Cognitive Resource Allocation in Children with Hearing Loss

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Cognitive Resource Allocation

Cognitive Demand

LESS

MORE

Speech Repetition
Nonword Repetition
List Repetition
Divided Attention
Reading Span
Rapid Word Learning
Cognitive Resource Allocation

Cognitive Demand

LESS

Speech Repetition
Nonword Repetition
List Repetition
Divided Attention

MORE

Reading Span
Rapid Word Learning
Divided Attention

- Hicks & Tharpe (2002)

Auditory
- Word repetition
- Percent words correct
- Varied signal-to-noise

Visual
- Button pushing
- Reaction time
Divided Attention

- Hicks & Tharpe (2002)

Auditory
- Word repetition
- Percent words correct
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Visual
- Button pushing
- Reaction time

![Diagram showing the relationship between word repetition and reaction time for auditory and visual tasks.](Image)
Divided Attention

• McFadden & Pittman (2008)

Auditory
  Word categorization
  Percent words correct
  Signal-to-noise

Visual
  Dot-to-dot games
  Dots/minute

Person
Food
Animal
Divided Attention

- McFadden & Pittman (2008)

Auditory
- Word categorization
- Percent words correct
- Signal-to-noise

Visual
- Dot-to-dot games
- Dots/minute

Signal-to-Noise Ratio

Word Categorization

Dot Rate
Back to the drawing board...

Rather than asking:

“Does poor speech perception affect performance for other tasks?”

We asked:

“Do other tasks affect speech perception?”
Method

• Subjects
  – 7-12 years of age
  – 24 normal hearing
  – 11 moderate hearing impairment

• Dual task
  – Visual: dot-to-dot games
    • Dots/minute
  – Auditory: word categorization
    • Percent correct
Method

• Subjects
  – 7-12 years of age
  – 24 normal hearing
  – 11 moderate hearing impairment

• Dual task
  – Visual: dot-to-dot games
    • Dots/minute
  – Auditory: word categorization
    • Percent correct
Method

- Conditions

- Dot-to-Dot Games

\[
\begin{align*}
\text{x1} & : 1 & 2 & 3 \\
\text{x2} & : 2 & 4 & 6 \\
\text{x3} & : 3 & 6 & 9
\end{align*}
\]
Method

- Presentation
  - Multitalker babble
  - 6 dB SNR
  - Via earphones
  - Frequency-shaped
  
Word Categorization

- Person
- Food
- Animal
  
the stimuli for the children with hearing loss
Expected Results

Dot Rate

Dot-to-Dot Increment

Word Categorization

Dot-to-Dot Increment

Person
Food
Animal
Results - NHC

Dot Rate

Dot-to-Dot Increment

Word Categorization

Dot-to-Dot Increment

Dot Rate (dots/min)

Categorization (%)

BL  x1  x2  x3
Results - HIC

Dot Rate

Dot-to-Dot Increment

Word Categorization

Dot-to-Dot Increment

![Graph showing Dot Rate (dots/min) with categories BL, x1, x2, x3]

![Graph showing Categorization (%) with similar categories]

- Dot Rate (dots/min)
  - BL
  - x1
  - x2
  - x3

- Categorization (%)
  - BL
  - x1
  - x2
  - x3
Results

Dot Rate

Dot-to-Dot Increment

Dot-to-Dot Increment

Word Categorization

Dot Rate (dots/min)

HIC
NHC

Dot-to-Dot Increment

Categorization (%)

BL x1 x2 x3

Categorization (%)

BL x1 x2 x3
Results

<table>
<thead>
<tr>
<th>NORMAL HEARING</th>
<th>ERRORS</th>
<th>NO RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>x1</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>x2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>x3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>x4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>x5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Results

<table>
<thead>
<tr>
<th>TASK DIFFICULTY</th>
<th>NORMAL HEARING</th>
<th>HEARING LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUMBER OF ERRORS</td>
<td>NO RESPONSE</td>
</tr>
<tr>
<td>BL</td>
<td>x1</td>
<td>x2</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

![Bar chart showing number of errors and no response for varying task difficulties in normal hearing and hearing loss conditions.](chart.png)
Conclusions

• Overall, children with hearing loss perform more poorly on cognitively demanding auditory tasks than children with normal hearing.

• Performance for auditory tasks is a composite of perception and attention.

• The cognitive resources of children with hearing loss may not be sufficient to process as much phonological information as children with normal hearing.