NEONATAL HEARING SCREENING AND ASSESSMENT

PROTOCOL FOR THE DISTRACTION TEST OF HEARING

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Introduction

The Distraction test 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). This screening test is carried out on 7-9 month old infants by health visitors in the community. The procedure described below applies to the use of the distraction test in audiology clinics where the aim is to assess hearing sensitivity rather than to screen for hearing loss.

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 a child of this age, the normal response to a quiet sound - made out of vision - is a head turn to locate the sound source *provided the child is suitably free from other distractions*. The upper age limit is variable but as children become more mature and concepts like object permanence become established it becomes more difficult to implement the test successfully and the child will habituate quickly. Historically the distraction test was used for children up to the age of 36 months, but this is no longer recommended: an upper limit of 15-18 months is more appropriate.

Test environment

The test should be carried out in a sound treated room or audiometric booth which is large enough to accommodate parent(s), child and 2 testers comfortably.

The room should be suitably furnished and free from unnecessary visual distractions.
The background noise in the test room should ideally meet the requirements of ISO 8253 -2 (1992).

Test equipment and set up
A suitable test set up is shown in Appendix 1.

The procedure requires two testers - one acts as the distractor and one as the assistant. Both testers should be fully trained and conversant with both roles.

The child is seated on the parent's lap, supported at the waist and facing forward. A low table is placed in front of the child to provide a surface for the distraction activity. The distractor 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.

The assistant stands behind the child and is responsible for presentation of stimuli at the appropriate position behind the child and on a horizontal level with the child's ear. The stimuli are generated by the assistant's voice, the high frequency rattle or by suitable hand held electronic sound generators. These should be stored behind the child along with the sound level meter (mounted on a tripod) and results sheet.

Preliminaries
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 becomes restless it may be appropriate to postpone the history 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. 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. Head control and ability to turn can be checked by having the child visually track an object through an arc of 180°. For children with visual problems it may be necessary to modify the distracting activity or to use tactile distraction - e.g. holding/stroking the child's hand. Alternatively the room lights may be dimmed and a light source used to distract the child.

Test procedure

The distractor works in front of the child and uses simple play activity (e.g. spinning a toy) on the table to capture and control the child's attention. At the same time the assistant moves into the correct position for stimulus presentation. When the child is suitably attentive the distractor phases out the play activity (e.g. by covering the toy). This is the cue for the assistant to present the auditory stimulus for a duration of around 5 s. The distractor continues to observe the child and judges the validity of any response. If the child responds and this is judged to be valid by the distractor, the assistant should reward the child (smile, tickle on the arm, verbally) and then lead the child's attention back to the front - where it is again taken by the distractor. The assistant waits until the distractor has regained the child's attention - before moving around behind the child. This helps to avoid the child becoming too interested in the existence and movement of the assistant. When the child is again facing forward, the assistant measures and records the previous response and prepares to present another stimulus. During this time the distractor maintains the child's attention in the forward direction.

The role of the distractor

- The distractor captures and controls the child'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 child's attention. Once the child's attention is under control the distractor phases out the activity by, for example, covering the toy object with the hand. 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 the distractor. The distractor continues to observe the child at all times but avoids eye contact with the child by keeping the child's gaze focussed on the table. If the child's attention starts to drift it can be re-focused on the table by briefly uncovering the toy, tapping on the table etc. When the distractor is re-focusing the child's attention in this manner the assistant should stop the auditory stimulus and restart it when the attention is again in a suitable state.
- The distractor judges whether any responses are valid. The testers work as a team and need to develop a mechanism whereby the assistant knows when to reward a response.
- The distractor should also observe the parent for signals which might cue the infant e.g. movement, pressure. The distractor should also be alert to any signs of distress or anxiety in either parent or child.

The role of the assistant

- The assistant presents the stimulus at the correct time which is the point at which the distractor phases out the play activity. The timing of the test is controlled by the distractor but the assistant's role in responding to these timing cues is crucial to the success of the test.
- The assistant stands behind the child and presents the stimuli at an azimuth of 135° and on a horizontal level with the child's ear ensuring that there are no visual cues.
- The assistant generally decides which stimuli to use, what presentation level and which side of presentation. Sometimes it may be more appropriate for the distractor to make these decisions particularly if the child is showing problems in localisation.
- The assistant is also well placed to observe any intentional or unintentional cueing behaviour from the parent.

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. The distractor may speak to the assistant taking care not to look directly at the assistant whilst doing so. The assistant should speak as little as possible to avoid reminding the child 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 child may learn to use this cue and respond in anticipation. This is assessed by the use of control trials.

The situation is set up as for a sound trial (i.e. the attention is captured and controlled, the distraction activity phased out, and the assistant 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 child fails to respond in these control trials then all is well and the test can proceed. If the child 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 child to hold the toy object in order to prevent this checking response by the child.

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, stilling) 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.

Pitfalls

- Visual cues- these may arise from mirrors, shadows on the floor or walls or other reflective surfaces e.g. observation windows, metal equipment, computer screens. [1]Visual cues may also arise during the test from the positioning of the signal generator or from any part of the assistant (clothes, hair, shoe). Both testers should check for this during the test.

- Tactile cues- vibration, air currents (e.g. from transducers operating at high intensity levels, physical pressure by parents to turn the child in the appropriate direction, assistant leaning on the parent's chair)

- Auditory cues- footsteps, squeaking shoes, clothes rustle, signal generator switches and extraneous noises

[1] To check for these visual cues the test room is 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 test position and checks for visual cues whilst the other moves around in the assistant's position.

- Olfactory cues- perfume, aftershave

Assessment of responsiveness
If the child 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 child'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 child on the ear or cheek.

A brisk response to both of these usually indicates that the child is in a responsive state and suggests that the failure to respond to the auditory stimulus is because of inaudibility. On the other hand if the child 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 child.

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 children to elicit responses reliably.

- High-frequency rattle (supplied by the Ewing Foundation c/o Centre for Audiology, Education of the Deaf and Speech Pathology, Manchester University).6-8 kHz
- Repeated, unforced 's' ~ 4kHz
- Minimal voice (i.e. voicing with intonation and rhythm but no articulation), humming ~500 Hz

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 threshold measurement at raised levels, it is preferable to use FM (warble) tones or narrow band noise. There are a number of commercially available hand 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.

Measurement of the intensity
The stimuli 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. A sample results sheet is shown in Appendix 2.

Threshold measurement procedure
Threshold measurement typically starts with a mid or high frequency stimulus presented at the minimum test level (typically 30 dB(A)). 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 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 early on in the test.

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. Table 1 shows conversion factors for conversion of dB(A) measurements to dB HL using data from ISO 389-7. It is suggested that levels shown on hand held warblers be disregarded 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 (1989) stipulate daily personal noise exposure levels beyond which hearing protection should be used. If daily noise exposure is above the first action level of 85 dB(A) but below the second action level of 90 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 dBSPL 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 sound generators used in distraction testing (105 dB(A)) and assuming that these levels are used in testing a child with a severe/profound loss in both the unaided and aided condition, it is unlikely that testing one child would result in a daily personal noise exposure beyond the first action level for any individual (tester, parent, observer) in the test room. However, it is possible that testing 4 such children in one day could result in a daily personal noise exposure beyond the first action level but below the second level.

(Similar calculations for a VRA system with a maximum output of 115 dB(A) indicate that the first action level could be exceeded when testing one child and the second action level when testing 4 children). 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 parents and observers as well as testers.

References

ISO 8253-2:1992 Acoustics - Audiometric test methods - Part 2:Sound field audiometry with pure tone and narrow-band test signals. Geneva: International Organisation for Standardisation.

ISO 389-7:1998 Acoustics - Reference zero for the calibration of audiometric equipment - Part 7:Reference threshold of hearing under free-field and diffuse-field listening conditions. Geneva: International Organisation for Standardisation.

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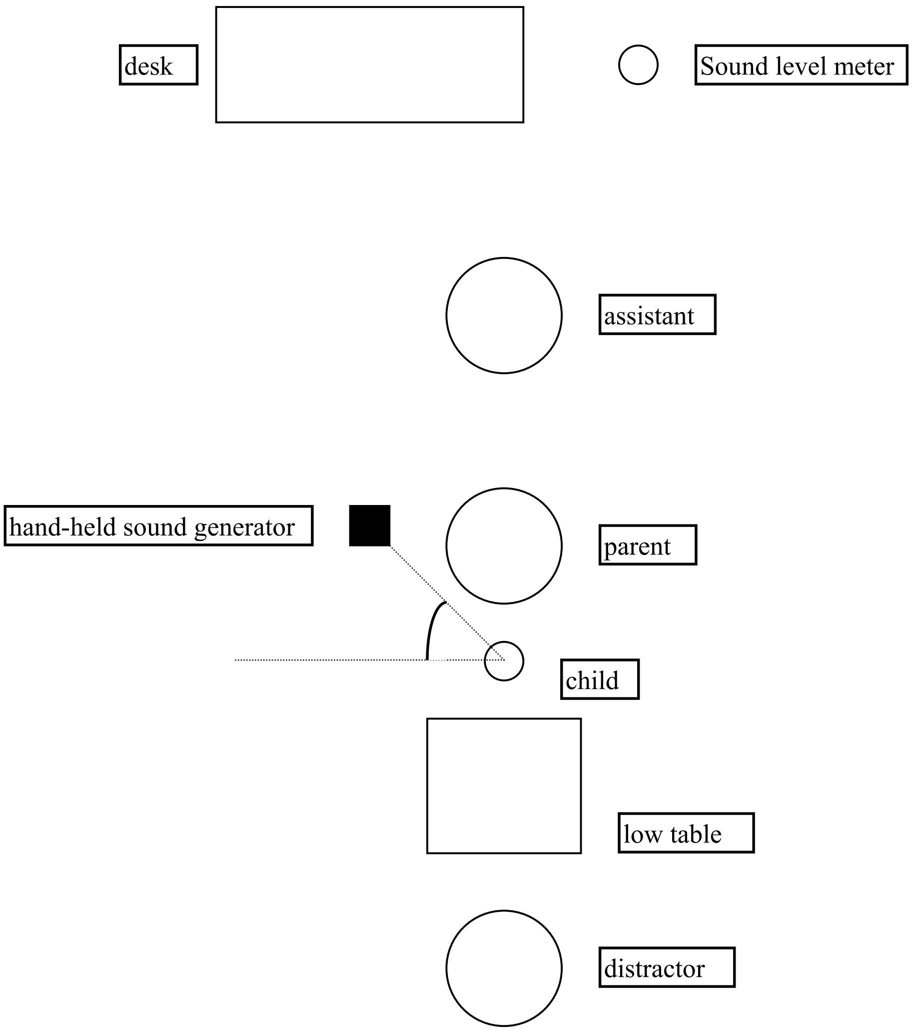
Appendix 1: Diagram of distraction test set up



Appendix 2: Sample results form for use with the distraction test

Distraction Test Results

Name

I.D. Number
Date
Testers

Stimulus	Right side	Left side
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)		
high frequency rattle (6-8 kHz)		
Other (broad band)		
wide band noise		
Non-auditory		
tactile		
visual		

Response head turn/other -specify

Localisation

Comments