The phonological abilities of hearing impaired children: Interim results from the LOCHI study

Presented by
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National Acoustic Laboratories

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Australian Hearing Hub Conference
Background

- Phonological assessment (analysis of error patterns)
- No universal agreement on precise ages or the order of suppression of error patterns (Flipsen & Parker, 2008)
- Developmental vs non-developmental (unusual) patterns
Phonological Patterns and HI children: Literature Summary

• 11 total studies
• Sample sizes <21 (Mean – 10)
• No clear criteria
• Patterns reported:

  cluster reduction, final consonant deletion, voicing & devoicing, stopping, assimilation, liquidation, initial consonant deletion, gliding of liquids, velar backing, glottal replacement, systemic simplification, deaffrication, stridency deletion, weak syllable deletion, affrication, palatal fronting, velar fronting, vowel neutralization, monophthongisation, no audible release, palatisation, reduced frication, cluster error, nasalisation, elongation.
Longitudinal Outcomes of Children with Hearing Impairment - LOCHI

- Population study
- Children with hearing impairment born between 2002-2007 in Qld, NSW and Victoria
- 460 participants

Assessment Intervals

6 mths post 12 mths post 3YRs 5YRs 9YRs 16YRs
Research Background

Child & Family Factors
- Age of intervention
- Aetiology
- Hearing thresholds
- Maternal education
- Socioeconomic status
- Cognitive ability
- Additional needs
- Communication mode
- Gender

Device Factors
- Hearing aid prescription
- Cochlear implant parameters

Intervention Factors
- Age of enrolment
- Type and amount
- Family involvement

Child Outcomes
- Speech production
- Speech intelligibility
- Speech perception
  Receptive & expressive lang.
  Receptive & expressive
    Vocabulary
  Phonological awareness
  Reading and writing
  Functional performance
  Psycho-social skills
  Pragmatics
  Educational attainment
Method / Analysis

- Diagnostic Evaluation of Articulation & Phonology (DEAP) (Dodd, Hua, Crosbie, Holm & Ozanne, 2002)
- Phonology subtest
- Quantitative information: PCC, PVC, PPC
- Qualitative information: phonological patterns
- 50 single words
- Transcribed online & video/audio reviewed

Analysis

- Computer Assisted Speech and Language Assessment version 4.0 (CASALA) (University of Melbourne, 2007)
RESULTS

3 YEAR data
### 3 year old phonology participants

<table>
<thead>
<tr>
<th></th>
<th>3 year olds with HAs</th>
<th>3 year olds with CIs</th>
<th>3 year olds with normal hearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>n =</td>
<td>153</td>
<td>57</td>
<td>48</td>
</tr>
<tr>
<td>Mean age</td>
<td>38 months (1.7)</td>
<td>38 months (2.2)</td>
<td>38 months (1.7)</td>
</tr>
<tr>
<td>(SD) Range</td>
<td>34-44</td>
<td>33-45</td>
<td>36-41</td>
</tr>
<tr>
<td>% Males</td>
<td>51%</td>
<td>46%</td>
<td>50%</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th></th>
<th>3 year olds with HAs n = 153</th>
<th>3 year olds with CIs n = 57</th>
<th>3 year olds with normal hearing n = 48</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean PCC</strong></td>
<td>51.4% (17.6) 2-86%</td>
<td>55.2% (20.1) 21-95%</td>
<td>72.9% (11.6) 41-90%</td>
</tr>
<tr>
<td><strong>Mean PVC</strong></td>
<td>86.6% (9.9) 40-100%</td>
<td>86.7% (11.9) 50-100%</td>
<td>93.4% (4.6%) 82-100%</td>
</tr>
<tr>
<td><strong>Mean no. of phonological patterns</strong></td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Predictor</td>
<td>Consonant p value</td>
<td>Consonant impact</td>
<td>Vowel p value</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------</td>
<td>------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Gender</td>
<td>0.82</td>
<td></td>
<td>0.95</td>
</tr>
<tr>
<td>Birth-weight</td>
<td>0.24</td>
<td></td>
<td>0.69</td>
</tr>
<tr>
<td>Age at first fit</td>
<td>0.53</td>
<td></td>
<td>0.52</td>
</tr>
<tr>
<td>Age at switch-on</td>
<td>0.16</td>
<td></td>
<td>0.72</td>
</tr>
<tr>
<td>Device (HA only to CI)</td>
<td>0.02</td>
<td>3.0</td>
<td>0.09</td>
</tr>
<tr>
<td>Other disability (no to yes)</td>
<td>0.02</td>
<td></td>
<td>0.03</td>
</tr>
<tr>
<td>Early intervention mode</td>
<td>0.59</td>
<td></td>
<td>0.28</td>
</tr>
<tr>
<td>Socio-economic status</td>
<td>0.44</td>
<td></td>
<td>0.91</td>
</tr>
<tr>
<td>Maternal education (school to university)</td>
<td>0.10</td>
<td>6.7</td>
<td>0.004</td>
</tr>
<tr>
<td>Prescription</td>
<td>0.93</td>
<td></td>
<td>0.88</td>
</tr>
<tr>
<td>4FA hearing loss</td>
<td>0.08</td>
<td></td>
<td>0.11</td>
</tr>
<tr>
<td>Device x 4FA</td>
<td>0.06</td>
<td></td>
<td>0.04</td>
</tr>
<tr>
<td>4FA, HA (43 to 85 dB HL)</td>
<td>-8.3</td>
<td></td>
<td>-8.5</td>
</tr>
</tbody>
</table>
RESULTS

5 YEAR data
### 5 year old phonology participants

<table>
<thead>
<tr>
<th></th>
<th>5 year olds with HAs</th>
<th>5 year olds with CIs</th>
<th>5 year olds with normal hearing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n =</strong></td>
<td>242</td>
<td>124</td>
<td>123</td>
</tr>
<tr>
<td><strong>Mean age</strong></td>
<td>62 months (2.1)</td>
<td>62 months (1.8)</td>
<td>62 months (1.6)</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>58-70</td>
<td>58-67</td>
<td>60-65</td>
</tr>
<tr>
<td><strong>% Males</strong></td>
<td>56%</td>
<td>51%</td>
<td>50%</td>
</tr>
</tbody>
</table>
## Results

|                          | 5 year olds with HAs  
n = 242 | 5 year olds with CIs  
n = 124 | 5 year olds with normal hearing  
n = 123 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean PCC</strong></td>
<td>71.8% (18) 17-99%</td>
<td>68.7% (21.2) 11-99%</td>
<td>89.9% (8.6) 45-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean PVC</strong></td>
<td>93.4% (9.0) 27-100%</td>
<td>90.7% (10.7) 39-100%</td>
<td>98.6% (1.8) 92-100%</td>
</tr>
</tbody>
</table>
Presence of additional disabilities impact on speech production ($p=0.03$), but not device ($p=0.8$) or age at fitting ($p=0.25$)
Phonological patterns at 5yrs

- Eg. twog for frog
- Eg. nake for snake
- Eg. trab for crab
- Eg. mato for tomato
- Eg. deep for sheep
- Eg. big for pig
- Eg. wep for web
- Eg. yellow for yellow
- Eg. boo for book
- Eg. kram for pram
Speech Intelligibility Rating (SIR)  
(Yoshinaga-Itano & Sedey, 2000)

• Measures how well child is able to be understood
• 6 point rating scale
• Ratings completed by
  1. Child’s teacher
  2. Parent (for themselves & others)
  3. Researcher (during language assess)
# Speech Intelligibility Rating

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I always or almost always understand the child’s speech with little or no effort</td>
</tr>
<tr>
<td>2</td>
<td>I always or almost always understand the child’s speech: however I need to listen carefully</td>
</tr>
<tr>
<td>3</td>
<td>I typically understand about half of the child’s speech</td>
</tr>
<tr>
<td>4</td>
<td>I typically understand about 25% of the child’s speech</td>
</tr>
<tr>
<td>5</td>
<td>The child’s speech is very hard to understand. I typically understand only occasional, isolated words and/or phrases</td>
</tr>
<tr>
<td>6</td>
<td>I never or almost never understand the child’s speech</td>
</tr>
</tbody>
</table>
Number of patterns vs SIR researcher rating at 5 years

Scatterplot: A60TotPP vs. SIR_R (Casewise MD deletion)

\[ SIR_R = 1.2051 + 0.30676 \times A60TotPP \]

Correlation: \( r = 0.74361, p < 0.001 \)

Number of patterns at 5 years
Summary:

- Speech production is still 1 SD below the normative mean
- Delayed phonological patterns
- 69% had SIR of 1 or 2 at 5 yrs