Word Learning in Children with Hearing Loss

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Why study word learning?

- Children with hearing loss typically have reduced vocabularies compared to children with normal hearing.

- UNHS has produced a new population of children with hearing loss
  - More, better, and longer access to the auditory signal
What we’ve learned...

- Children with hearing loss and children with language impairment have similar word learning outcomes but for different reasons
  - HL: Quality of the acoustic signal
  - LI: Cognitive factors

- Lexical development appears to be delayed ~2 years in children with hearing loss
What we’d like to know…

- How a child’s hearing loss (elevated hearing thresholds) affects word learning

- How access to the acoustic signal (amplification) affects word learning
Word Learning Paradigms

- Learning Performance Paradigm
  - Performance after a fixed number of exposures to a new word

- Learning Rate Paradigm
  - Number of exposures necessary to learn a new word
Learning Performance

“Rapid Word-Learning in Normal-Hearing and Hearing-Impaired Children: Effects of Age, Receptive Vocabulary, and High-Frequency Amplification”

Purpose

- Characterize word-learning in children with normal hearing and children with hearing loss
- Characterize the effects of stimulus bandwidth on word learning
# Novel-Word Construction

<table>
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<th>Manner</th>
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<th>Post Alveola</th>
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Novel-Word Construction

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m n η
f v θ ē s z ẓ j h
r j
w l
Novel-Word Construction

\begin{align*}
\text{ba} & \text{ir} & \text{il} & \quad \text{vo} & \text{j} & \text{i} & \eta \\
\text{ju} & \text{3æp} & \quad \text{zi} & \text{k} & \text{i} & \text{n} \\
\text{di} & \text{wim} & \quad \text{tai} & \text{ðu} & \text{s} \\
\text{θo} & \text{g} & \text{i} & \text{ʃ} & \quad \text{hυç} & \text{i} & \text{f}
\end{align*}
Novel-Word Construction

bayrill    vojing
youzzap    zeekin
deevim     tathus
thogish    hoochiff
Novel-Word Construction

bayrill

youzzap

deewim

thogish

vojing

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Story Construction
Story Presentation

- Bandwidth conditions
  - Standard (LPF 4 kHz)
  - Extended (LPF 9 kHz)
- Each word was presented 3 times in the 4-minute story.
- The story was presented twice.
- Word-learning parameters
  - 8 words
  - 6 presentations each
  - 8 minute period
Participants

- 97 Children between 5- and 14-years-old
  - 60 Normal Hearing (mean age: 9yrs, SD: 2yrs)
  - 37 Hearing Loss (mean age: 9yrs, SD: 2yrs)

- Estimated receptive vocabulary (PPVT)
Results
Results
Results

The bar chart illustrates the word learning performance in percentage correct for two groups: NH (normal hearing) and HI (hearing impaired). The chart compares the standard and extended conditions. The NH group shows a higher percentage of correct responses compared to the HI group in both conditions. The extended condition generally yields better performance in both groups, as indicated by the taller bars for the extended condition in each group.
Conclusions

- Given the same number of exposures, children with normal hearing learned more words than the children with hearing loss.

- An extended bandwidth did not significantly improve word learning in either group.
What really happens?

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<th>Group</th>
<th>Standard</th>
<th>Extended</th>
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What happens over the long term?
Word Learning Rate

“Short-term word learning rate in children with normal hearing and children with hearing loss in limited and extended high-frequency bandwidths”

Pittman (June 2008) JSLHR

Purpose

- To determine the rate of word learning in children with normal hearing and children with hearing loss.
  - Rate defined as the number of exposures necessary to achieve 70% performance
- To determine the effect of bandwidth on learning rate.
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Novel-Word Construction
Novel-Word Construction

s α θ n η d

d a z t e l

f a s n η f

s t a m η n

h a m t e l
Novel-Word Construction

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<th>Standard</th>
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Method

- **Children**
  - 36 with NH
  - 14 with HL
  - 8-10 yrs of age

- **Bandwidths**
  - Standard (4kHz)
  - Extended (9kHz)

- Half the children learned the words in the standard bandwidth and half in the extended bandwidth

- 150 randomized trials (5 words x 30 repetitions)
Learning Game
Results

The graph illustrates the comparison of PPVT scores between two groups: Standard and Extended, for NH and HL (Hearing Loss) individuals. The scores are represented as (106) and (110) for NH, and (99) and (95) for HL, respectively.
Results
Results

The chart shows the performance over trials for different conditions:

- **NH** (solid line with black circles)
- **HI** (solid line with white squares)
- **EXTENDED** (solid line with black circles)
- **LIMITED** (solid line with white squares)

The y-axis represents performance (% correct) ranging from 0 to 100, and the x-axis represents trial numbers ranging from 0 to 150.
Results
## Results

### Number of Trials to Learn 5 New Words

<table>
<thead>
<tr>
<th></th>
<th>Normal Hearing</th>
<th>Hearing Loss</th>
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</thead>
<tbody>
<tr>
<td>Standard</td>
<td>43</td>
<td>121</td>
</tr>
<tr>
<td>Extended</td>
<td>20*</td>
<td>72</td>
</tr>
</tbody>
</table>
Results

Number of Trials to Learn 1 New Word

<table>
<thead>
<tr>
<th></th>
<th>Normal Hearing</th>
<th>Hearing Loss</th>
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</thead>
<tbody>
<tr>
<td>Standard</td>
<td>16</td>
<td>27</td>
</tr>
<tr>
<td>Extended</td>
<td>5*</td>
<td>10</td>
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</table>
Conclusions

- Children with hearing loss require more exposures to learn a new word than children with normal hearing.
  - As much as 5x the exposures.

- Minor acoustic properties can impact long-term word learning.
  - Nothing beats a high quality signal.
In the Future...

- Simulating hearing loss to determine effects of elevated thresholds on word learning.

- Learning Rate paradigm will allow us to quickly assess different hearing-aid, signal processing characteristics.
Thank you