Practice Guidance

Assessment Guidelines for the Distraction Test of Hearing

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General foreword

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Introduction

The Distraction test (DT) is based on principles first outlined by Ewing and Ewing (1944) and later developed by McCormick (1993). It has been widely used both in audiology clinics and as the basis for a screening test of hearing - known as the Health Visitor Distraction Test (HVDT).

Since the introduction of the Newborn Hearing Screening Programme (NHSP) and the recommended use of Visual Reinforcement Audiometry (VRA) in audiology clinics, it is not recommended to use the DT routinely. It is more often used as part of an assessment of hearing sensitivity in infants who are unable to perform behavioural testing reliably using VRA.

The basic principal of the DT involves presenting a frequency specific stimulus in the soundfield, then observing and rewarding a response to the sound. The response for example may be a head turn towards the side of the sound signal.

Scope

The distraction test measures hearing sensitivity rather than absolute threshold of hearing. It must be accepted that there are many pitfalls in the distraction method (McCormick, 2004) and therefore the DT is not recommended for routine clinical use or used solely for testing. When DT is used it should be within a battery of various testing methods to aid diagnosis. DT should not be used as a tool on which to discharge paediatric patients.

Age range

The test is suitable for infants who are able to sit unsupported or with minimal support and have good head control - i.e. infants with a developmental age of 6-7 months and above. The test is based on the fact that for an infant of this age, the normal response to a quiet sound is a head turn to locate the sound source provided the infant is suitably free from other distractions. The upper age limit is variable but as infants become more mature and concepts like object permanence become established it becomes more difficult to implement the test successfully and the infant will habituate quickly. Historically the distraction test was used for infants up to the age of 36 months, but this is no longer recommended (Wood et al, 2003).

Although there is no strict upper age range, it becomes more difficult to apply in a typically developing infant beyond the 1st year of life. This is because by then the infant is socially attuned to the surrounds and is much more likely to be aware of the presence of tester 1.

The infant must have matured to the stage of being able to sit erect on their own and be able to perform stable head turn responses.

Test environment

The test should be carried out in a sound treated room or audiometric booth which is large enough to accommodate parent/carer(s), infant and two testers comfortably.

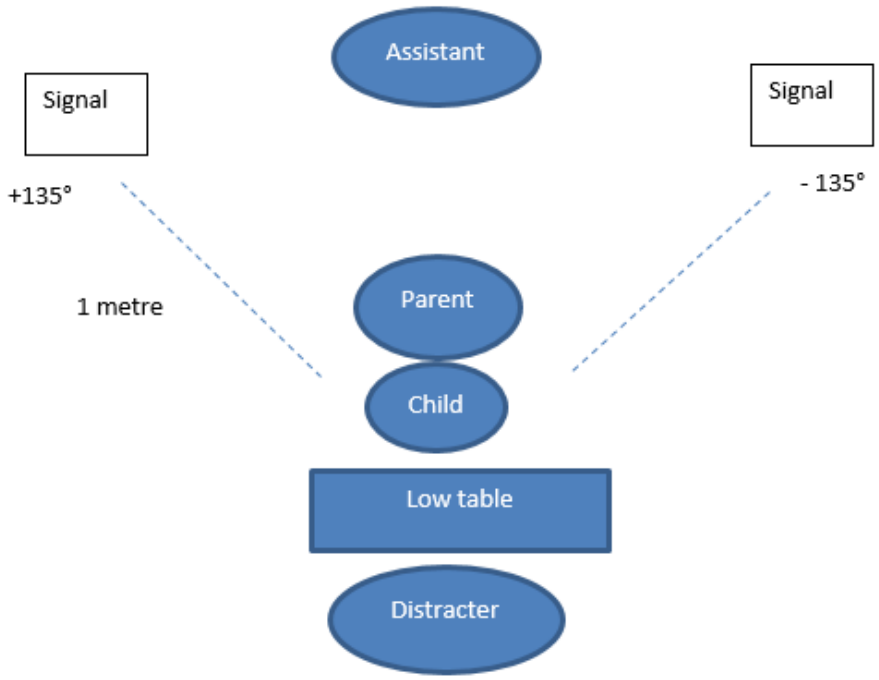
The room should be suitably furnished and free from unnecessary visual distractions. See Fig.1

The background noise in the test room should ideally meet the requirements of ISO 8253 - 2:2009

Test equipment and set up

A suitable test set up is shown below Fig. 1.

Figure 1: Diagram of distraction set up



The procedure requires two testers. Tester 1 presents the sound and tester 2 attempts to maintain the infants attention. Both testers should be fully trained and conversant with both roles.

The infant is seated on the parent/carer lap, supported at the waist and facing forward. Alternatively the infant can be seated on a low infant's chair with a harness for safety reasons. A low table is placed in front of the infant to provide a surface for the distraction activity. Tester 2 is either seated on a low chair or kneels in front of the table facing the infant and has a concealed supply of suitable toys close at hand-held.

Tester 1 stands behind the infant and is responsible for presentation of stimuli at the appropriate position behind the infant and on a horizontal level with the infant's ear. The stimuli is generated by tester 1's voice, the high frequency rattle (HFF) or by suitable hand-held held electronic sound generators. The intensities of the voice and the HFR intensities should be verified using a sound level meter. The hand-held held sound generator should be calibrated to dB(HL). If this is not possible then possible intensities must be verified using a sound level meter (SLM) in dB(A).

Preliminaries

Parent/carer(s) and infant are brought into the room, seated and introductions made. Case history taking provides an opportunity for the infant to settle in an unfamiliar environment and for the audiologist to make some preliminary observations about the infant. When taking a history information should be obtained about the infant's developmental and visual status before starting the test. If there is any doubt about the infant's ability to respond in the desired manner (i.e. with a head turn), this can be discussed with the parent/carer(s). Head control and ability to turn can be checked by having the infant visually track an object through an arc of 180°. If the infant becomes restless it may be appropriate to postpone the history and begin testing.

The test procedure is explained to the parent/carer(s) and if the infant is sitting with the parent/carer(s), explain suitable cautions about cueing the infant to the presence of an auditory stimulus. For infants with visual problems it may be necessary to modify the distracting activity or to use tactile distraction – (e.g. holding/stroking the infant's hand). Alternatively, the room lights may be dimmed and a light source used to distract the infant.

Test procedure

Tester 2 works in front of the infant and uses quiet, simple play activity (e.g. spinning a toy), on the table to capture and control the infant's attention to just the right degree in preparation for the presentation of the sound stimulus. At the same time tester 1 moves

into the correct position for stimulus presentation. When the infant is suitably attentive tester 2 phases out the play activity (e.g. by covering the toy). This is the cue for tester 1 to present the auditory stimulus for duration of up to 10 seconds or until the infant turns to locate the sound. The sound should be presented in the horizontal plane of the infant's ear at an angle set back between 30^{o} and 45^{o}. Tester 1 needs to be aware, to keep anything outside of the infant's peripheral vision. Tester 2 continues to observe the infant and judges the validity of any response. If the infant responds and this is judged to be valid by tester 2, tester 1 should reward the infant (smile, tickle on the arm, verbally) and then lead the infant's attention back to the front - where it is again taken by tester 2. Tester 1 waits until tester 2 has regained the infant's attention - before moving around behind the infant. This helps to avoid the infant becoming too interested in the existence and movement of tester 1. When the infant is again facing forward, tester 1 measures and records the previous response and prepares to present another stimulus. During this time tester 2 maintains the infant's attention in the forward direction.

The role of tester 1

• Tester 1 presents the stimulus at the correct time which is the point at which tester 2 phases out the play activity. The timing of the test is controlled by tester 2 but tester 1's role in responding to these timing cues is crucial to the success of the test.

• Tester 1 stands behind the infant, out of infant's peripheral vision and presents the stimuli on a horizontal level with the infant's ear back between 30^{o} and 45^{o}, ensuring that there are no visual cues.

• Tester 1 generally decides which stimuli to use, what presentation level and which side of presentation. Sometimes it may be more appropriate for tester 2 to make these decisions particularly if the infant is showing problems in localisation.

• Tester 1 is also well placed to observe any intentional or unintentional cueing behaviour from the parent/carer.

The role of tester 2

• Tester 2 captures and controls the infant's attention by the use of a simple play activity e.g. spinning a brightly coloured object on the table. The activity level should be the minimum level consistent with holding the infant's attention. Once the infant's attention is

under control tester 2 phases out the activity by, for example, covering the toy object with the hand-held. This acts as the cue for the presentation of the auditory stimulus. Thus, it can be seen that the timing of the test is controlled by tester 2. Tester 2 continues to observe the infant at all times but avoids eye contact with the infant by keeping the infant's gaze focussed on the table. If the infant's attention starts to drift it can be re-focused on the table by briefly uncovering the toy, tapping on the table etc. When tester 2 is re-focusing the infant's attention in this manner tester 1 should stop the auditory stimulus and restart it when the attention is again in a suitable state.

• Tester 2 judges whether any responses are valid. The testers work as a team and need to develop a mechanism whereby tester 1 knows when to reward a response.

• Tester 2 should also observe the parent/carer(s) for signals which might cue the infant e.g. movement, pressure. Tester 2 should also be alert to any signs of distress or anxiety in either parent/carer(s) or infant.

Communication between testers

It is very important that both testers understand their own and each other's role. There need be very little verbal communication between testers during the test. Tester 2 may speak to tester 1 taking care not to look directly at tester 1 whilst doing so. Tester 1 should speak as little as possible to avoid reminding the infant of their presence.

Use of control trials

In most threshold measurement procedures (PTA, VRA) the inter-stimulus interval is deliberately varied in order to reduce the likelihood of the patient developing a rhythmic pattern of response and anticipating the signal. With these procedures there is no other change linked to stimulus presentation which might serve as a cue for signal presentation.

In distraction testing the situation is different. Phasing out the visual distraction activity may serve as a cue to the presentation of the auditory stimulus and an alert infant may learn to use this cue and respond in anticipation. This is assessed by the use of control trials or no sound trials during testing.

When assessing if a response is valid the attention is captured and controlled, and the distraction activity phased out. Tester 1 holds the stimulus generator in the test position but without presenting any auditory signal.
Control trials should be used at suitable intervals throughout the test procedure. If the infant fails to respond in these control trials, then all is well, and the test can proceed. If the infant does respond or check, the no sound trial is repeated without any reward, until the

response is extinguished. Testing can then resume but with very frequent control trials. In some cases, it is necessary to modify the distraction activity by continuing it while the stimulus is presented or by allowing the infant to hold the toy object in order to prevent this checking response by the infant.

Criterion for positive response
Ideally, this should be a clear head-turn to locate the stimulus source. If an alternative response e.g. partial turn, eye movement, is accepted this should be checked rigorously with appropriate control trials and noted on the results sheet. Any difficulties with localisation or incorrect localisation should be noted.

Infants with asymmetric hearing loss may locate to the better ear; infants with severe hearing loss may show a generalised difficulty with localisation. However, DT is not a test of localisation.

Note: there may be a reason, not relating to hearing, which prevents the infant from responding with a full head turn. For example, the infant may not be developmentally ready for the test or might not be in an appropriate attention state. A quick check of the infant's physical maturation and readiness for the test can be made by bringing a bright object into the infant's central vision and them moving it smoothly through a 90^{o} arc on each side to see if the infant can track it visually and can perform a head turn response.

Pitfalls
• Visual cues may arise from mirrors, shadows on the floor or walls or other reflective surfaces e.g. observation windows, metal equipment, computer screens. Visual cues may also arise during the test from the positioning of the signal generator or from any part of tester 1 (clothes, hair, and shoe). Both testers should check for this during the test. To check for visual cues the test room can be set up exactly as normal i.e. with the same arrangement of lighting, curtains and blinds (open or closed) and positioning of furniture and other equipment. One tester sits in the tester 2 position and checks for visual cues whilst the other tester moves around in the tester 1 position.

• Tactile cues such as vibration, air currents, may arise from transducers operating at high intensity levels, physical pressure by parent/carer(s) to turn the infant in the appropriate direction, assistant leaning on the parent/carer(s) chair etc.

• Auditory cues such as footsteps, squeaking shoes, clothes rustle, signal generator switches and extraneous noises

• Olfactory cues such as perfume, aftershave

Assessment of responsiveness
If the infant is not responding to auditory stimuli their response to visual and tactile stimuli should be assessed.

Response to visual stimulation can be checked by deliberately bringing the stimulus generator into the infant's peripheral visual field and/or demonstrating the flashing lights (if any) on the sound generator. Response to tactile stimulation can be checked by touching the infant on the ear or cheek.

A brisk response to both of these usually indicates that the infant is in a responsive state and suggests that the failure to respond to the auditory stimulus is because of inaudibility. On the other hand-held if the infant fails to respond to these other modes of stimulation their response state is probably not optimal and it is worth using alternative methods to arouse their interest e.g. more extravagant reward, use of novel or broad-band auditory stimuli, demonstrating and playing with the auditory stimulus with the infant.

Test signals
In its traditional use as a screening test the following stimuli have been found to provide reasonably consistent spectrally-restricted energy, while being sufficiently interesting to infants to elicit responses reliably.

- High-frequency rattle 6-8 kHz
- Repeated, unforced production of unvoiced phoneme 's' ~ 4kHz
- Minimal voice (i.e. voicing with intonation and rhythm but no articulation), humming ~500Hz

Intensity level of the HFR and voice stimuli must be measured with a sound level meter for accuracy. These stimuli tend to lose their frequency specificity once the level is raised significantly above the traditional screening level of 30-35 dB(A)

For responses that are measured at raised levels, it is preferable to use frequency-modulated (warble) tones or narrow-band noise using a hand-held held sound generator. There are a number of commercially available hand-held held sound generators which are suitable for use in the distraction test. There are no standards specifying the performance of these units and therefore a somewhat pragmatic approach to calibration needs to be adopted. Clinics need to be satisfied that the test signals provided are suitable in terms of frequency specificity and should undertake some regular checks of the equipment's

performance. Details are outside the scope of this document. Noisemakers for diagnostic clinical application can also be used and it is suggested that they are calibrated to dB(HL) at a certain distance if possible (BSA 2018 – Guidelines on the Acoustics of Soundfield Audiometry in Clinical Audiological Applications).

Measurement of the intensity

The stimuli, such as a warble tone, a narrow-band noise can be pre-calibrated for a given dial setting and distance from the test point; alternatively, the dial setting and distance at which a response occurs is reproduced and measured at the sound level meter on each occasion in dB(A). A sample results sheet is shown in Appendix 1.

Response measurement procedure

The response measurement typically starts with a mid or high frequency stimulus presented at the minimum test level (typically 30 dB(A) or 30 dB(HL)). Failure to respond is followed by stimulus presentations at successively higher levels until a reliable response is obtained. This is then repeated for the same stimulus with a criteria of 2 positive responses out of 3 at a given level to define threshold. It is not appropriate to define a precise step size and tracking procedure – clinical judgement must be used. For example, it is often appropriate to vary the stimulus frequency and side of presentation rather than tracing threshold for a given frequency and side of presentation.

If a hearing loss is suspected it is usually advisable to use fairly high presentation levels, such as levels of > 70 dBHL early on in the test.

Alternatively, responses can be observed at supra-threshold levels initially and then the levels can be reduced and raised from quiet until the lowest levels at which the infant's response is recorded for each frequency.

For both procedures a response on 2 out of 3 presentations is needed to accept the level as the minimal response level.

Conventionally it has been accepted practice to test down to a level of 30 dB (A) and to accept responses at this level as indicative of normal hearing (or at least the absence of any significant degree of hearing loss). This is probably because of the availability of relatively cheap sound level meters with the 'A' weighting network and the problems of background noise. If testing with a noise maker that is calibrated to dB(HL), it is acceptable to accept 30 dB(HL) for a minimal test level to rule out a significant hearing loss.

Table 1 shows conversion factors for conversion of dB(A) measurements to dB(HL) using data from ISO 389-7: 2005.

It is suggested that levels shown on hand-held held warblers be converted and the stimulus levels measured on the SLM in dB(A) and converted to dB(HL) using these correction factors. Thus, the only correction required (to the nearest 5 dB) is +5 at 4 kHz.

250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
-2.4	-0.3	-0.5	+0.3	+4

Table 1: Conversion factors to be added to dB(A) value to estimate dB(HL)

There is little data available from which to estimate the relationship between threshold and minimum response level for the distraction test. When using VRA it is very often possible to obtain responses at 20 dB(HL) but this may not be the case with the slightly different reward conditions in the distraction test. Testers will need to use clinical judgement in deciding upon and interpreting minimal response levels. There is some evidence to suggest that minimum response levels obtained with the distraction test may be worse (i.e. higher) than would be obtained with sound field VRA (Gliddon et al, 1999).

Hearing protection

The 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 140 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.

Given the maximum output levels of typical hand-held-held sound generators used in distraction testing (105 dB(A)) and assuming that these levels are used in testing an infant with a severe/profound loss in both the unaided and aided condition, it is unlikely that testing one infant would result in a daily personal noise exposure beyond the first action level for any individual (tester, parent/carer(s), observer) in the test room. However, it is possible that testing 4 such infants in one day could result in a daily personal noise exposure beyond the first action level but below the second level. However, some of the sound levels used may be uncomfortable and for this reason also hearing protection (muffs and/or plugs) should be available for parent/carer(s) and observers as well as testers.

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Appendix 1: Sample results form for use with the distraction test

Distraction Test Results

Name

NHS Number

Date

Testers

Stimulus	Right side	Left side	No sound trial
Low frequency			
250 Hz warble tone			
500 Hz warble tone			
Voice (~500 Hz)			
Mid frequency			
1 kHz warble tone			
2 kHz warble tone			
3 kHz warble tone			
High Frequency			
4 kHz warble tone			
“s” (~ 4 kHz)			
HFR (6-8 kHz)			
Other			
Non auditory			
Tactile			
Visual			

Response head turn/ other ……..

Localisation

Comments