NHS
Antenatal and Newborn Screening Programmes

NEWBORN HEARING SCREENING AND ASSESSMENT

Visual reinforcement audiometry testing of infants

A recommended test protocol

Version 2.0

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NHSP Clinical Group

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CONTENTS:

1. INTRODUCTION

This document has been prepared as part of the advice and guidance from the Newborn Hearing Screening Programme (NHSP) in England. It is an update of that produced in 2001. Opportunity has been taken to incorporate the latest evidence-based knowledge on this procedure and provide more practical guidance on key issues, particularly around utilisation of the test and interpretation of results. Protocols for other test procedures are available on the NHSP website (http://hearing.screening.nhs.uk).

Visual Reinforcement Audiometry (VRA) is a key behavioural test for young children. It is central to completion of the diagnostic process for those hearing-impaired infants identified by newborn screening. Furthermore, contemporary paediatric amplification fitting methods rely on solid foundations of measurement to ensure the validity and reliability of hearing aid fitting. Also, it is hoped that the standardised VRA technique described here will facilitate training of Audiologists and be of use in research studies.

There were many points of debate relating to set-up and methodology for this test technique. For some features of the technique, it is recognised that alternative approaches exist. However, for the purposes of standardisation a decision to adopt the one described approach has been made. It is advised that only experienced Audiologists (or those led by such colleagues) should consider deviating from this protocol.

2. SCOPE

The document sets out to provide guidelines for testing babies with a minimum developmental age of 5-7 months. In common with the distraction test, the test is suitable for infants who are able to sit unsupported or with minimal support and have good head control. It is assumed that the reader of this document is familiar will the principles of VRA. This protocol covers only VRA, including the defining feature of one-sided reinforcement (rather than two-sided reinforcement of the conditioned orientation response test).

The document covers the technical procedure of carrying out a manual VRA test, equipment/environment considerations, basic interpretation of the results, reporting and patient handling procedures relevant to the test.

3. FACILITIES & PREPARATION

Test Environment - Maximum Ambient Noise Levels

The maximum levels of ambient noise, and reverberation time in the test room should meet the requirements defined in ISO 8253 for testing down to 0 dB HL, relevant to the stimuli and transducers employed. For soundfield and bone conduction testing it is pragmatic to relax the specification so as to permit testing of thresholds down to 10 dB HL. This entails adding 10 dB to the ambient noise values given in ISO8253 for sound field testing. Audiologists using the test facility and reporting on results should be aware of the limitations of the test environment relevant to the stimuli and transducers employed (i.e. the lowest stimuli levels that can be reliably used).

A high quality sound level meter (conforming to type 1 of IEC 60651) should be used to measure ambient noise against those levels specified in ISO 8253-2. It is also important to be aware of the limitations of the sound level meter at low sound levels. For these reasons, centres are advised to consider commissioning noise measurement specialists to survey new or modified test facilities.

Note that a simple test is if a person with normal hearing can hear signals of 10dB below the minimum presentation levels.

Test Environment - Other Considerations

The test should be performed in a room which is of adequate size to accommodate parent(s), child and 2 testers comfortably. As a guide, a minimum floor area of 12m^2 is advised. Note, this specification assumes that the room is dedicated to VRA/distraction testing. More space will be required if the room is multi-use. The room should have adequate ventilation and air conditioning is recommended for patient comfort – babies who are uncomfortable are less likely to respond well to testing. The room should offer minimal visual distraction to the child. It is advised that room lights should be capable of being dimmed, in order to permit enhancement of illuminated visual rewards – this is particularly useful for children who have a visual impairment or who are just distractable.

The preferred arrangement is for control of stimuli and reward to be operated from a second (observation) room. Such an arrangement allows for discreet communication/instructions to the tester controlling the child's attention, reduces the potential for distraction, and allows for optimum (frontal) observation of the child's behavioural responses. The test and observation room should be separated by a one-way window (or alternative arrangements provided, e.g. image on a monitor screen) such that the child is not distracted, yet allowing the observer (Tester 1) a clear view of the child. There should also be the facility for the observer to hear sounds made in the room (for appropriate timing of stimulus) - see below.

Where an observation room is not available (e.g. as might be the case at a more basic test centre), another possibility is to use a monitor screen linked to a camera positioned to observe the front of the child. Tester 1 must also be out of view of the child, perhaps behind a screen.

Test Equipment and Set-up

It is recognised that a variety of test room arrangements can be employed for VRA. However, the test protocol described below will be based upon the preferred test equipment and set-up described here (see Fig 1). The two-speaker and two-reinforcement unit arrangement as described is the basis of the test procedure presented below. The arrangement also allows Tester 1 to present live speech to the patient through the sound-field speakers, via a microphone with presentation level

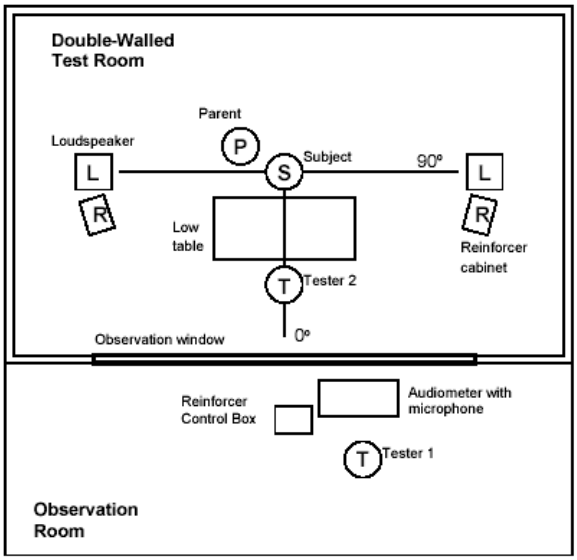

Fig 1 Room layout

controlled by the audiometer intensity attenuator.

Type of Reinforcement: Illuminated and animated toys.

These should be located within a cabinet, obscured by smoked perspex screen such that the toys are not visually attractive without illumination. A switch in the observation room should control animation and bright illumination of the toys. Ideally, at least two independently controllable toys should be provided for each side of testing. Alternatively, a variety of equivalent video images could be used and a rotating light would be a useful additional reinforcer.

Positioning of Reinforcers:

90° azimuth (or as close to 90° as possible) with facility to re-position to reduce the angle if required. 90° azimuth is used in order to elicit the clearest head turn, while a lesser angle may be appropriate if the child is not developmentally ready for full head turn. The reinforcers should be located approximately level with the child's head at a distance of 1-2m. Facility should exist to move the reinforcers closer to the child if their developmental readiness is uncertain. Reinforcers positioned to both sides allows children to be rewarded on their preferred side (e.g. useful when testing through insert earphones or through bone conduction).

Positioning of Loudspeakers

45° or 90° azimuth (RETSPLs are only available for these angles of presentation). The speakers should be positioned at least 1m from the test position. Speakers should be positioned adjacent to reinforcement apparatus and approximately level with the child's head - such positioning provides the most efficient means for conditioning the behaviour and establishing threshold.

Positioning of Child and Tester

A younger infant (age 5-12 months) should be seated on the parent's knee, gently supported at the waist and facing forward. Alternatively, the infant may be placed in a secure 'high chair'. An older child can be seated on a low chair, with parent seated on the opposite side to reinforcement, and slightly behind. The child should be at a point determined and marked during calibration of the sound field. A low table is placed in front of the child to provide a surface for the distracting activity. Tester 2[1] is either seated on a low chair or kneels in front of the table facing the child and has a concealed supply of suitable toys close at hand adequate for the duration of the assessment.

Position of Tester in Observation Room:

The tester should have a clear view of the child's face and tester activity. The audiometer, reinforcer control box and recording materials should be within easy reach.

Communication between testers:

Good two-way communication between testers is essential requirement for the test. Communication from Tester 1 to Tester 2 should be direct and discreet so as to avoid auditory distractions for the subject for example the use of wire-free type infrared earphones (recommended) or a FM radio system[2].

Hearing Protection

The Control of Noise at Work Regulations (2005) stipulate daily personal noise exposure levels beyond which hearing protection should be used. If daily noise exposure is above the first action level of 80 dB(A) but below the second action level of 85 dB(A), hearing protection should be available to the employee. If daily noise exposure is beyond the second action level or if any peak levels exceed 137 dB SPL then hearing protection must be used. Daily personal noise exposure level can be calculated from knowledge of the level and duration of stimuli.

[1] An alternative approach is to dispense with Tester 2. This option could be considered if the child is shy and the parent is able to understand the test requirements.
[2] If a single tester arrangement is adopted, the observation room tester may communicate with the parent via infrared earphones.

Calculations for a VRA system with a maximum output of 115 dB(A) indicate that the second action level could be exceeded when testing one child with severe or profound hearing loss. As well as this, some of the sound levels used may be uncomfortable and for this reason also hearing protection (muffs and /or plugs) should be available for parents and observers as well as testers. The maximum output at each frequency should be measured and this information used to calculate likely noise exposure levels according to the methods described in the Noise at Work Regulations. This information can be used to specify local hearing protection policy.

4.STIMULI

Stimulus Type

Frequency-modulated (warble) tones and/or narrow-band noise should be employed. If the child is unresponsive to one of the above stimulus types use of the alternative should be considered For insert earphones, pure tones are acoustically acceptable as a stimulus. For inserts used with a child's earmoulds, actual levels will differ from standard calibration.

Stimulus Delivery

There are advantages and disadvantages/limitations related to each method of stimulus delivery, which will not be explored here. However, a comprehensive range of transducers should be available for use: supra-aural earphones (e.g. TDH39/49), insert earphones (e.g. EAR3A coupled with immittance tip, foam tip or earmould), speakers for soundfield presentation and a bone conductor.

Precautions Against Cross-Infection

Local procedures should be adhered to. If insert ear phones are used with non-disposable tips (e.g. immittance tips), these should be swabbed down with cotton wool soaked in a suitable solution such as chloro-hexadine.. It is recommended that local advice be sought regarding best practices for cross-infection control.

Calibration

Stimuli presented through 'closed circuit' transducers (headphones, bone vibrator or insert-earphones) should be calibrated in accordance with the relevant ISO standards in dB HL or dB SPL (see below). Calibration of stimuli presented in the sound field is less straightforward. Most test environments do not provide the ideal anechoic condition and a number of measures have to be taken to ensure that the sound delivered to the patient's ear is accurate and stable.

Soundfield calibration requires a considerable knowledge of the use and limitations of sound level meters and soundfield acoustics . It is recommended that expert help is sought from centres with experience in this field. The reader is referred to the British Society of Audiology Guidelines for Soundfield Audiometry in Clinical Applications (BSA, 2007) particularly as they relate to use of static systems as employed in VRA.

Whatever the range of stimuli, a weekly visual examination and listening test should be carried out (Stage A check). Such checks are particularly important for VRA given the variety of stimuli and transducers typically employed and routing of signals between rooms often via additional cable connections. Aside from the requirement for initial and 5-yearly interval full calibration (Stage C) against the standards, an intermediate annual calibration should be carried out, and also when any major changes are made (e.g. to room layout) or changes in external noise levels occur. The BSA guidelines state that the test environment should be clearly documented with a defined layout of furniture, furnishings, equipment and positions for people in the room during testing. It also recommends that marks be provided to floors and ceilings to ensure that layout and positions remain consistent as any deviation may compromise calibration.

If sounds other than warble tones and narrow-band noise are to be used, a biological calibration will have to be carried out. This is outside the scope of this document.

5. TEST PROCEDURE

Preliminaries

Following equipment checks, parent(s) and child are brought into the room, seated and introductions made. History taking provides an opportunity for the child to settle in an unfamiliar environment and for the audiologist to make some preliminary observations about the child. If the child is becoming restless it may be appropriate to cut the history short and begin testing.

The test procedure is explained to the parent with suitable cautions about cueing the child to the presence of an auditory stimulus, and the need to minimize distracting noise. If a 'Tester 2' is not used, particular attention must be paid to instructions to parents remaining in the test room with the child. Information should be obtained about the child's developmental and visual status before starting the test. If there is any doubt about the child's ability to respond in the desired manner (i.e. with a head-turn) this can be discussed with the parent. If necessary, head control and turning can be checked by having the child visually track an object of interest through an arc of 180°.

Any others present are best invited to sit in the observation room (preferred) or directly behind parent and child. The child will be placed in the test position with reference and care should be taken when positioning parent and child to ensure that soundfield calibration (if relevant) is not compromised. The transducer should be fitted to the child, insert-earphones by clip to clothing on the child's back. The fitting of insert earphones should be preceded by otoscopy or if it is not done this is on the basis of an assessment of risk and benefit for individual subjects . An elasticated headband may be used to position the bone conductor in place as a more comfortable alternative to a conventional 'Alice Band'. If the child is resistant to either method of placement the bone conductor could be held in place by the parent. Whatever the means of placement Tester 2 should be alert to ensure that the conductor remains appropriately placed throughout the test procedure.

Procedure for Measurement of Minimum Response Levels (MRLs)

Initiation of Test and Role of Tester 2

Tester 2 will choose a suitable table-top activity (e.g. playing with small toys). The toys selected and manner employed will be the minimum necessary to encourage the child to adopt a midline forward position and maintain alertness. Importantly, Tester 2 should provide no change in activity linked to stimulus presentation which could serve as a cue for signal presentation (e.g. distinct and rhythmical phasing should be avoided). Tester 2 will avoid noisy play, and refrain from engaging with the child too fully, save for praising a correct response.

Familiarisation/Conditioning

Before testing it is essential to establish conditioning. Some children will give a clear and repeatable head-turn to an auditory stimulus without any formal conditioning while others will require a number of conditioning trials.

The following sequence is suggested:

A 2 kHz[3] stimulus is presented at a level judged adequately supra-threshold (as a guide, 60-70 dB

[3] Another frequency may be selected if it is judged that the child is likely to be more responsive, e.g. a lower initial frequency would be appropriate if there is suspicion that the child has a severe high frequency hearing loss.

HL is suitable for routine purposes, although consideration should be given to the type and degree of hearing impairment anticipated). If the child gives a clear head turn within 2-3 seconds visual reinforcement is provided, in combination with the sound, for a further 2-3 seconds. Conditioning can be considered to be established and the test sequence begins.

If the child does not respond spontaneously with a head turn a more formal conditioning procedure is needed. Initially stimulus and reward are presented simultaneously and if necessary the child's attention directed towards the reward. A number of such paired presentations may be required. When a head turn response is reliably elicited to the combined stimulus conditioning is checked by presenting the auditory signal alone and presenting the visual stimulus as a reward **after** the head turn response. Once the child is responding to sound alone testing can begin. If the child responds to the combined stimulus/reward but fails to demonstrate a response to the stimulus alone it may be that the stimulus is insufficiently interesting or is not audible. This can be checked by changing the stimulus type e.g. to narrow band noise, changing the frequency and/or level of the stimulus and ultimately by using a vibrotactile stimulus (e.g. around 50 dB HL at 500 Hz) generated from the bone conductor with reconditioning using the paired presentation.

If the child is not responding to the stimulus/reward combination it may be that the reward is insufficiently visible or interesting. This may be remedied by lowering the room lighting, changing the reward, using two or more rewards in combination or moving the visual reward closer to the child. Alternatively it may be that the child is not developmentally ready for the procedure or is not sufficiently motivated by the reward in which case other test procedures will be required.

Testing

When conditioning is secure (at least two consecutive correct responses), Tester 1 will proceed to the test trials proper. Here sound only will be presented for 2-3 seconds. If Tester 1 judges that the child has turned in response to the sound, then visual reinforcement will be presented for 1-2 seconds. The desired response is a clear head-turn to view the reinforcer. Eye glances or small movements should be interpreted with more caution and be reported as such.

False 'checking' responses will be managed by using variable inter-trial intervals, some of long duration – additionally, use of deliberate control trials may be employed. Withholding the visual reinforcer for a moment or two after the child turns also may help to distinguish checking glances, which are often short-lived, from real responses.

A '10 dB down, 5 dB up' rule for stimulus presentation should not be rigidly applied through threshold measurement. Once responses have been established to the initial high level, the level should be dropped as rapidly as possible (perhaps 20 dB steps) as long as responses are still observed. Tester 1 should determine presentation level based upon age of the child, attention state, and other factors concerned with time. However, around the estimated threshold a '10 dB down, 5 dB up rule' should be adopted. The criteria for threshold will be 2 out of 3 responses at any level. Minimum response level at one frequency should be defined before moving to another frequency where possible.

The initial and subsequent test frequency will vary for each patient according to information obtained by previous methods and the need for further information. When changing stimulus frequency, present the initial stimulus at a level judged to be above threshold. It may also be helpful to present clear supra-threshold stimuli or re-condition a child who has become distracted. For a child who is restless or bored, it may be possible to maintain/restore interest by: using a combination of warble tones and narrow-band noise; randomly changing frequency; and increasing or varying the visual reward (e.g. changing toys or multiple toys).

It may be useful to measure speech detection thresholds using live speech, in order to provide some validation of the information obtained from electronically generated stimuli. Tester 1 should talk to the child through the sound-field speakers, using their name frequently, while slowly raising the level from around 20 dB(A) (using the audiometer intensity attenuator), until a response is seen. The recorded level, in dB(A), can be compared with the average minimum response level for the child.

For soundfield VRA, once thresholds have been defined at the required frequencies, the child's localisation ability for narrow band noise or voice (supra-threshold, up to 30 dB above the minimal response level) may be assessed, using both low and high frequency narrow-band noise. It may be necessary to recondition the child using loudspeakers on both sides. Difficulty with localisation may indicate an asymmetric hearing impairment and warrant testing each ear individually with insert earphones.

The selection of transducer to use will not be covered in depth in this protocol - as with selection of frequencies for testing, this will depend upon the profile of information previously obtained on the child and that required for further management. However, use of insert earphones is strongly preferred for those suspected or known to have a permanent hearing loss, in order to obtain reliable ear-specific information.

Tips for Effective VRA Testing

- The procedure relies on continued cooperation of the child, in particular their ability to stay in the required test position – time will be therefore be limited. To avoid delay/disruptions ensure that all required equipment is checked in advance (stage A calibration checks are completed, reward system operating and communications equipment ready for immediate use).

- Some children may be upset by certain animated toys. If so, reward through simple illumination rather than animation or switch to alternative toys.

- To extend interest in responding, switch reward toys and/or use in combination. Also be prepared to take a break from testing and return to complete the assessment, or switch testers. The interest of older children in particular may be extended by praise/encouragement of correct head turn, provided by Tester 2.

- Towards the end of the test procedure, return to the first frequency tested and present at MRL (or 5 dB above that dial level) - does the child still respond? This information will help the tester judge validity of later responses.

The Most Common Pitfalls of VRA Testing

- Inadequate test set-up and communication between testers.

- Attempting conditioning to sub-threshold stimuli.

- Not establishing clear responses at supra-threshold levels before descending to threshold.

- Incorrect scoring as true responses i.e. scoring of movement other than a clear head-turn, or false positive (checking) responses.

- Distinct and/or rhythmical phasing of attention by Tester 2 such that response cues are given to the patient.

- Use of toys or behaviour by Tester 2 (or parent) that are too distracting for child and so inhibit responses.

- Overemphasis on quantity of results (number of thresholds obtained) rather than quality (reliability) of those thresholds obtained.

- Not using time efficiently, often spending too long at high intensities.

- Inaccurate interpretation and reporting of results due to inadequate consideration of differences in infant MRLs compared to adult normative (threshold) values (see below).

Testing Children with Vision Disorders, with other Disabilities or at an Early Age.

Visual disability may interfere with conditioning and responses. Consider bringing the reward closer to the child. Alternatively use of more visually contrasting rewards (e.g. bright flashing light), or removal of the smoked perspex cover to the reinforcer unit should be considered. Dimming the room lights will also increase the contrast. For the more severely visually impaired, use of other sensory reinforcement such as air puffs, vibratory stimulation or music may be needed to bring children under stimulus control.

General developmental delay may not interfere with VRA. However, motor difficulties may obscure head-turn responses. A more flexible approach to response reward and interpretation may be appropriate. However, any deviations from the standard approach should be described when reporting.

Although VRA is generally reliable in assessment of normally developing children from age 30 weeks (corrected age), some infants may be testable at younger ages, from age approximately 20-26 weeks. Testing at this age may be required because of parental or professional concern and of particular value to early diagnosis and habilitation. However, for younger children it should be recognised that a sequence of test appointments may be required to incrementally gain the information required (e.g. a series of frequency and ear specific MRLs).

For children with disabilities or where VRA is used speculatively at an early age, a realistic appraisal of the likelihood of test success should be presented to parents/carers before testing. Testers should also seek the advice of parents/carers in advance of assessment to determine the appropriate test strategy. For more detailed information on conducting VRA for children with disabilities, clinicians are advised to refer to Coninx & Lancioni (1995).

Sequence and Objectives of Assessment

The sequence of assessment should be adapted depending on the objectives of the Audiologist and the status of the child. However, the testers must be aware that the cooperation/interest of the child may fail at any time and this should be reflected in the sequence of assessment – the clinically more important information should be obtained first. As a guide the following sequences are suggested for an initial formal behavioural assessment commencing with stimuli presented in the soundfield:

$$2\text{ kHz} \rightarrow 500\text{ Hz} \rightarrow 4\text{ kHz} \rightarrow 1\text{ kHz}\ \text{ or}$$

$$1\text{ kHz} \rightarrow 4\text{ kHz} \rightarrow 500\text{ Hz} \rightarrow 2\text{ kHz}$$

Soundfield testing could be followed by delivery of stimuli through insert earphones where ear specific information will be of use (e.g. where the possibility of significant asymmetry is indicated by the history) or where results will be used to guide amplification. Likewise BC testing may be indicated, albeit with awareness of increased likelihood of vibrotactile responses at the lower frequencies compared to adults If ear-specific thresholds are desired and use of insert earphones is contra-indicated (e.g. due to wax) use of a hand held single TDH earphones could be considered.

The timescale for acquisition of MRLs should be considered carefully. On the basis that quality of results takes prominence over quantity (of MRLs) consideration should be given to arranging a sequence of appointments particularly where a large quantity of information is required and/or where the child is only just at sufficient developmental age or has relevant disabilities. A duration of 30 minutes would be typical for an assessment appointment that included soundfield VRA.

6. INTERPRETATION OF RESULTS

The process described above provides calibration to adult norms for a conventional audiometric technique. There are no specific international standards on the RETSPL values for stimuli used for VRA. Audiologists should be mindful of the influence of age of subject and the test method employed when interpreting and reporting results. Consideration should also be given to the use of MRL information, whether to inform others (e.g. ENT medical colleagues) of hearing status or for use by the Audiologist to guide effective amplification to a prescriptive target.

There are numerous factors contributing to the known difference between infant VRA MRLs and adult normative thresholds. These include sensory and non-sensory factors (including ear canal size) and other factors such as the effects of subject generated noise. The effect of these contributory elements is complex and not fully understood. However, the sum of these effects is that normally hearing infants performing VRA require a higher intensity stimulus to induce a response (e.g. a head turn) than that required for normally hearing adults performing pure tone audiometry. Although some studies have investigated and reported on the difference between MRLs obtained by VRA in infants and adult threshold normative data, the data set (relating to test frequency, age of subject and type of transducer) is far from complete. Further studies are required to confirm and build upon this knowledge base before we can endorse a series of specific correction factors for VRA (as is the case for Auditory Brainstem Response testing of newborn babies – see relevant NHSP guidelines). With due consideration of the above, the materials presented below (and in the references) represent current information on the scale of infant-adult correction factors based upon the mode of stimulus delivery, stimulus type and age. Consequently, the correction values indicated are provisional at this time.

Soundfield

Information available on the relationship between adult thresholds and MRLs for soundfield VRA test indicates that normally hearing infants (ages 7-12 months) present mean thresholds at approximately +10dB relative to the adult normative RETSPLs (from 0.5 kHz to 4 kHz). A child responding at say 45 dB HL might therefore be considered to have equivalent hearing to an adult responding at 35 dB HL. The BSA descriptors for results of pure tone audiometry define thresholds at ≤15 dB HL as being within normal limits (based upon the adult normative scale). **Therefore, it is provisionally suggested that when testing by VRA in the soundfield, hearing should be tested down to at least 25 dB HL (equivalent to adult 15dBHL) and that responses at this level are accepted as indicative of hearing within normal limits. Such guidance should not discourage testing down to lower levels subject to the ambient noise limitations of the test environment.** Those interpreting and reporting results should be mindful that sound field assessment only indicates the hearing status of the better hearing ear at each test frequency.

Insert Earphones

For insert earphones the frequency specific correction factors are equivalent to the MRLs measured in studies on normally-hearing children, examples of which are presented in Table 1. The Parry et al study employed a VRA protocol similar to that described here and was conducted on 8-12 month old infants.

Table 1. Comparison of infant MRLs in dB HL between insert earphone VRA studies.

Reported Studies	Infant MRLs dB HL (std.dev.)			
	500 Hz	1 kHz	2 kHz	4 kHz
Nozza (1995)		14.1		
Nozza & Henson (1999)	17.2		6.8	
Parry et al (2002)	16.4 (5.9)	13.3 (6.1)	7.1 (5.5)	6.4 (6.2)
RECOMMENDED PROVISIONAL VALUE	**15**	**15**	**5**	**5**

The normative values presented above may be used as correction factors to convert MRLs into values that are more comparable to an adult audiogram, say for interpretation by medical colleagues. Correction of raw MRLs achieved by insert earphone VRA may also be appropriate when estimating the audiometric profile, required when using prescription formulae to fit hearing aids.

Bone Conduction

No studies have been identified relating to bone conduction VRA MRLs.

7. REPORTING OF RESULTS

Reporting of results should be clearly accompanied by a description of the type of transducer and the reliability of assessment. Where recorded results represent the MRLs (dial settings) this should be indicated. Similarly, the nature of any MRL threshold corrections applied (to guide interpretation or to provide an estimated audiogram for the purpose of prescription for amplification) should be indicated. The Audiologist leading the VRA procedure should be responsible for ensuring that results are appropriately documented and reported upon.

Finally, guidance on the matter of MRL to adult threshold corrections may change with the outcome of further research. The use of this (standardised) VRA protocol in further research studies around VRA MRLs is encouraged in order to facilitate future transferability of findings.

8. STAFF TRAINING AND EXPERTISE

Staff engaged in performing VRA testing should have received specific training associated with documented assessment to demonstrate their competency to perform this test. The level of competency should be at least adequate for the role performed (whether supporting or leading the assessment). Those leading the assessment should be competent in briefing/debriefing carers, use of the equipment deployed, and the correct interpretation of results to ensure appropriate recording/reporting of results for use by oneself and others. To ensure correct reporting of results

for interpretation by others, it is particularly important that the difference between MRLs obtained by VRA and adult normative thresholds are recognised and understood.

GLOSSARY

Azimuth	Direction of a sound source measured in angular degrees in a horizontal plane in relationship to the listener; e.g. 0° azimuth is directly in front of the listener, 180° is directly behind.
MRL	Minimum Response Level – the lowest level to which a child will respond behaviourally to sound.
NHSP	Newborn Hearing Screening Programme (England)
RETSPL	Reference equivalent threshold sound pressure level

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Includes materials referred to in the text and others used to guide the content of the protocol.

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APPENDIX – VISUAL REINFORCEMENT AUDIOMETRY MINIMUM RESPONSE LEVEL RESULT FORM

Patient Details: Date…….

Testers…….

Audiometer (room).....

Condition (circle) unaided :- aided **Transducer** (circle): Sound Field : BC : Insert Earphone

Key: ✓ = response ✖ = no response **?** = uncertain

Circle or otherwise indicate final minimum response level (MRL) for each signal type

	Warble tones or Narrow Band Noise (or other as marked) RIGHT / CENTRE				Warble tones or Narrow Band Noise (or other as marked) LEFT / CENTRE			
Frequency (kHz)	0.5	1	2	4	0.5	1	2	4
Dial setting								
0								
5								
10								
15								
20								
25								
30								
35								
40								
45								
50								
55								
60								
65								
70								
75								
80								
85								
90								
95								
100								
105								
110								
115								
120								

Comments/Reliability: ……