Word recognition threshold from two to five years of age using an Automated Toy Test

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Overview

- Automated McCormick Toy Test
- Avon Longitudinal Study of Parents And Children
- Word recognition threshold population data
- Clinical implications
Speech recognition testing

- Speech recognition tests are commonly used in paediatric audiology
  - Screen for hearing loss
  - Method of estimating hearing threshold
  - Evaluating functional impact of OME and sensorineural hearing loss
  - Assessing benefit from hearing aids
- Speech testing can be used from a developmental age of 2 years upwards
Automated McCormick Toy Test

- Common test used in paediatric audiology is the McCormick Toy Test (McCormick, 1977)
- The automated version was developed by IHR
- 7 paired words
- Automatic stepwise method for finding threshold
- The test can be performed in both quiet and noise
Automated McCormick Toy Test

- Provides measure of word recognition threshold (WRT)
- Close relationship between WRT and HTL (Summerfield et al, 1994)
- 35 dB (A) is the cut-off level for normal hearing (Palmer et al, 1991; Summerfield et al, 1994)
- Test-retest reliability is 7 dB
- No age normative data available
Automated McCormick Toy Test

- There is a developmental improvement on psychoacoustic tests with age (Schneider and Trehub, 1992)
- Most cross-sectional studies of word recognition show an improvement in performance with age
  - 9 dB from 5 to 10 years (Elliot et al, 1979)
  - 4 to 6 dB from 3 to 6 years (Jerger and Jerger, 1982)
  - 0.5 dB/year from 2 to 13 years (Palmer et al, 1991)
Automated McCormick Toy Test

- Does age influence performance on the automated McCormick Toy Test?
- Does variation in test set-up influence performance?
Automated McCormick Toy Test

- OME has a variable effect on hearing thresholds
- Evidence that early OME/hearing loss influences later auditory sensitivity (e.g. Gravel et al, 2006)
- How does OME influence WRT across the age range?
- Is early OME associated with worse WRT?
Avon Longitudinal Study of Parents And Children (ALSPAC)

- Prospective cohort study
- Aims to understand the ways in which the *physical* and *social* environment interact, over time, with *genetic* inheritance to affect health, behaviour and development in children and then into adulthood
- All children born to women due to give birth in Avon between April 1991 – December 1992
- 14,893 mothers joined the study (~80% of population)
Avon Longitudinal Study of Parents And Children (ALSPAC)

Selection of participants

- Pregnancy

TIME

- Measurement of pre-natal exposures
- Measurement of other risk factors and confounders

Hearing and other outcome measures

- Exposure measured before knowledge of outcome
- Contemporaneous measures of exposure variables
- Recall bias minimised
Avon Longitudinal Study of Parents And Children (ALSPAC)

- Self-completion questionnaires to mothers, their partners and from age 5 the children
- Medical & educational records
- Hands-on assessment at frequent intervals on random 10% sample – the Children in Focus
- Annual hands-on assessment of whole study from age 7 onwards
- Biological samples from mother, her partner and child
Avon Longitudinal Study of Parents And Children (ALSPAC)

- Summary of hearing assessments

<table>
<thead>
<tr>
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<th>Age (months)</th>
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<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Tympanometry</td>
<td></td>
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<tr>
<td>Toy Test</td>
<td></td>
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<td>Audiometry</td>
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Key:
- Children in Focus (~1000 children attended)
- Whole ALSPAC cohort (~7000 children attended)
Research aims

1. To investigate the association between the WRT and:
   a) The number of toy pairs
   b) The number of reversals

2. To provide longitudinal WRT reference data between age 2 ½ and 5 years age with and without current OME

3. To determine the effect of a positive history of OME up to age 4 on WRT at age 5?
Method

- Data were available through the ALSPAC study
- Testing was performed by qualified audiologists in a quiet room
- Ethical approval was obtained from the ALSPAC Ethics and Law committee
- Performance on the Automated McCormick Toy Test was assessed at 2 ½, 3 ½ and 5 years age
Method

- Tympanometry was assessed at 9 time points between 8 months and 5 years
- Tympanograms were classified as type A, B, C1 or C2
- Descriptive statistical analysis was used to provide normative data
Results

- 762 children attended all 3 time points
- Those attending the Children in Focus test sessions were more advantaged than the rest of the cohort
  - Mothers more highly educated ($p<0.001$)
  - Mothers older ($p=0.006$)
  - A lower proportion in local authority housing ($p<0.001$)
Results 1. Association between number of toy pairs and WRT

- Mean WRT (+/-1 SD) at 2 ½ years old
- $P=0.99$
Results 2. Association between number of reversals and WRT

- Mean WRT (+/-1 SD) at 2 ½ years age
- p=0.001
Results 3. WRT by age in children OME free

- Mean WRT (+/-1 SD)
- 5 – 6 dB improvement in threshold

![Graph showing WRT improvement over age](image_url)
Results 4. WRT according to middle ear status

- Mean WRT (+/-1 SD) at 2 ½ years

![Graph showing WRT levels for OME free, Unilateral OME, and Bilateral OME at 2 ½ years with values 29 dB, 34 dB, and 46 dB respectively.]
Results 4. WRT according to middle ear status

- Mean WRT at 2 ½ and 3 ½ years

![Graph showing WRT according to middle ear status](image-url)
Results 4. WRT according to middle ear status

- Mean WRT at 2 ½, 3 ½ and 5 years
Results 4. WRT according to middle ear status

- Mean WRT (+/- 1 SD) at 2 ½, 3 ½ and 5 years

![Graph showing WRT mean and SD for different ear status categories: OME free, Unilateral OME, Bilateral OME.](image-url)
Method

- Linear regression was used to assess the influence of early OME on WRT at 5 years
  - Excluded children with fewer than 4 tympanometric assessments
  - Exposure: OME positive children were defined as those with 4 or more occasions of bilateral OME (type B or C2 tympanograms) between 8 months and 4 years
  - Outcome: WRT at 5 years
- Statistically adjusted for presence of OME at 5 years, sex, age and social class
Results 5. Early OME and WRT at 5 years

- Effect size dB (95% CI) comparing the OME *positive* children to the rest of the group

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<thead>
<tr>
<th></th>
<th>N</th>
<th>Unadjusted</th>
<th>Adjusted for OME at 5 years</th>
<th>Adjusted for OME at 5 years, age, sex &amp; SES</th>
</tr>
</thead>
<tbody>
<tr>
<td>OME neutral</td>
<td>858</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>OME positive</td>
<td>99</td>
<td>5 dB (4 to 6 dB)</td>
<td>2 dB (0.6 to 3 dB)</td>
<td>2 dB (0.6 to 3 dB)</td>
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</table>
Summary and clinical implications

- No association between number of toy pairs used (>3) and WRT

- Fewer toy pairs can be used in clinical practice if necessary
Summary and clinical implications

- Using fewer reversals was associated with an increased WRT

- Beware of terminating the test early
Summary and clinical implications

- Children who are OME free, score on average 29 dB at 2 ½ and 23 dB at age 5
- Expect children to score better than the 35 dB screening cut-off
- These norms can be used in clinic e.g. for evaluating hearing aid benefit
Summary and clinical implications

- Bristol Children’s Hospital
- Data from 30 consecutive notes of children aided for persistent OME
- Aided (red bars) versus unaided WRT (yellow bars)

Most children fitted with Oticon Zest hearing aids
Summary and clinical implications

- There is a developmental improvement in WRT of 5 dB between 2 ½ and 3 ½ years

- This change is too small to detect within individual children
Summary and clinical implications

- Bilateral OME is associated with a mean decrease in WRT of 15 dB

- Greatest effect of OME on WRT at age 2 ½ years

- Demonstrates the impact of OME on WRT in relation to the population range
Summary and clinical implications

- Unilateral OME has a detrimental effect on word recognition

- Counsel parents of children with unilateral OME on the importance of good listening conditions and hearing tactics
Summary and clinical implications

- Early positive history of OME in the first 4 years of life is associated with a small deficit in WRT at age 5
- The deficit is too small to be detected within individual children
- Provides evidence for a small but lasting effect of early OME on auditory development up to age 5
- Limitation: definition of “OME positive”
Summary and clinical implications

- Limitations
- Observational methodology
- Generalisability of results
- No long term follow up of WRT
Future work

- ALSPAC is a unique resource

- Work is ongoing to further investigate the influence of early OME/hearing loss on development
Reference

Acknowledgements

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Any questions?