Hearing Loss, Hearing Devices, and the Business of Childhood

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pedamp.asu.edu/presentations

Pediatric Amplification Lab
We Give Kids Volume
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Kristy Winters – Michigan Univ Hospital, MI
The kids we're talking about
The kids we're talking about

![Diagram showing hearing loss by age and severity](image)
The business of childhood
Vocabulary Development

Secretly Awesome

81 HI Children
110 NH Children

PPVT Vocabulary Age (Yrs)

Chronological Age (Yrs)

AGE (years)

HEARING LOSS (degree)

Pittman & Latto (1998-2008)
Vocabulary Development

Vocabulary Knowledge - College Students

What does it take to learn a new word?

To learn a new word a child needs to be able to:

1) Perceive speech
2) Detect that a word is new (unknown)
3) Learn what the new word means
4) Remember the new word
Auditory Lexical Decision Task

“Swim”

<table>
<thead>
<tr>
<th>Repeat</th>
<th>Categorize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swim</td>
<td>Real</td>
</tr>
<tr>
<td>Swim</td>
<td>Not Real</td>
</tr>
<tr>
<td>Srim</td>
<td>Real</td>
</tr>
<tr>
<td>Srim</td>
<td>Not Real</td>
</tr>
<tr>
<td>Whim</td>
<td>Real</td>
</tr>
<tr>
<td>Whim</td>
<td>Not Real</td>
</tr>
</tbody>
</table>

“Glat”

<table>
<thead>
<tr>
<th>Repeat</th>
<th>Categorize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glat</td>
<td>Not Real</td>
</tr>
<tr>
<td>Glat</td>
<td>Real</td>
</tr>
<tr>
<td>Glad</td>
<td>Not Real</td>
</tr>
<tr>
<td>Glad</td>
<td>Real</td>
</tr>
<tr>
<td>Grat</td>
<td>Not Real</td>
</tr>
<tr>
<td>Grat</td>
<td>Real</td>
</tr>
</tbody>
</table>
Amplification Bandwidth (Wide vs Narrow)

Digital Noise Reduction (On vs Off)

Bone Conduction (Softband vs Direct)

[Graph showing force vs frequency with error bars for Softband and Direct conditions.]

[Graph showing in-situ thresholds (dB HL) vs frequency with error bars for Softband and Direct conditions.]

[Bar graph showing direct coupling (prop correct) vs softband coupling (prop correct) with data points.]
Non-Word Detection 2.0

<table>
<thead>
<tr>
<th># of nonsense words</th>
<th>Example phrase</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Clocks tick on time.</td>
</tr>
<tr>
<td>1</td>
<td>Birds <em>rike</em> long worms</td>
</tr>
<tr>
<td>2</td>
<td><em>Dats</em> catch slow <em>bice</em>.</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>
Amplification (Unaided vs Aided)

- Frequency (kHz)
  - 0.25
  - 0.5
  - 1
  - 2
  - 4
  - 8

- Hearing Level (dB HL)
  - -20
  - 20
  - 40
  - 60
  - 80
  - 100
  - 120

- Aided (Prop. Correct)
  - 0
  - 0.2
  - 0.4
  - 0.6
  - 0.8
  - 1

- Unaided (Prop. Correct)
  - 0
  - 0.2
  - 0.4
  - 0.6
  - 0.8
  - 1

- Real
- Nonsense

Pittman & Daliri (in progress)
Bone Conduction (Softband vs Direct)

![Image of bone conduction device on a person's head]

![Graph showing the comparison between Direct Coupling and Softband Coupling, with black dots representing Real and red dots representing Nonsense]

Pittman (in progress)
Rapid Word Learning

Learning Speed:
3 = 1 trial (perfect learning)
2 = 10 trials
1 = 100 trials
0 = 1000 trials (no learning)

\[ P_c = 1 - 0.80e^{-n/c} \]
Rapid Word Learning

115 correct/150 trials

=77%
High-Frequency Amplification

Digital Noise Reduction (on vs off)

Bone Conduction (direct vs softband)
Group Results – Amplification Bandwidth

Group Results – Digital Noise Reduction

Group Results – Bone Conduction

- **Word Recognition**
  - Softband: 0.74
  - Direct: 0.76

- **Lexical Decision**
  - Softband: 0.61
  - Direct: 0.71

- **NWD 2.0**
  - Softband: 1.18
  - Direct: 1.44

- **Word Learning**
  - Softband: 0.84
  - Direct: 1.19

Pittman (in progress)
Are the new words remembered?

Retention Posttest

Learning

Word Bank

<table>
<thead>
<tr>
<th>Sentop</th>
<th>Nushtul</th>
<th>Pedsot</th>
<th>Homtul</th>
<th>Kaystill</th>
<th>Podtep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doztul</td>
<td>Stomul</td>
<td>Stornun</td>
<td>Pedton</td>
<td>Doznud</td>
<td>Gaystill</td>
</tr>
<tr>
<td>Daystnin</td>
<td>Stillmay</td>
<td>Depton</td>
<td>Smentos</td>
<td>Maystll</td>
<td>Maystln</td>
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<tr>
<td>Sothnud</td>
<td>Tayskit</td>
<td>Fosmud</td>
<td>Kenson</td>
<td>Smenkop</td>
<td>Gaysmlt</td>
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<tr>
<td>Fosnush</td>
<td>Homstun</td>
<td>Kitstln</td>
<td>Kentop</td>
<td>Deppost</td>
<td>Kayskim</td>
</tr>
</tbody>
</table>

Pittman, Wright, Latto, Wright (in process)
If given enough trials, children with hearing loss can learn as quickly as children with normal hearing but they need more training than children with normal hearing to remember what they’ve learned.
Catching up
Vocabulary Size

The average undergraduate student knows between 15,000 and 200,000 words (D’Anna et al, 1991).

Oxford Dictionary of American English:
1000+ new entries each year
1. new words
2. new definitions to existing words

Let’s do a little math…

Children:
- 50,000 word vocabulary
- learned over 18 years (3 to 22 years)
- = 7 new words everyday

Adults:
- 1,000 new words per year
- = 3 new words every day
Vocabulary Knowledge - Adults

Older adults outperform younger adults on standardized vocabulary tests (Verhaeghen, 2003).

Flynn Effect: Scores increase with age due to a cohort effect that favors the earlier born (Flynn, 1987).

## Vocabulary Knowledge - Adults

<table>
<thead>
<tr>
<th>Word Type</th>
<th>#</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Words</td>
<td>15</td>
<td>Aghast: Filled with horror or shock</td>
</tr>
<tr>
<td>Old words with a new definition</td>
<td>15</td>
<td>Ship: The desire of a fan for two fictional characters to be in a romantic relationship</td>
</tr>
<tr>
<td>New words</td>
<td>15</td>
<td>Geotag: An electronic tag that assigns a geographical location to a photograph</td>
</tr>
<tr>
<td>Nonsense words</td>
<td>5</td>
<td>Desill</td>
</tr>
</tbody>
</table>
## Vocabulary Knowledge - Adults

<table>
<thead>
<tr>
<th></th>
<th>20-30 yrs</th>
<th>40-50 yrs</th>
<th>60-70 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old Words</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Words</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonsense Words</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pittman, Stahl & Marzan (in process)
Vocabulary Knowledge - Adults

21 Adults 19-88 years

Old Words: $r = -0.17$, $p = 0.51$
Partial correlations controlling for age

New Words: $r = -0.83$, $p < 0.001^*$
Partial correlations controlling for age
What have we learned today?
We’ve learned that…

Perceiving words we already know is easy, but learning new words is more challenging.

Learning new words is directly related to:

1) the quality of the auditory signal
2) the opportunities to learning

When we optimize amplification for children (and adults), we optimize their opportunities to learn.
Thank you!