Auditory-Based Learning in Children and Adults with Hearing Loss

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Disclosures

This work was supported by grants from:

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Elizabeth Rainy  Ashley Wright
Amy Stahl  Jacelyn Olson
(and many more)

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Ravi Sockalingam – Oticon Medical, US
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Learning something new

Vocabulary Learning and Hearing Loss

Air-Conduction Hearing Device Applications

- Oticon miniAlta RITE

- 21 children with SN hearing loss (8-12 years)


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Bone-Anchored Hearing Device Applications

Conventional Skin-Drive  Percutaneous Direct-Drive

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# Bone-Anchored Hearing Device Applications

<table>
<thead>
<tr>
<th>Authors</th>
<th>Configuration</th>
<th>Subjects</th>
<th>Speech Perception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kara et al (2016)</td>
<td>Abutment vs. Softband</td>
<td>Adults and Children</td>
<td>Significant*</td>
</tr>
<tr>
<td>Verstraeten et al (2009)</td>
<td>Abutment vs. Softband</td>
<td>Adults</td>
<td>Abutment +10% better</td>
</tr>
<tr>
<td>Hol et al (2013)</td>
<td>Abutment vs. Magnet</td>
<td>Children</td>
<td>Abutment +7% better</td>
</tr>
</tbody>
</table>
To determine if the benefit of direct stimulation is limited to small improvements in speech perception or if direct stimulation also improves performance for auditory processes important for learning new information.
Method

Participants

17 children
10 boys, 7 girls
7 – 15 years
Method

Participants

17 children
10 boys, 7 girls
7 – 15 years

14 bilateral conductive
1 unilateral conductive
2 unilateral profound
Method

Participants

17 children
10 boys, 7 girls
7 – 15 years

14 bilateral conductive
1 unilateral conductive
2 unilateral profound
Method

Fitting & Testing

Direct Drive

Skin Drive

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Method

Verification

Interacoustics Affinity Hearing Aid Analyzer with SHS10 Skull Simulator
Method

Verification

![Graph showing force (µN) vs. frequency (kHz) for Skin Drive and Direct Drive, with a bar chart showing the difference (Skin-Direct) at various frequencies.](image)
Method

Verification

Aided Sound-Field Thresholds

- Skin Drive
- Direct Drive

Difference (Skin-Direct)
Method

Test Parameters
50 dB SPL in quiet
0° azimuth

Data Collection
Computer interface
Digital audio recordings
Test Battery

Word Recognition: How well they can recognize words they already know

Lexical Decision: How well they can recognize words they don’t know

Non-Word Detection: How well they can detect words they don’t know in context

Rapid Word Learning: How rapidly they can learn new words
Word Recognition

NU-6 Word Lists (25) words

Oticon miniAlta RITE

21 children with SN hearing loss (8-12 years)


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Word Recognition

Direct stimulation improved perception of familiar words.

<table>
<thead>
<tr>
<th></th>
<th>Direct</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>79%</td>
<td>72%</td>
</tr>
<tr>
<td>SD</td>
<td>6%</td>
<td>8%</td>
</tr>
<tr>
<td>N</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

F(1,15) = 10.014, \( p = .006 \), N = .40

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Auditory Lexical Decision

<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>
Auditory Lexical Decision

Direct stimulation improved children’s lexical decisions.

<table>
<thead>
<tr>
<th></th>
<th>Direct</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>72%</td>
<td>59%</td>
</tr>
<tr>
<td>SD</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>N</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

\[ F(1,15)=11.948, \ p=.004, \ N=.44 \]
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>
Non-Word Detection 2.0

23 children with SN hearing loss (8-17 years)


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Non-Word Detection 2.0

Direct stimulation did NOT improve detection of unfamiliar words in context.

<table>
<thead>
<tr>
<th></th>
<th>Direct</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.41</td>
<td>1.18</td>
</tr>
<tr>
<td>SD</td>
<td>0.95</td>
<td>1.08</td>
</tr>
<tr>
<td>N</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

F(1,16)=1.975, p=.179, N=.11
Rapid Word Learning

Learning something new

PERFORMANCE (% Correct)

$P_c = 1 - 0.80e^{-n/c}$

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

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Rapid Word Learning

Oticon miniAlta RITE

21 children with SN hearing loss
20 children with normal hearing (8-12 years)

Direct stimulation significantly improved the speed of word learning.

<table>
<thead>
<tr>
<th></th>
<th>Direct</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.22</td>
<td>.78</td>
</tr>
<tr>
<td>SD</td>
<td>.21</td>
<td>.16</td>
</tr>
<tr>
<td>N</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

F(1,15)=7.694, p=.014, N=.34

Trials 60 166
What have we learned?

Detecting and learning new words is...

... more challenging than recognizing familiar words

... independent of the type of amplification device

... determined by the quality of the auditory input
Thank you