The emergence of speech intelligibility in long-term pediatric cochlear implant users

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Childhood Development after Cochlear Implantation (CDaCI)
Disclosure

• Kathryn Wiseman, Andrea Warner-Czyz, Olga Peskova, and Ann Geers
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Speech intelligibility

How understandable a person’s speech is to a listener
Speech intelligibility

Speech production ≠ Speech intelligibility
Importance of speech intelligibility

• Poor intelligibility related to:

  Isolation

  Poor social interactions

  Mental health issues

Most et al, 1999, 2011; Freeman et al., 2017
Previous research findings

• Less accurate, more variable in cochlear implant (CI) users vs. typical hearing (TH) peers

• Intelligibility improves over time

Better speech intelligibility:

- ↓ Age at CI
- ↓ Family size
- ↑ Family income
- ↑ Speech perception
- ↑ Other speech/language outcomes
- Females
- Oral communication

Allen et al., 1998; Beadle et al., 2005; Tobey et al., 2003, 2011; Osberger et al., 1993; Montag et al., 2014; Freeman et al., 2017
Research questions

• Does speech intelligibility change as a function of duration of auditory experience (i.e., 4-8 years)?

• Which demographic variables predict speech intelligibility scores at
  – 4-5 years post-CI?
  – 6-8 years post-CI?
Childhood Development after Cochlear Implantation Study (CDaCI)

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Childhood Development after Cochlear Implantation
# Participant characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CI participants ($n = 128$)</th>
<th>TH participants ($n = 81$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory experience</td>
<td>4 – 8 yrs</td>
<td>6.5 – 10.4 yrs</td>
</tr>
<tr>
<td>Percent Female</td>
<td>57%</td>
<td>56%</td>
</tr>
<tr>
<td>Percent congenital onset</td>
<td>55%</td>
<td>-</td>
</tr>
<tr>
<td>Mean amplification age (yrs)</td>
<td>1.1 (0.8)</td>
<td>-</td>
</tr>
<tr>
<td>Mean CI activation age (yrs)</td>
<td>2.5 (1.2)</td>
<td>-</td>
</tr>
</tbody>
</table>
McGarr Sentence Intelligibility Test

- 36 English sentences
- 3, 5, and 7 syllables
- **Keywords with** high and low context
Speech intelligibility increases with longer duration of auditory experience.

Speech intelligibility increases with longer duration of auditory experience.
### Early and late speech intelligibility

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Early (4-5 yrs post-CI)</th>
<th>Late (6-8 yrs post-CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean chronologic age (yrs)</td>
<td>7.1 (1.0)</td>
<td>10.1 (1.4)</td>
</tr>
<tr>
<td>Mean CI experience (yrs)</td>
<td>4.6 (0.5)</td>
<td>7.5 (0.7)</td>
</tr>
</tbody>
</table>
56% of CI users attain scores within 1 SD of the TH mean by 8 years post-CI.
Mean speech intelligibility improves as a function of CI experience.
Analysis

• Demographic predictors
  – Chronologic age
  – Age at CI
  – Duration of CI experience
  – Speech perception at 3 years post-CI (SRI-Q)
<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>Open-set Hearing in Noise Test for Children (quiet)</td>
</tr>
<tr>
<td>500</td>
<td>Open-set Phonetically Balanced Kindergarten words</td>
</tr>
<tr>
<td>400</td>
<td>Open-set Lexical Neighborhood Test</td>
</tr>
<tr>
<td>300</td>
<td>Closed-set Pediatric Speech Intelligibility Test</td>
</tr>
<tr>
<td>200</td>
<td>Closed-set Early Speech Perception Test</td>
</tr>
<tr>
<td>100</td>
<td>Parent report Meaningful Auditory Integration Scale</td>
</tr>
</tbody>
</table>
## Predictors of EARLY speech intelligibility (4-5 years post-CI)

<table>
<thead>
<tr>
<th></th>
<th>Regression model 1</th>
<th>Regression model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronologic age</td>
<td>$\beta = -.164$</td>
<td>$\beta = -.252^{***}$</td>
</tr>
<tr>
<td>SRI-Q at 3 years post-CI</td>
<td>--</td>
<td>$\beta = .704^{***}$</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.027</td>
<td>.514</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>.027</td>
<td>.487***</td>
</tr>
</tbody>
</table>

***$p < .001$
## Predictors of LATE speech intelligibility (6-8 years post-CI)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Regression model 1</th>
<th>Regression model 2</th>
<th>Regression model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI experience</td>
<td>$\beta = .284^{***}$</td>
<td>$\beta = .277^{***}$</td>
<td>$\beta = .170^*$</td>
</tr>
<tr>
<td>Age at CI</td>
<td>--</td>
<td>$\beta = -.191^*$</td>
<td>$\beta = -.330^{***}$</td>
</tr>
<tr>
<td>SRI-Q at 3 years post-CI</td>
<td>--</td>
<td>--</td>
<td>$\beta = .612^{***}$</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.081</td>
<td>.117</td>
<td>.462</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>.081*</td>
<td>.036*</td>
<td>.345***</td>
</tr>
</tbody>
</table>

*p < .05, **p < .01, ***p < .001
Conclusions

• Speech intelligibility improves through 8 years after CI

• Speech perception at 3 years post-CI predicts speech intelligibility