Maximizing Cochlear Implant Benefits with Short-term AR Intervention

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Purpose

- To evaluate the effectiveness of training to improve outcomes for adult cochlear implant (CI) users.

- Specifically, to provide evidence of benefits resulting from short-term aural rehabilitation (AR) in a randomized controlled clinical trial.
Cochlear Implants & Communication Function

- Increasing numbers of adults receiving CIs and many are achieving high levels of speech perception (Dowell, 2012; Fabry et al., 2009; Gifford et al., 2008; Krueger et al., 2008).

However, a proportion of adults still struggle in daily life and seek greater communication competency.

- CI does not resolve all communication issues. Residual issues can negatively impact psychosocial function and quality of life (Helvik et al., 2006).

- Some individuals demonstrate limited outcomes, as shown by poor speech recognition and/or evidence of significant hearing handicap. Others have good speech recognition, but not sufficient to meet the communication demands of their daily life.
Role of AR and Neuroplasticity

- AR can be key to overcome and resolve communication and adjustment issues, and maximize the benefit they receive from their implant (Boothroyd, 2010; Fu & Galvin, 2008; Green, 2008; Pedley et al., 2005).

- Role of neuroplasticity- CI users develop new neural connections (Green et al., 2008; Neuman, 2005; Russo et al., 2005). Greater improvement in first year, but neuroimaging studies suggest plasticity continues longer (Fallon et al. 2008; Merabet & Pascual-Leone, 2010; Tobey et al., 2005).

- Thus an extended window of opportunity to improve performance when enhanced by AR, especially auditory training.
Auditory Training Outcomes

- Renewed interest in auditory training to improve speech recognition (Burk & Humes, 2008; Miller et al; 2008; Stacey et al., 2010; Sweetow & Sabes, 2007).

- Role of auditory experience, especially focused auditory training, may be key to maximize functional outcomes in CI users (Boothroyd, 2010; Fu & Galvin, 2008; Tobey et al., 2005).

- Systematic review of evidence-based practice in audiology, Sweetow & Palmer (2005), Brouns et al. (2011) and more recently, Chisolm & Arnold, in Wong & Hickson book (2012) cite evidence in support of benefits of auditory training, but recommend that future studies include a control group in order to establish the efficacy of training.
<table>
<thead>
<tr>
<th>Participant Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thirty post-lingually deafened CI users.</td>
</tr>
<tr>
<td>Three months to three years post-activation.</td>
</tr>
<tr>
<td>Sentence recognition between 10%-85% (CasperSent).</td>
</tr>
<tr>
<td>Speech Tracking rate &gt;20 wds/min</td>
</tr>
<tr>
<td>No AR therapy post-implantation.</td>
</tr>
<tr>
<td>English speaking.</td>
</tr>
<tr>
<td>Normal cognitive function.</td>
</tr>
</tbody>
</table>
Timeline

Session 1
Pre-Assessment

Session 2-7
AR Group
Control Group

Session 8
1 week Post-Assessment

Session 9
2 month Post-Assessment

Session 10
6 month Post-Assessment
## Treatment Protocol

<table>
<thead>
<tr>
<th>Aural Rehabilitation Group (AR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informational Counseling</td>
</tr>
<tr>
<td>CI orientation</td>
</tr>
<tr>
<td>Hardware</td>
</tr>
<tr>
<td>Assistive listening devices</td>
</tr>
<tr>
<td>Telephone use</td>
</tr>
<tr>
<td>Communication Strategies Training</td>
</tr>
<tr>
<td>Auditory Training</td>
</tr>
<tr>
<td>Sentence identification</td>
</tr>
<tr>
<td>Vowel and consonant contrasts</td>
</tr>
<tr>
<td>KTH Speech Tracking</td>
</tr>
</tbody>
</table>
## Treatment Protocol

### Cognitive Training Group (CT)

**Cognitive Training Exercises**
- Spot the Difference
- Crossword Puzzles
- Ken-Ken
- Word Searches
- Sudoku

**Choice of 3 activities**
## Outcome Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>CasperSent Sentence Recognition (Boothroyd, 2008)</td>
<td></td>
</tr>
<tr>
<td>Hearing Handicap Inventory (HHIE/A)</td>
<td>(Ventry &amp; Weinstein, 1982; Newman et al., 1990)</td>
</tr>
<tr>
<td>Client Oriented Scale of Improvement (COSI)</td>
<td>(Dillon et al., 1977)</td>
</tr>
<tr>
<td>Nijmegen Cochlear Implant Questionnaire (NCIQ)</td>
<td>(Hinderink et al., 2000)</td>
</tr>
</tbody>
</table>
AR Group: Speech Tracking for 30 5-minute trials over six sessions (N=8)
Sentence Recognition Pre and Post Intervention (N=8)

*Post-6 Month (N=6)
<table>
<thead>
<tr>
<th>Participant</th>
<th>Pre-Treatment</th>
<th>Post 1 Week</th>
<th>Post 2 Month</th>
<th>Post 6 Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT01</td>
<td>83.5</td>
<td>79.3</td>
<td>80.0</td>
<td>78.3</td>
</tr>
<tr>
<td>CT02</td>
<td>36.7</td>
<td>37.0</td>
<td>36.3</td>
<td>------</td>
</tr>
<tr>
<td>CT03</td>
<td>21.5</td>
<td>20.5</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>CT04</td>
<td>59.3</td>
<td>61.7</td>
<td>------</td>
<td>------</td>
</tr>
</tbody>
</table>

**Individual CasperSent Scores**

Pre and Post-Treatment for CT Group Participants
CasperSent Change Post-Training

Mean Improvement in Percent

Post 1 Week: AR Group (N=8)
N=6 at 6 months
CT Group (N=4)
N=2 at 2 months

Post 2 Months: CasperSent Change Post-Treatment Percent Change Scores

Post 6 Months: 18.1

CasperSent Post 1 Week
18.6
CT Group (N=4)
N=2 at 2 months

CasperSent Post 2 Months
13.3
CT Group (N=4)
N=2 at 2 months

CasperSent Post 6 Months
13.3
CT Group (N=4)
N=2 at 2 months
HHIE/A: CT Group

Pre and Post Treatment Scores (N=4)

*Post-2 Month (N=2)

- Pre-Treatment
- Post-1 Week
- Post-2 Month

<table>
<thead>
<tr>
<th>Category</th>
<th>Pre-Treatment</th>
<th>Post-1 Week</th>
<th>Post-2 Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional</td>
<td>30</td>
<td>34.5</td>
<td>64.5</td>
</tr>
<tr>
<td>Social Situational</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>64.5</td>
</tr>
</tbody>
</table>

*Post-2 Month (N=2)
Emotional Social Situational Total

HHIE/A: AR Group

Pre- and Post-Treatment Scores (N=8)

*Post-6 Month (N=6)
Goal 1

Pre and Post Treatment Listening Ability Scores (N=4)

* Post 2-Month (N=2)
Goal 1

% Time can hear satisfactorily

Pre and Post Treatment Listening Ability Scores (N=8)

*Post-6 Month (N=6)
NCIQ: CT Group

Pre and Post Treatment Scores (N=4)
*Post-2 Month (N=2)
NCIQ: AR Group

AR Group: Pre and Post-Treatment Scores (N=8)
*Post-6 Month (N=6)
Summary of Preliminary Findings: Speech Recognition Measures

CT Group
- Participants showed no improvement in sentence recognition following training.

AR Group
All participants showed improved speech recognition post-training (from 6.5% to 28.3%).
Mean improvement post-training was
- 18.1% at one week post-training
- 18.6% at two months post
- 13.3% at six months post
Summary of Preliminary Findings: Psychosocial Measures

CT Group

• Minimal improvement was seen on the COSI.
• Minimal improvement basic speech domains, but none in psychosocial function (NCIQ).
• No reduction in self-perceived hearing handicap (HHIE/A).

AR Group

• Improvement seen in personal goals (COSI).
• Improvement seen in social participation, self-assessed communication, and psychosocial function (NCIQ).
• Reduction of self-perceived hearing handicap (HHIE/A).
### Who Can Benefit from Training?

<table>
<thead>
<tr>
<th>Participant</th>
<th>Initial Score</th>
<th>Mean Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR04</td>
<td>78.5</td>
<td>17.2</td>
</tr>
<tr>
<td>AR03</td>
<td>75.0</td>
<td>10.7</td>
</tr>
<tr>
<td>AR01</td>
<td>71.5</td>
<td>20.9</td>
</tr>
<tr>
<td>AR08</td>
<td>67.25</td>
<td>15.25</td>
</tr>
<tr>
<td>AR07</td>
<td>57.3</td>
<td>24.7</td>
</tr>
<tr>
<td>AR06</td>
<td>32.5</td>
<td>28.0</td>
</tr>
<tr>
<td>AR05</td>
<td>30.0</td>
<td>22.9</td>
</tr>
<tr>
<td>AR02</td>
<td>28.5</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Individual CasperSent Scores
Pre and Post-Treatment in Descending Initial Performance Order.
Preliminary Conclusions

• Study contributes to the body of evidence that informs clinical practice of AR

• AR intervention contributed to increased speech recognition and to self-perceived improvement in psychosocial function

• This preliminary data suggests that short-term AR can maximize outcomes for adult CI users
Acknowledgements

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* Hearing Loss Association of America
* Hearing and Speech Agency of Baltimore
* Northern Virginia Resource Center for Deaf and Hard of Hearing

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<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Device</th>
<th>Etiology</th>
<th>Time Post-Activation</th>
<th>Duration of Profound HL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR01</td>
<td>65</td>
<td>Female</td>
<td>Cochlear Nucleus 5</td>
<td>Familial</td>
<td>5 months</td>
<td>2 years</td>
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<tr>
<td>AR02</td>
<td>77</td>
<td>Female</td>
<td>Cochlear Freedom</td>
<td>Unknown</td>
<td>1 year, 4 mos</td>
<td>37 years</td>
</tr>
<tr>
<td>AR03</td>
<td>58</td>
<td>Female</td>
<td>MED-EL Opus 2</td>
<td>Turner’s syndrome</td>
<td>1 year, 4 months</td>
<td>8 years</td>
</tr>
<tr>
<td>AR04</td>
<td>56</td>
<td>Male</td>
<td>Cochlear Nucleus 5</td>
<td>Noise-induced</td>
<td>4 months</td>
<td>2 years</td>
</tr>
<tr>
<td>AR05</td>
<td>67</td>
<td>Female</td>
<td>Cochlear Freedom</td>
<td>Familial</td>
<td>3 months</td>
<td>17 years</td>
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<tr>
<td>AR06</td>
<td>64</td>
<td>Male</td>
<td>AB Harmony</td>
<td>Meningitis</td>
<td>11 months</td>
<td>61 years</td>
</tr>
<tr>
<td>AR07</td>
<td>73</td>
<td>Female</td>
<td>Cochlear Nucleus 5</td>
<td>Familial</td>
<td>9 months</td>
<td>10 years</td>
</tr>
<tr>
<td>AR08</td>
<td>61</td>
<td>Female</td>
<td>AB Harmony</td>
<td>Auto-immune</td>
<td>4 months</td>
<td>8 years</td>
</tr>
<tr>
<td>CT01</td>
<td>59</td>
<td>Female</td>
<td>Cochlear Nucleus 5</td>
<td>EVAS</td>
<td>5 months</td>
<td>45 years</td>
</tr>
<tr>
<td>CT02</td>
<td>55</td>
<td>Female</td>
<td>MED-EL Opus 2</td>
<td>Meniere’s</td>
<td>4 months</td>
<td>3 years</td>
</tr>
<tr>
<td>CT03</td>
<td>68</td>
<td>Female</td>
<td>MED-EL Opus 2</td>
<td>Familial</td>
<td>11 months</td>
<td>1 year, 9 months</td>
</tr>
<tr>
<td>CT04</td>
<td>50</td>
<td>Female</td>
<td>MED-EL Opus 2</td>
<td>High Fever</td>
<td>8 months</td>
<td>34 years</td>
</tr>
</tbody>
</table>