Behavioural Audiometry for Infants and Young Children
Whose hearing loss has been detected in infancy

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Diagnosis and Management of Hearing Loss in Children

- Quantify the type, degree and configuration of hearing loss as accurately as possible
  - Understand the likely impact of hearing loss
  - Identify range of intervention options
    - Benefits and limitations
    - Behavioural thresholds are the gold standard for defining hearing when the child can be conditioned to respond reliably to sound
- Explain the results and options to parents/carers
- Parents and clinician agree on the management plan
Behavioural Assessment

Birth → 7 mth → 2.5 yrs

Behavioural Observation

Visual Reinforcement / Conditioned Orientation Response

Play Audiometry

Best correlation with threshold
Behavioural Observation

• Observe subtle *unconditioned* changes in behaviour in response to sound
  • Eye turn, eye widen, sucking, alerting, stilling

• **Minimum Response Level (MRL) is not a threshold**
  • Dependent upon infant’s age and state during testing
  • Responses likely to be suprathreshold
  • Correlation with Pure Tone Thresholds is variable
Unconditioned responses vary with age

<table>
<thead>
<tr>
<th>Age</th>
<th>MRL (noisemakers)</th>
<th>MRL Warble tones</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 weeks</td>
<td>50-70 dB SPL</td>
<td>75 dB HL</td>
</tr>
<tr>
<td>6 weeks – 4 mths</td>
<td>50-60 dB SPL</td>
<td>70 dB HL</td>
</tr>
<tr>
<td>4-7 mths</td>
<td>40-50 dB SPL</td>
<td>50 dB HL</td>
</tr>
<tr>
<td>7-9 mths</td>
<td>30-40 dB SPL</td>
<td>45 dB HL</td>
</tr>
</tbody>
</table>

Reference: Northern and Downs 2002
Unconditioned responses

- Thompson & Bruce, 1974: 190 Normally hearing infants age 3-59 mths
  - 10% responded ≤20dBSPL
  - 50% responded ≤50dBSPL
  - 90% responded ≤88dBSPL
  - Children who could be reliably tested with both BOA & play audiometry responded to softer sounds using play audiometry
Is BOA still relevant in 2014?

For children who have a cochlear hearing loss

- Evoked Potentials provide the most accurate threshold estimation
- BOA may be useful for parent education
  - Demonstrate subtlety of infant hearing responses
  - Demonstrate change in response levels when comparing aided & unaided conditions
- Lack of exposure to sound can impact upon unconditioned responses
  - May not be a useful demonstration at first fitting appointment
Is BOA still relevant in 2014?

For children who have Auditory Neuropathy Spectrum Disorder

- Evoked Potentials do not correlate with behavioural thresholds
- BOA forms part of the test battery
  - Combine with Cortical Auditory Evoked Potentials and functional hearing assessment (eg PEACH, Ching et al, 2007)
- Consider amplification if responses consistently poorer than age-appropriate responses
Case Study – child M
*born 29 weeks gestation, surviving twin*

<table>
<thead>
<tr>
<th>Corrected Age (weeks)</th>
<th>Best Minimum Response Level dB(A)</th>
<th>Age Ave. MRL for Normal Hearing dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>55-60 (light sleep)</td>
<td>50-70</td>
</tr>
<tr>
<td>11</td>
<td>70 (deep sleep)</td>
<td>50-60</td>
</tr>
<tr>
<td>16</td>
<td>60 (awake, calm)</td>
<td>40-50</td>
</tr>
<tr>
<td>19</td>
<td>55 (awake, calm)</td>
<td>40-50</td>
</tr>
</tbody>
</table>
Audiogram
Infants who have a mild hearing loss

- Evoked potentials are used to estimate behavioural hearing thresholds
  - Based upon statistical relationships
- When the evoked potential threshold suggests a mild hearing loss be aware that some infants may have normal behavioural thresholds
Evoked Potentials and Mild Hearing Loss

\[ O = \text{ABR} (\text{dBnHL}) \]

\[ = \text{Estimated Behavioural threshold} \]

\[ = +/- 1 \text{ SD} \]

Behavioural threshold (dBHL) = ABR (dBnHL) + correction

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Air Conduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>-10 dBnHL</td>
</tr>
<tr>
<td>2000</td>
<td>0 dBnHL</td>
</tr>
<tr>
<td>4000</td>
<td>+5 dBnHL</td>
</tr>
</tbody>
</table>

Standard Deviation (used for determining deterioration)

| Standard Deviation | 10 dBnHL | 10 dBnHL | 15 dBnHL |

Van Der Werff et al 2009

Hear the sounds you love
Infants who have a mild hearing loss

• In this instance it is usually advisable to obtain further behavioural data before deciding whether or not to provide amplification
  • Visual Reinforcement Audiometry
  • Track progress with functional questionnaire such as PEACH – compare to age norms.

• Consequences of amplifying normal hearing likely to be more significant than consequences of delaying amplification for a mild hearing loss
Visual Reinforcement Orientation Audiometry

- **Conditioned response**
  - Reinforces the natural tendency to turn towards a sound
  - Typically rewarded by an illuminated puppet or a film clip.
- **Child must be in a calm, alert state, not scanning room**
- **May be performed by a single audiologist or by 2 clinicians (tester & observer).**
- **Risk of observer bias in deciding if response is genuine**
  - Can be reduced by presenting masking noise to observer or by automating the reward system.
Behavioural tests can also provide information about a child’s development
Visual Reinforcement Orientation Audiometry

- “Traditionally” tests were performed via loudspeaker in the sound field.
  - May still be best option for children who are restless or fearful
  - Does not differentiate between hearing in each ear

- Ear specific information can be obtained
  - Headphones (can be difficult to retain on head)
  - Insert earphones with foam tips or personal earmould

- Important to know about hearing in each ear to advise parents about options
For children whose hearing loss is detected in infancy

- Behavioural tests are the gold standard for defining hearing loss

- The role of behavioural hearing tests varies depending upon
  - The child’s age
  - The degree and configuration of hearing loss
  - The presence/absence of ANSD

- Behavioural tests also provide developmental information
References:


Thank you for listening

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