Consequences of UHL in children:
How do we measure deficits and possible CI benefits

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Introduction

• We are studying several patient populations with varied asymmetry between ears

• One group has Unilateral Hearing Loss (UHL)
  Defined as having one poor ear and one NH ear

• Children and Adults

• No implants at this time
Aims of Pediatric Study

1) Identify abilities of children with UHL on measures that address known deficits, and quantify deficits on these measures
   Critically need baseline information with which to compare treatment outcomes

2) Investigate sources of variability

3) Compare performance and variability to gender matched peers of similar ages
### UHL Children and NH Matches

<table>
<thead>
<tr>
<th>Mean (Range)</th>
<th>Age at Test (years)</th>
<th>Unaided FF PTA (dB HL)</th>
<th>Age SPHL Onset (years)</th>
<th>Length of Deafness (years)</th>
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<tr>
<td>UHL (n = 20)</td>
<td>12.0 (6.9 – 16.3)</td>
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<td>6.6 (-2 – 20)</td>
<td>1.0 (0.0 – 7.9)</td>
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<td>NH (n = 20)</td>
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## UHL Children and NH Matches

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<td>95.2 (61 – 120+)</td>
<td>5.9 (-2 – 20)</td>
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<td>UHL (n = 11)</td>
<td>10.5 (6.9 – 13.4)</td>
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<td>NH (n = 10)</td>
<td>10.4 (7.5 – 15.5)</td>
<td>4.4 (0 – 17)</td>
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Monosyllable Word Recognition (CNC)

Quiet  50 dB SPL

<table>
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<tr>
<th>Condition</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHL (n = 20)</td>
<td>95%</td>
<td>4%</td>
</tr>
<tr>
<td>NH (n = 20)</td>
<td>99%</td>
<td>1%</td>
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Noise  60 dB SPL +8 dB 4TB

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<th>Mean</th>
<th>SD</th>
</tr>
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<tr>
<td>UHL (n = 20)</td>
<td>84%</td>
<td>8%</td>
</tr>
<tr>
<td>NH (n = 20)</td>
<td>90%</td>
<td>4%</td>
</tr>
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Reeder, Cadieux, Firszt
Submitted

* p < 0.05; ** p < 0.01
HINT Sentences in Restaurant Noise R-Space™

- 8 loudspeakers surround the listener
- Sentences from the front
- Restaurant noise from all loudspeakers
- Adaptive measure: Noise at 60 dB SPL, speech level is varied
- Participants repeat the sentence
- SNR-50 score (SNR at which the patient scores 50% correct)

Illustration from Revit et al, 2002
R-Space

Lower scores are better

**UH L (n = 20)**
Mean -2.0 dB (SD 1.4 dB)

**NH (n = 20)**
Mean -4.6 dB (SD 1.7 dB)

**p < 0.001**

**NH Adults = -5 dB**

Reeder, Cadieux, Firszt
Submitted
Localization

Scored as degrees of error (RMS)
10° between each speaker
Lower scores are better

Localisation

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean (°) (SD)</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>UHL</td>
<td>28.1 (13.5)</td>
<td>n = 11</td>
</tr>
<tr>
<td>NH</td>
<td>6.0 (3.7)</td>
<td>n = 10</td>
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</table>

*** p < 0.001

NH Adults = 2-3 degrees

Reeder, Cadieux, Firszt
Submitted
Adaptive SRT Methods

- 4 alternative, forced-choice adaptive task
- Using picture format, child identifies word
- For each spondee word presentation, background is randomized—either quiet or one of the 3 different talkers—adds uncertainty to the listening task
  - Noise from 3 different locations
  - Front, 90 degrees right, 90 degrees left
AdapGve
SRT
in
Noise
by
Noise
Type

\[\text{** p < 0.01; *** p < 0.001}\]

UH
L
(n = 11)
NH (n = 10)

Lower scores are better

SRT (dB)

Female
Male
MTB

Noise Type

Reeder, Cadieux, Firszt
Submitted

** p < 0.01; *** p < 0.001
Adaptive SRT in Noise by Noise Location

** p < 0.01; *** p < 0.001

Lower scores are better

UH (n = 11)

NH (n = 10)

SRT (dB)

0 10 20 30 40 50 60

***

**

Noise Location

Front NH/Left Ear Deaf/Right Ear

Reeder, Cadieux, Firszt
Submitted

** p < 0.01; *** p < 0.001
Speech, Spatial, and Qualities of Hearing Scale (SSQ)

*** p < 0.001

Reeder, Cadieux, Firszt
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Summary: UHL vs NH Children

• Results poorer for UHL than NH - most measures
• Effect of noise was less predictable with UHL
• Considerable variability on all measures with UHL
• Although UHL were more varied, some children had scores within the range of NH children
• On all measures except Spatial section of SSQ, overlap exists
What do these results tell us about how to measure deficits and possible CI benefits?

• Need measures of:
  - Localization
  - Speech in noise with noise directed to good ear, or noise from all around the listener
    • Muti-talker babble, female talker
  - Speech understanding at soft level
  - Measure of perceived ability in real world settings
Other Assessment Considerations

• Need language assessment?
  - Children with UHL had poorer language comprehension, oral expression and oral composite scores (Lieu et al 2010)

• Need educational/teacher feedback?

• Need cognitive measures? Listening effort?
Considerations with Respect to Variability

• If not all children have a deficit, how to identify those that do

• Maybe all children have a deficit and we need different measures

• Those with performance comparable to NH peers, how are they doing it? Using other resources? Greater cognitive load? Some other work around?

• If younger is better, how do we identify deficits early? And then how do we measure benefits?
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WUSM/SLCH Research Team

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- Sallie Vanderhoof, AuD

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- Joel Goebel, MD
- Keiko Hirose, MD
- Timothy Hullar, MD
- Jonathan McJunkin, MD
- J. Gail Neely, MD

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