



Behavioural hearing assessment of children - theory

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Aims

- Which tests to consider – main focus on VRA
- Basis of testing
- Who to test
- Room set-up
- Roles of testers and procedures
- Interpretation of results

VRA

VISUAL REINFORCEMENT AUDIOMETRY

National guidelines

- BSA Recommended Procedure - Visual Reinforcement Audiometry June 2014, updated version will be released later in 2022
- Available at <https://www.thebsa.org.uk/resources/>

VRA -Who to test

- From 6 - 7 months **developmentally**
- Children with developmental delay may not be ready for test until older
- Until child is able to do a performance test (e.g. reached stage when they can 'wait') – around 24-30 months developmentally

Basis of test

- Babies start to localise new and interesting sounds between the ages of 4 - 6 months (orientation reflex)
- Babies tend to be able to sit upright and have good head control by 6 months
- Visual reward used to maintain interest so comprehensive testing can take place
- Conditioned response – classical conditioning to elicit response

Video Clip

[VRA training - MedOne, Thieme](#)

First 2.20 of video

and 19.27-20.25

Is the test suitable?

- Does the baby have good head control?
- Can the baby sit up by themselves?
- Is the baby able to turn his / her head freely?
- Do they have good vision?

If unsure, check

- get the baby to track a toy
- ask the parent to set them on their lap and observe posture
- remove any obstructions (e.g. hats)

Test set-up – the room

Need to consider

- Background noise levels
- Room acoustics
- Furniture
- Size – minimum recommended 6m x 4m
- 2 way communication system (if separate observation room)
- Provision for lighting dimmer
- Ventilation

Test set-up - furniture

Minimal furniture will give

- More uniform soundfield (less reflections)
- Less distractions

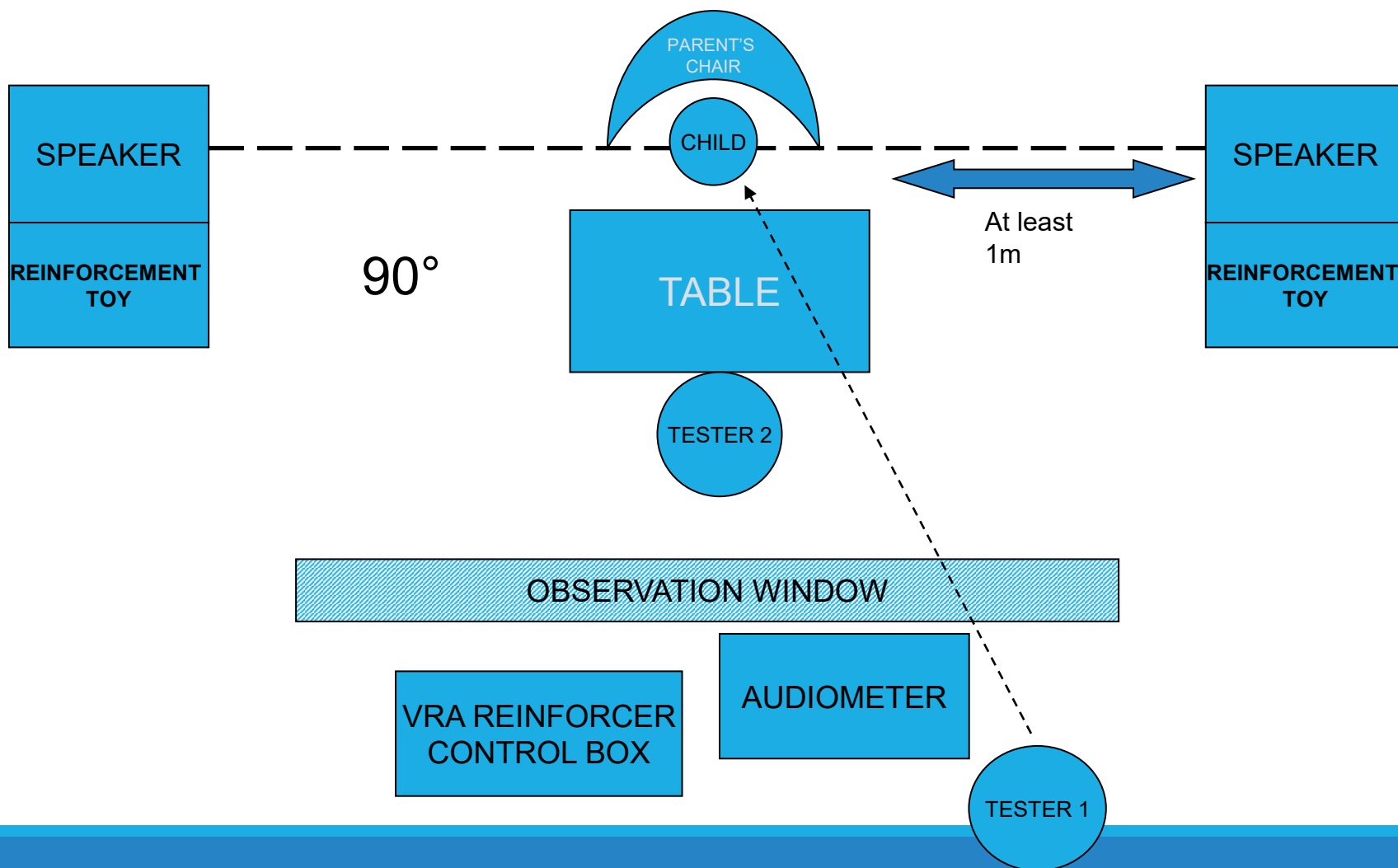
Table at a suitable height

Ensure rewards at 90 degrees to elicit clear head turn

Variety of suitable toys for Tester 2

- Out of sight
- Out of reach

Test set up – room set up



Test set up – parents/baby

- Younger children seated on parents/carers knee with support round the trunk
- Could be seated in secure high chair
- Older children can sit on a small chair independently from parents



Reward toys

Conventional vs. video – mixed evidence

- Lowery (2009) showed no significant difference in 2 groups tested using both methods
- Schmida (2003) showed more head turns with DVD reinforcer in 2 year olds
- Karzon (2010) showed more responses using animated VRA with no significant differences in age
- Ideally have access to both in clinic



Procedure - roles of testers

Testers should have specific training and have been assessed as competent in their role

Tester 1

- Operates audiometer and reinforcement toys
- Judges if responses are valid – must be a clear head turn not eye blink or unclear response
- Overall responsibility for test

Tester 2

- 'Entertains' child, adjusting level of activity as necessary
- Not changing activity when sound presented
- Responsible for positioning of child
- Observe parent for any cues
- Advise lead of any noises which would make presentations invalid

Procedure – testers

Tester 2

- Ideally don't give a toy to the child – SEE GUIDELINE
- Not too interesting
- As long as conditioned well, should still turn

Procedure – Instructions to Parents / Carers

Important points in instructions:

- Explain test principle and gain consent
- Instruct to sit in test position on calibration spot and support child round trunk if needed
- Instruct not to react to the sounds themselves or give any clues (can use ear defenders for both loud sounds and if they find this difficult)

Procedure – conditioning

1. Start with stimulus level of 65 dBHL (or suprathreshold) at 1 or 2kHz warble tones
2. Stimulus and VRA reward presented simultaneously
3. Tester 2 points out the VRA reward if child doesn't turn by themselves (only in the conditioning phase)
4. Then just present stimuli and see if child turns, reward after turn
5. May need to repeat steps 1-3 3 or 4 times to establish conditioning. If however still not conditioning consider if signal audible or need to change conditioning stimulus

Procedure – testing phase

1. Only once conditioning established move onto the test phase
2. At least 2 consecutive clear responses during conditioning can then move to testing phase
3. In testing phase sound presented first and child only rewarded with correct head turn
4. Sound presented for 2-3 seconds, reward for 2 seconds, with overlap
5. Drop stimulus in 20dB steps as long as still responding clearly
6. Around minimal response level, 10 down 5 up should be used
7. Minimal response level where 2/3 head turns to that level
8. Gold standard to take ascending responses only, larger steps and ascending / descending responses not gold standard and should be recorded on results sheet

Procedure – stimulus selection

2 or 1kHz → 4kHz → 500Hz → 1 or 2kHz

- Exact test order will depend on the patient and clinical question
- May also go onto other frequencies as appropriate
- Frequency modulated warbles initially
- Only if child non-responsive use FRESH noise or narrowband noise as less frequency specific
- Can't use pure tones in soundfield due to standing waves
- Can use pure tones with BC & inserts but may be better to stick with warbles if the child is used to this

Procedure – transducer selection

- Often start with soundfield
 - Do not need to get close to child
 - Assesses overall hearing
- Proceed to bone conduction if thresholds are raised
- Proceed to inserts if ear specific information required, based on history

Procedure – minimal levels

- May be dependent on room and how good sound proofing is
- Typically
 - Soundfield 25 dBHL
 - BC – limited research in this area
 - Inserts 10 – 30 dBHL dependent on age and frequency
- Be aware many factors influence MRLs and understand this when you are interpreting results

Procedure – acceptable responses

- Clear head turn towards speaker
- Gaze only towards speaker treated with extreme caution
- Eye glances / flicks, small movements or stalling should not be considered a response – further conditioning to encourage the child to make a clear head turn should be used. If not possible other tests should be considered

Procedure –

When NOT to present the stimulus

- When the child or parent is talking
- When the child is reaching for a toy
- When the child is leaning back on their parent
- When they have lost interest in the toy in front
- When they are checking to see if the reinforcement toy is there

Procedure – when NOT to present the VRA reward

- If there is not a clear head turn to the VRA reward, do not present the reward
- Do not present the VRA reward if there is a subtle response only or if tester 2 tells you they think the child heard the sound, only present the reward to a clear head turn
- Do not present the VRA reward if the child has just checked

Procedure – results recording

- Mark each presentation (excluding conditioning) as a positive (✓) or negative (x) response
- If unsure, mark as negative
- Avoid marking unsure responses wherever possible
- Use and record formal “no sound trials” to check validity of test
- Mark concluded threshold / minimal response level at the bottom of the work sheet
- Must have two clear positive responses - if there was no level at which 2 clear responses were seen, no threshold can be concluded

Interpretation of results

- Same principles as for PTA
 - Minimal levels reached = satisfactory hearing
 - If air bone gap = conductive loss
 - If no air bone gap = sensorineural
- If done in soundfield or non-masked BC results for better ear only
- If child could not be conditioned or not developmentally ready, no conclusions can be drawn

Pitfalls of VRA

- 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 provides too little or too much engagement for the child and therefore inhibit responses
- Obtaining MRLs with speakers on right and left and interpreting these as providing ear-specific information (which they do not)
- Cues from parents (e.g. parents moving when sound is presented)
- Tester response bias (e.g. tester believing or wishing that child's hearing is normal) leading to lack of objective interpretation of turns vs. checks

PERFORMANCE
TESTING / PLAY
AUDIOMETRY

Guidance

- Currently no national guidance specifically on performance testing / play audiometry
- Should follow principles of PTA but with use of a play signal as a response
- Conditioning needs to be secure and certain before proceeding to quieter levels, just like with VRA
- Need to be certain child is waiting for a sound before performing the play task to ensure valid responses

Behavioural testing in general

- Always use the “Cross Check Principle” where tests from other tests may be used to back up results, if there is any doubt as to the validity of a test
- For example, use of results of speech discrimination testing to back up results of performance testing, use of objective tests such as OAE’s and ABR to back up results of behavioural testing
- Not relying solely on parental report of lack of hearing concerns
- Do not be tempted to try and “prove” normal hearing – a lot of children who attend clinic will have a hearing loss, even if temporary