Ling6(HL) sounds, Glista et al., 2014), or newly-developed audiometric bands of noise (F.R.E.S.H. or Pediatric Noise are stimuli that are available in some audiometers) may provide alternative, calibrated stimuli that can assist in establishing threshold levels. Non-standard stimuli, such as noises made by favourite toys or a favourite song, may be helpful to initiate a conditioned response and facilitate further testing with calibrated stimuli.

SECTION 4: INTERPRETATION AND FOLLOW-UP

4.1 NORMAL, CONDUCTIVE, SENSORINEURAL, OR MIXED HEARING LOSS

NORMAL HEARING IS CONCLUDED PER EAR IF ALL OF THE FOLLOWING ARE OBSERVED:

1. Ear-specific MRL of 25 dB HL or better at 500 and 2000 Hz by air conduction
2. Normal DPOAE OR MRL of 25 dB HL or better at 4000 Hz by air conduction if DPOAE abnormality isolated to F2 at 4000 Hz
3. Normal middle ear status.

If all MRLs established in each ear are at a level of 25 dB HL or lower, the infant will be considered to have normal hearing under the IHP protocol. However, testing at lower presentation levels to establish individual MRLs is supported at the clinician's discretion. In clinical decision-making, the cognitive and developmental status of the child is a factor in MRL. MRLs obtained via CBA in normal-hearing infants aged 6 to 8 months are 15 to 20 dB higher than thresholds of normal-hearing adults (Gravel & Wallace 1997; Nozza & Wilson 1984; Sabo et al., 2003). However, the majority of infants in the 8 to 12 month corrected age range with no reported risk factors or hearing concerns and normal tympanometric results can respond to a minimum test level of 20 dB HL (Widen et al., 2000), with average thresholds of about 20 dB in the 6 to 12 month range. This changes to about 15 dB in the 9 to 35 month range for VRA testing by air conduction, then to about 10 dB in the 25 to 35 month range with CPA testing. Adult-like levels and standard test techniques emerge in the 3 to 5 year old group (Sabo et al, 2003). Tests of infants to aged 7 to 30 months with VRA and bone conduction also indicate that the normal response range is up to about 20 dB HL (Hulecki & Small, 2011). The average age of successful completed VRA in review of Ontario IHP data is approximately 10 months, with feasible testing to 20 dB HL. Therefore, the minimum level at which a child responds may become lower as the child matures. The majority of evidence in this area has been obtained in children with normal hearing.

TEMPORARY CONDUCTIVE HEARING LOSS IS CONCLUDED PER EAR IF ALL OF THE FOLLOWING ARE OBSERVED:

1. MRL of ≤ 25 dB HL at 500 and 2000 Hz by bone conduction
2. Elevated MRL by air conduction (air-bone gap of ≥ 10 dB).
3. Otoscopy rules out any significant abnormality of the ear canal
4. Flat tympanogram with normal ear canal volume, or negative pressure. (Appendix C)
5. Absence of known or suspected syndrome associated with structural abnormality of the ear
6. Confirmed absence of structural cause for a permanent conductive hearing loss (for example, no evidence of atresia, stenosis OR the child has a craniofacial abnormality but outer/middle ear involvement has been ruled out); OR ongoing medical management for temporary conductive loss (tubes, etc).

PERMANENT CONDUCTIVE HEARING LOSS IS CONCLUDED PER EAR IF ALL OF THE FOLLOWING ARE OBSERVED:

1. MRL of 25 dB HL or better at 500 and 2000 Hz by bone conduction

2. Full or partial atresia of the ear OR otologist confirmation of permanent conductive hearing loss

PERMANENT SENSORINEURAL OR MIXED HEARING LOSS IS CONCLUDED PER EAR IF ALL OF THE FOLLOWING ARE OBSERVED:

1. MRL greater than 25 dB HL at any frequency between 500 and 4000 Hz by bone conduction
2. MRL greater than 25 dB HL at any frequency between 500 and 4000 Hz by air conduction
3. Otoscopy completed and consistent with other test results
4. Immittance completed and consistent with other test results
5. DPOAEs completed and consistent with other test results (Appendix C)

If any MRL is greater than 25 dB HL, a hearing loss is considered to be present. When there is a bilateral hearing loss, the bone conduction MRL may help to determine if there is a conductive component in at least one ear. The use of masking is necessary to determine ear-specific bone conduction thresholds. The MEA and DPOAE testing may provide an important contribution to the interpretation of the VRA results.

For children with previously identified PCHI, follow-up visits are necessary to monitor any change in hearing. This includes quarterly assessments (with hearing aid re-evaluation if the child is using amplification) in the first year after diagnosis of hearing loss or post hearing aid fitting, and biannually in the second year. More frequent re-assessment may be needed if transient middle ear infections cause temporary conductive overlays, or if the sensorineural hearing loss is fluctuating or progressive, or if other concerns in the management of the child's intervention or outcomes arise, in order to provide ongoing follow-up and to monitor/re-adjust amplification settings to maintain consistent access to sound for children who use hearing aids.

4.2 AUDITORY NEUROPATHY SPECTRUM DISORDER (ANSD)

Within the category of permanent sensorineural hearing loss, some children will fall within the subcategory of auditory neuropathy spectrum disorder (ANSD). MRL testing is not sufficient to determine ANSD. Prior testing within the ABRA protocol may have already confirmed ANSD for some children. For children who were not previously tested with ABRA, MRLs may suggest ANSD. Consultation with a DTC should be requested if the following are observed:

1. MRLs greater than 50 dB HL by air conduction
AND
2. DPOAEs are present (Appendix C)

4.3 INTERPRETATION OF DISCREPANCIES AMONG TEST RESULTS

Review of ABRA and VRA results over time in children receiving IHP services indicate that when the IHP ABR corrections are applied, the two tests agree closely (within 1 to 2 dB on average, and within 1 to 2 step sizes for individuals) when progressive losses and conductive overlays are not factors in either assessment, and when both results are converted to ear canal SPL in order to remove changes attributable to ear canal growth. These results support the idea that ABRA and VRA should be comparable to one another, within the same baby and over time. Correction from nHL to eHL is necessary for valid comparisons. Correction to ear canal SPL is a routine component for children receiving amplification services and may provide a more valid comparison over time. If the possibility

of progressive or fluctuating hearing loss is a factor, incorporation of ear canal corrections is recommended at the audiologist's discretion.

4.4 INCOMPLETE OR INCONCLUSIVE TEST RESULTS

Every attempt should be made to complete the evaluation in one visit. However, if the test results are incomplete (fewer than two AC MRLs in each ear, or no BC threshold obtained when MRLs are elevated bilaterally and no evidence of middle ear pathology), or if the results were considered unreliable or invalid (<70% correct control trials), the infant may be scheduled for retest, at a better time (if s/he seemed tired or irritable), or when s/he is a little older (if the results seem to be related to his/her developmental level). Very closely-timed re-booking is indicated more strongly for children who are able to condition but cease responding because of fatigue midway through the session, because this indicates that they are developmentally able to do the task. Close re-booking is also indicated more strongly the more indicators of likely hearing loss are available from cross-check objective measures of hearing (e.g., referred on screening; absent OAE, previous ABRA results, etc.). Acceptance of earphones upon second test session may be improved by instructing parents to desensitize the child to ear touching in between appointments (e.g., by rubbing the ears at home to familiarize the child to ear touching; providing some insert foam tips to take home and place in child's ears to desensitize). However, if no improvement in behavioural responses is expected or seen, or if the infant has not tolerated the earphones long enough to complete necessary testing after repeated (no more than three) closely-scheduled (within three months total) attempts, consultation with a DTC should be requested.

If the degree of the infant's PCHI has already been established with satisfactory ABRA results, but there have been no reliable ear-specific VRA results for the infant by age 12 months after three repeated attempts, consultation with a DTC should be requested. Each case should be assessed on an individual basis through review of the infant's entire clinical picture to determine if a referral for further testing (ABRA, sedated ABRA, or re-attempted CBA) will be initiated. The audiologist will document the nature and outcome of the VRA assessment attempts, and the reason for failure to obtain acceptable results.

4.5 PROVIDING TEST RESULTS TO FAMILIES

Upon completion of a test session, the Audiologist shall review the results with the family, explaining whether interpretable results were or were not obtained, and if appropriate the type and degree of hearing loss that is suggested by the results. The Audiologist shall also discuss with the family the implications of the hearing loss for the child's communication development. If, based on audiometric data, the infant may be a candidate for amplification and support for communication development, and this has not yet been addressed, information about these issues should be provided, and a communication development planning process should be initiated. Information about medical referral and/or audiologic follow-up, if appropriate, should also be provided.

If, as a result of a complete assessment, it is determined that the infant has 'normal' hearing for IHP purposes (i.e. the target disorder is not present), the family should be provided information about the need for their continued vigilance concerning their child's hearing. The family should be provided with written information concerning risk indicators, communication development milestones and what to do if they have concerns about their child's speech, language or hearing.

4.6 REFERRAL TO OTOLARYNGOLOGIST

In the IHP context, an assessment by an otolaryngologist shall be recommended to the child's primary care physician whenever the IHP Audiologic Assessment reveals PCHI. That referral has the main goal of a broad review of the child's health status in light of the hearing impairment, and may include radiologic, serologic, and ophthalmologic tests, as well as genetic review and other cross-referrals.

For all infants identified with permanent hearing impairment, referral leading to review by an otolaryngologist is required. In the case of an infant for whom hearing aid prescription is indicated and chosen by the family, the otolaryngology assessment may occur prior to the taking of earmold impressions and hearing aid fitting if local caseloads permit. If the family elects to pursue use of hearing aids, the Audiologist should be aware that the Assistive Devices Program of Ontario also requires an otolaryngologist's assessment and clearance for the family to receive provincial funding for hearing instruments and assistive devices. Loaner hearing aids are provided by the IHP for use while obtaining approvals.

At the time of behavioural audiometry, this referral may have already been made on the basis of ABRA results. If it has not, referral is necessary if the above criteria are met.

4.7 RECORD-KEEPING AND REPORTS

The detailed results of the hearing assessment (including MEA and DPOAEs, if performed) must be maintained in a local clinical chart/file, in compliance with current CASLPO standards and IHP specifications. The records should be sufficient to demonstrate compliance with the required elements of the IHP protocol and to support clinical conclusions, for the ongoing care of the child and in the event of any reviews done for continuous quality improvement, second opinions, or other elements of IHP program support. This includes a completed VRA/CPA worksheet (Appendix A1, A2, or similar) and Summary of MRLs (Appendix C), MEA results (summary table or printout) and DPOAE printouts for each ear, and documentation of any modifications to protocols and the reasons for modifications. Editable copies of sample worksheets will be made available for use.

When the hearing assessment has been completed and the test results are judged to be valid, the IHP Audiologic Assessment report form (Appendix D) must be completed and sent to the Regional Infant Hearing Program. This must be done within the regionally designated time frame following the testing session.

APPENDIX A1: SAMPLE VRA WORKSHEET

Clinic Logo

Patient Label

Audiology VRA Worksheet

- Transducer**
- Insert + foam
 - Insert + mold
 - TDH
 - Bone
 - SoundField
- Right
 Left
- 0°
 45°
 90°
- Aided:
 Yes/No
 Right
 Left
 Bilateral

- Stimulus**
- Tones
 - Warble
 - FRESH
 - Narrowband Noise
 - Live voice
 - Team tested?
 - Masking? _____
- Reliability**
- Good
 - Fair
 - Poor

250		500		1000		2000		4000		6000		Speech	
c		c		c		c		c		c		c	
0		0		0		0		0		0		0	
	5		5		5		5		5		5		
10		10		10		10		10		10		10	
	15		15		15		15		15		15		
20		20		20		20		20		20		20	
	25		25		25		25		25		25		
30		30		30		30		30		30		30	
	35		35		35		35		35		35		
40		40		40		40		40		40		40	
	45		45		45		45		45		45		
50		50		50		50		50		50		50	
	55		55		55		55		55		55		
60		60		60		60		60		60		60	
	65		65		65		65		65		65		
70		70		70		70		70		70		70	
	75		75		75		75		75		75		
80		80		80		80		80		80		80	
	85		85		85		85		85		85		
90		90		90		90		90		90		90	
	95		95		95		95		95		95		
100		100		100		100		100		100		100	
	105		105		105		105		105		105		
110		110		110		110		110		110		110	
	115		115		115		115		115		115		
120		120		120		120		120		120		120	

Comments:

APPENDIX B: SUMMARY OF MINIMUM RESPONSE LEVELS (MRLS)

**Visual Reinforcement Audiometry / Conditioned Play Audiometry
Summary of Minimum Response Levels (MRLs)**

Name: _____

Date Tested: _____

VALIDITY TRACKING

Number of correct Control Trials (no response) = _____

÷

Total number of Control Trials = _____

X 100 = _____

MINIMUM RESPONSE LEVELS (MRLS) IN DB HL

Frequency (Hz)	Air Conduction MRLs (dB HL)		Bone Conduction MRLs (dB HL)	
	RIGHT	LEFT	RIGHT	LEFT
500				
750				
1000				
2000				
3000				
4000				
6000				

APPENDIX C: NORMATIVE RANGES FOR MIDDLE EAR ANALYSIS

Middle ear analysis may be completed using any make or model of equipment, provided that it meets calibration requirements, and offers a 1 kHz probe tone for use with infants younger than 6 months corrected age if infants in this age range are part of the clinic’s caseload (see ABRA protocol for specific details). As per CASLPO (2008) requirements, middle ear analysis must be performed using a diagnostic (Type 1) tympanometer. A pressure sweep range that includes -200 daPa is required to facilitate measurement of negative middle ear pressures.

For tympanometry, the following normative ranges are recommended, and intended for use with a 226 Hz probe tone unless otherwise specified. Visual examples of flat and normal tympanograms, are available in Rosenfeld et al., (2016) Clinical Practice Guideline: Otitis Media with Effusion (Update).

If the tympanic membrane is intact: ²				
Age group	Equivalent ear canal volume (Vec)	Static compensated admittance (Y _{tm})	Tympanometric Width ³	Tympanometric peak pressure (TPP)
<6 months (1000 Hz probe)	0.2 – 0.8 cc	≥ 0.6 mmho (negative tail compensation)	<150 daPa	N/a
6 – 18 months	0.5 – <1.0 cc	≥0.2 mmho	<250 daPa	-75 to + 25 daPa are typical, but peak pressure as low as -199 may be consistent with transient middle ear issues and may resolve. Consider results together with other findings.
>18 months – 10 years	0.6 – 1.2 cc	≥0.3 mmho	<200 daPa	
If otoscopy reveals a patent tube or perforation				
1 to 7 years ⁴	1.0 – 5.5 cc			

² Hunter, 2013, BSA 2013, Rosenfeld et al., 2016

³ For information purposes only

⁴ ASHA, 2004

APPENDIX D: NORMATIVE RANGES FOR DPOAE

For distortion product otoacoustic emissions, the following normative ranges are recommended and are quoted with those used in the ABRA 2018 protocol:

“A DPOAE system that satisfies the collection parameters listed in this protocol shall be used. DPOAEs must be measured for nominal F2s of 1.5, 2, 3 and 4 kHz, in descending frequency order. Measurement of DPOAE above 4 kHz is discretionary. To determine response presence or absence, stimulus levels, DPOAE amplitude, noise levels, reproducibility, and frequency profile are relevant. For a single f2, presence requires 8 dB above the noise and a test-retest difference of under 5 dB. For two or three adjacent frequencies, SNR of at least 5 dB at each F2 is sufficient.” (from section 5.01, ABRA 2018.01).

DPOAE measurements, when used in clinical interpretation, should meet the following criteria for a high-quality measurement and interpretation (AAA, 2012):

1. Stimulus levels must be within 3 dB of nominal test levels across the run to ensure valid test results. If otherwise, the results are not interpretable and the assessment may not be complete.
2. Response presence should be evaluated against normative data that are (a) age-appropriate and (b) appropriate for the type of measurement (e.g., DPOAE and TEOAE normative data are not the same). Stimulus levels of 65 and 55 dB SPL are typical. Detailed guidance on response interpretation is provided in AAA (2012).
3. Screening DPOAE systems are acceptable for use in DPOAE testing aimed at cross-check with behavioural results.
4. Because the primary interpretation of the presence or absence of DPOAE is to separate ears that do and do not have normal hearing (30 dB HL or better: AAA, 2012), differences between systems are not expected to affect significantly the overall interpretation and crosscheck impact of the measurement.
5. The presence or absence of DPOAE should agree with the behavioural test results, or the principle of crosscheck is not met and further testing should be pursued in a short time frame to achieve a complete assessment.

APPENDIX E: KEY PERFORMANCE INDICATORS

Indicator	Observed	N/A	Comments
File(s) contain(s) evidence of case history with consideration of screening history and current IHP risk factors.	○	○	
Files indicate that developmentally appropriate choices of behavioural test techniques are routinely chosen. Any modifications are noted.	○	○	
Review of available equipment indicates that the clinic offers the necessary equipment for both VRA and CPA, along with equipment for middle ear analysis (Type 1) and measurement of otoacoustic emissions (minimally screening equipment).	○	○	
Any concerns about test conditions (noise, child state, test reliability/validity) are noted clearly with reported results.			
Files contain clear evidence of administration and tracking of control trials during VRA.	○	○	
Step sizes, bracketing, and blocking strategies are used that maximize efficiency and assessment of ear-specific, frequency-specific thresholds by air and/or bone when indicated.	○	○	

Test results from behavioural hearing assessments are integrated with ABRA when indicated, and use the cross-check principle with middle ear analysis and OAE measures.	<input type="radio"/>	<input type="radio"/>	
Test results from objective measures of the hearing system (MEA, OAE) are conducted to achieve a valid test result (stable probe placement) and results are interpreted against age-appropriate normative data that are appropriate for the type of test.	<input type="radio"/>	<input type="radio"/>	
Schedule of re-testing is modified to meet the needs of children who have fluctuating, progressive, or mixed hearing losses.	<input type="radio"/>	<input type="radio"/>	
Modification of test procedures, including consultation with the BLV program as needed, are completed to test within the ability range of the child.	<input type="radio"/>	<input type="radio"/>	
Appropriate recommendations for intervention are provided, within the context of forming a Communication Development Plan for Language Development services .	<input type="radio"/>	<input type="radio"/>	
Appropriate supports (referrals, forms) for obtaining external funding are provided as appropriate.	<input type="radio"/>	<input type="radio"/>	

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