The multidimensional effects of hearing loss on word learning in children

Andrea Pittman
Arizona State University
Knowles Research Symposium
October 2014

© 2014 Andrea Pittman All Rights Reserved
What’s the problem?

(Pittman & Latto, in process)
Word Learning Model

“blahblahblah”

Lexical Processing
Overall word knowledge

Identification
Prerequisite to perception

Configuration
Form acoustic and semantic representation

Detection
Engagement

(Gray, Pittman & Weinhold, JSLHR, 2014)
(Storkel & Lee, Lang Cog Proc, 2011)
(Leach & Samuel, Cog Psych, 2007)
“Assessing advanced hearing aid features using behavioral tasks that vary in cognitive demand”

Two-year project (2013-15)
Purpose

To examine the effects of subtle acoustic alterations resulting from advanced forms of amplification on the auditory components involved in the word learning process.

Hypothesis

The effect of small acoustic alterations increase as the auditory components become more demanding.
Participants

13 children with normal hearing

12 (20) children with hearing loss

8 to 12 years of age

Mainstreamed at grade level

Native speakers of English

© 2014 Andrea Pittman All Rights Reserved
Methodology

Testing
  52 dB SPL in the free field

Data collection
  Computer interface
  Digital audio recordings

Three visits
  1 Unaided session
  2 Aided sessions
Wide-Band Amplification

Oticon miniAlta RITE
Auditory Tasks

1. Word Recognition

2. Lexical Decision

3. Non-word Detection

4. Rapid Word Learning

Lexical Processing
Overall word knowledge

Identification
Prerequisite to perception

Configuration
Form acoustic and semantic representation

“blahblahblah”
1. Word Recognition Task

![Graph showing percent of responses across different listening conditions.]

![Graph showing correlation between narrowband and wideband conditions.]

\[
F_{1,23} = 4.998, \ p = 0.036
\]
2. Auditory Lexical Decision Task
2. Auditory Lexical Decision Task

- Stimulus: Real "cat" 
- Not Real 
- Ambiguous 

- Correct: Repetition Accurate "glug" 
- Misperception: Inaccurate "glug" 
- Misconception: Inaccurate "plug" 

© 2014 Andrea Pittman All Rights Reserved
2. Auditory Lexical Decision Task

Unaided Listening Conditions

- **Performance**
  - Unaided: 17%
  - NB: 16%
  - WB: 9%

- **Misperception**
  - Unaided: 12%
  - NB: 9%
  - WB: 6%

- **Misconception**
  - Unaided: 10%
  - NB: 5%
  - WB: 5%

- **Abiguity**
  - Unaided: 0%
  - NB: 20%
  - WB: 40%

Performance (% correct)

© 2014 Andrea Pittman All Rights Reserved
2. Auditory Lexical Decision Task

(F₁,2₃ = 84.465, p<0.001)
3. Non-Word Detection Task

Cooks make hot foo\textit{m}.
3. Non-Word Detection Task

<table>
<thead>
<tr>
<th>Listening Conditions</th>
<th>Unaided</th>
<th>NB</th>
<th>WB</th>
<th>NH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Responses</td>
<td>31%</td>
<td>21%</td>
<td>15%</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>29%</td>
<td>24%</td>
<td>23%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>39%</td>
<td>56%</td>
<td>62%</td>
<td>72%</td>
</tr>
</tbody>
</table>

© 2014 Andrea Pittman All Rights Reserved
3. Non-Word Detection

![Scatter plot showing the relationship between wideband and narrowband percent correct. The equation $(F_{1,23}=0.934, p=0.344)$ is indicated on the graph.]

$(F_{1,23}=0.934, p=0.344)$
4. Rapid Word Learning Task
4. Rapid Word Learning Task

Data Reduction

\[ P_c = 1 - 0.8e^{-n/c} \]
4. Rapid Word Learning Task

Overall Learning

Performance (% Correct)

Trials

- Unaided
- NB
- WB
- NHC

© 2014 Andrea Pittman All Rights Reserved
4. Rapid Word Learning Task

Overall

(F_{1,23}=160.3, p<.001)

Word

(F_{1,23}=13.693, p=.01)
What have we learned?

1. Amplification is the first and best thing that we can provide to children with hearing loss.

   - Children’s performance improved significantly on all of the auditory tasks in the aided conditions
What have we learned?

2. Maximizing bandwidth increased performance significantly.
   
   - The effect appears to increase as the “difficulty” of the task increases.
What have we learned?

3. Children with hearing loss have difficulty detecting new words in context
   May miss opportunities to learn new words.
In Summary…

Tasks that represent a range of auditory skills may best characterize the effects of hearing loss and the benefits of amplification.
Funding:

Hearing Industry Research Consortium
Arizona Community Foundation

Colleagues:

Joshua Alexander, Purdue University
Visar Berisha, Arizona State University

Research Assistants (The Pitt Crew):

Elizabeth Stewart  Ian Odgear
Amanda Willman  Tia Mulrooney
Ashley Pederson  Allison Latto
Ethan Light  Laura Chenier
Ali Laubscher  Madalyn Rash