Longitudinal Outcomes of children with hearing impairment: findings from the LOCHI study

Teresa YC Ching, PhD

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We are here!

Population: 22.7 million
Annual births: 297,200 (2011)
Est PCHI: 327

Population: 1.4 billion
Annual births: 16.5m (2012)
Est PCHI: 19,774

Annual births: 134.8 million (2001)
听力损失发病率 1.2/1000
Est PCHI: 148,300
Why LOCHI?


• UNHS aims to alleviate huge burden of disability

• 2008 US Preventive Services Task Force
  – "Moderate certainty that net benefit of screening all newborn infants for hearing loss is moderate"
  – Based on a single quasi-randomised trial

• Research on population outcomes scant
In 2005,

**Longitudinal Outcomes of Children with Hearing Impairment ...**
Aims

• Does UNHS and early intervention improve child language and literacy outcomes, at a population level?
• What factors (modifiable or otherwise) influence outcomes?
• Does early performance predict later outcomes?
Method

- About 460 participants from population in 3 states,
- YOB: 2002-2007
- 53% fitted with hearing aids and enrolled in early education < 6 months
- About 20% with non-English speaking background
- About 37% have additional disabilities
We collect a range of information,

**Child**
- Age at fitting
- Age at implantation
- Birthweight
- Gender
- Hearing thresholds
- HA – Prescription
- Use of device
- Additional disabilities
- Auditory neuropathy
- Aetiology
- Cognitive ability

**Family**
- Communication mode
- Involvement in intervention
- Language used at home
- Maternal education
- Socio-economic status

**Intervention**
- Age at enrolment
- Communication mode
- Hours of intervention
- Parental involvement
And measure children’s outcomes …

**Language**
- Expressive Communication
- Auditory comprehension
- Receptive vocab.
- Expressive vocab.

**Speech**
- Articulation
- Phonological development
- Speech perception
- Spatial release from masking

**Literacy & numeracy**
- Phonological awareness
- Reading
- Spelling
- Math reasoning

**Psycho-social dev.**
- Aural-oral function in real life
- Pragmatics
- Mental health
- Quality of life

**Education & employment**
- Educational attainment
- Employment

**Cognition**
- Working memory
- Orthographic learning
- Paired associate learning
- Lexical access
At multiple intervals as they grow
AT 5 YEARS,
Age 5 Test scores: 25th, 50th, 75th percentiles...
To analyse findings,

- Combine multiple test scores into a global language score
- Fit regression models separately for
  - Children using hearing aids
  - Children using cochlear implants
Children with hearing aids
### Significant Predictors for 243 children with HA

Impact of category change. For continuous variables, variation as per specification.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$R^2 = 74$</th>
<th>Significance ($p$)</th>
<th>$p$ – value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age first fit (log)</td>
<td>0.003</td>
<td>&lt;0.001</td>
<td>0.11</td>
</tr>
<tr>
<td>4FA hearing loss</td>
<td></td>
<td>&lt;0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>Log Age first fit x 4FA</td>
<td>0.07</td>
<td></td>
<td>0.06</td>
</tr>
<tr>
<td>Cognitive ability/WNV</td>
<td>&lt;0.001</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender</td>
<td>0.16</td>
<td></td>
<td>0.19</td>
</tr>
<tr>
<td>Birthweight</td>
<td>0.73</td>
<td></td>
<td>0.08</td>
</tr>
<tr>
<td>Other disability</td>
<td>0.04</td>
<td></td>
<td>0.13</td>
</tr>
<tr>
<td>Maternal education (university re school)</td>
<td>&lt;0.001</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Socio-economic status (dec)</td>
<td>0.39</td>
<td></td>
<td>0.44</td>
</tr>
<tr>
<td>Communication mode in Edn (other re oral)</td>
<td>0.007</td>
<td></td>
<td>0.009</td>
</tr>
</tbody>
</table>

$R^2 = 69$

$R^2 = 74$

$R^2 = 77$
Increase in HTL decreases language ability
Effect of age at fitting on language, for different HL
Maternal education

![Graph showing maternal education levels and global language scores. The graph indicates a difference of 0.6 SD between maternal education levels.]

- School: n = 82
- TAFE: n = 56
- University: n = 89
Communication mode in early education

![Graph showing the impact of different communication modes on global language scores. The graph indicates a difference of -0.5 SD between oral only and other communication modes.](Image)
Children with cochlear implants
## Significant Predictors for 114 children with CI

**Impact of category change. For continuous variables, variation as per specification.**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Significance (p-value)</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age first switch on (log)</td>
<td>0.001</td>
<td>-0.06 (-0.30, 0.17)</td>
</tr>
<tr>
<td>4FA hearing loss</td>
<td>0.60</td>
<td>-0.06 (-0.30, 0.17)</td>
</tr>
<tr>
<td>Cognitive ability/WNV</td>
<td>&lt;0.001</td>
<td>0.53 (0.37, 0.69)</td>
</tr>
<tr>
<td>Gender (Female re male)</td>
<td>0.15</td>
<td>4.84 (-1.73, 11.42)</td>
</tr>
<tr>
<td>Birthweight</td>
<td>0.79</td>
<td>0.51 (-3.27, 4.3)</td>
</tr>
<tr>
<td>Other disability</td>
<td>&lt;0.001</td>
<td>-19.1 (-28.39, -9.83)</td>
</tr>
<tr>
<td>Maternal education (Dip re school) (university re school)</td>
<td>0.20</td>
<td>4.64 (-4.33, 13.61)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.28 (0.76, 17.32)</td>
</tr>
<tr>
<td>Socio-economic status (dec)</td>
<td>0.40</td>
<td>2.3 (-3.05, 7.65)</td>
</tr>
<tr>
<td>Communication mode in Edn. (other re oral)</td>
<td>0.04</td>
<td>-12.38 (-24.5, -0.31)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.56 (-7.42, 12.55)</td>
</tr>
</tbody>
</table>

$R^2 = 58$ for the model, $R^2 = 70$ for the significant predictors.
Delaying CI switch-on decreases language ability
Communication mode in education

Early intervention communication mode

- Oral only: n = 53
- Other only: n = 12
- Changed/never attended: n = 23

Global language score

-1 SD
Yr 5 data suggest ...

- Higher cognitive ability
- Lesser hearing loss
- Earlier age at HA fitting
- Earlier age of implantation
- Higher maternal education
- Oral communication mode

Additional disabilities
If we add 3-yr scores as a predictor, the model accounted for 86% of total variance of scores.
Does UNHS improve outcomes?

Yes!

- Early age at hearing-aid fitting
- Early age at cochlear implantation
Why does hearing loss affect language development?

Hearing loss

Speech discrimination

Language skills

ANSD

Early education

HA or CI

Cognition

Gender

SES

Maternal education/Family Involvement

Language input

Literacy

Psycho-emotional outcomes

Speech production and perception
Does early performance predict outcomes at 5 years?

Yes!

- Language ability at 3 yrs accounted for 23% of variance in addition to other predictors (total: 83%)
- Language ability before 2 yrs accounted for 3% of variance at 5 yrs (total: 63%).
- Functional performance in real life (PEACH) before 2 yrs was a significant predictor of language at 3 & 5 yrs.
To do ...

• Streamline services to ensure early fitting and implantation
• Monitor early outcomes to identify children who may be “at-risk” of language impairment
  – develop effective diagnostic methods,
  – Develop evidence-based strategies for intervention
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From left to right: Linda Cupples, Louise Martin, Paola Incerti, Megan Gilliver, Kirst Gardner-Berry, Vicky Zhang, Sanna Hou, Vivienne Marnane, Teresa Ching, Miriam Gunnourie, Jessica Sjahalam-King, Lauren Burns, Harvey Dillon, Julia Day, Laura Street, Patricia Van Buynder, Jessica Thompson, Christopher Flynn.

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For information

www.outcomes.nal.gov.au
www.nal.gov.au

Teresa.Ching@nal.gov.au