Performance and Subjective Benefit from a Digital CROS/BiCROS Instrument

Nicolle Baldus, Miranda D’Souza, Katherine Algier, Margaret Hill, Paige Whitley, & Erin C. Schafer,
University of North Texas, Department of Speech and Hearing Sciences

Introduction

Management strategies for patients with single-sided deafness or asymmetrical hearing loss range from non-invasive, low-risk approaches including CROS/BiCROS hearing instruments and FM systems to more invasive surgical procedures including bone anchored hearing aids (BAHA) or cochlear implants. Most of the previous research on CROS/BiCROS hearing instruments utilized analog technology and showed low satisfaction (e.g., Hartgerink & Botti, 1986). The largest CROS/BiCROS study of 31 participants focused on return rates and showed high satisfaction with digital instruments; however, limited subjective information was collected from this group of participants (Bennett et al., 2006). In studies that compared the benefits of analog CROS and BiCROS instruments, speech recognition performance was equal to the BAHA (Dobson et al., 2003) or better with the BAHA (Bennett et al., 2006; Lin et al., 2004; Wazen et al., 2003). In most of these studies, a preference was found for the BAHA, but the BAHA was always the final condition tested in each study. Given the limited subjective reports about the potential benefits of CROS/BiCROS hearing instruments in previous research as well as the advancements in digital signal processing, the goal of the present study was to assess the efficacy and effectiveness of wireless digital CROS and BiCROS hearing instruments.

Methods

Participants: Participants met the following inclusion criteria:
- CROS Group - Adults or adolescents (≥14 years) who have severe/profound sensorineural hearing loss in one ear with normal hearing in the opposite ear
- BiCROS Group - Adults or adolescents (≥14 years) who have severe/profound sensorineural hearing loss in one ear with a lesser degree of sensorineural hearing loss in the opposite ear

Table 1 provides the demographic information for the 12 adults in the CROS group and 14 adults in the BiCROS group; figure 1 provides average audiograms for each group.

CROS Participants

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Gender</th>
<th>Hearing in Better Ear</th>
<th>Hearing in Poorer Ear</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>M</td>
<td>20 dB HL</td>
<td>60 dB HL</td>
</tr>
<tr>
<td>33</td>
<td>F</td>
<td>20 dB HL</td>
<td>60 dB HL</td>
</tr>
<tr>
<td>29</td>
<td>M</td>
<td>20 dB HL</td>
<td>70 dB HL</td>
</tr>
<tr>
<td>35</td>
<td>F</td>
<td>20 dB HL</td>
<td>50 dB HL</td>
</tr>
<tr>
<td>30</td>
<td>M</td>
<td>20 dB HL</td>
<td>80 dB HL</td>
</tr>
<tr>
<td>38</td>
<td>F</td>
<td>20 dB HL</td>
<td>50 dB HL</td>
</tr>
<tr>
<td>31</td>
<td>M</td>
<td>20 dB HL</td>
<td>60 dB HL</td>
</tr>
<tr>
<td>34</td>
<td>F</td>
<td>20 dB HL</td>
<td>70 dB HL</td>
</tr>
<tr>
<td>32</td>
<td>M</td>
<td>20 dB HL</td>
<td>60 dB HL</td>
</tr>
<tr>
<td>42</td>
<td>F</td>
<td>20 dB HL</td>
<td>70 dB HL</td>
</tr>
<tr>
<td>36</td>
<td>M</td>
<td>20 dB HL</td>
<td>50 dB HL</td>
</tr>
<tr>
<td>38</td>
<td>F</td>
<td>20 dB HL</td>
<td>60 dB HL</td>
</tr>
</tbody>
</table>

CROS Group Audiograms

- Figure 1 provides average audiograms for each group.

CROS Results

- Average participant ratings for the 3 listening situations shown in Figure 5
- Average participant ratings on a scale from 0 to 99
- 0% = not at all able to do or experience what was described
- 100% = perfectly able to do or experience what was described

- Significant improvement in ability for speech hearing (p < .05)
- Significant improvement in ability for spatial hearing (p < .05)
- Significant improvement in quality of hearing (p < .05)

CROS results for SSQ

- Average participant ratings for the 3 subscales shown in Figure 3
- Participants provided ratings on a scale from 0 to 99
- 0% = not at all able to do or experience what was described
- 100% = perfectly able to do or experience what was described

- Wilcoxon Signed Rank Test for Difference in Medians:

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>Fine</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Poorly</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>

CROS results for APHAB

- Average participant ratings for the 4 subscales shown in Figure 4
- Participants provided ratings on a scale from 0 to 99
- 0% = not at all able to do or experience what was described
- 100% = perfectly able to do or experience what was described

- Significant improvement in functioning in social situations (p < .05)
- Significant improvement in noise (p < .05)
- Significant improvement in ability to hear (p < .05)
- Significant improvement in ability to function (p < .05)

CROS results for APS-SSD

- Average participant ratings for the 4 listening situations shown in Figure 6
- Participants provided ratings on a scale from 0 to 99
- 0% = not at all able to do or experience what was described
- 100% = perfectly able to do or experience what was described

- Significant improvement in ability for speech hearing (p < .05)
- Significant improvement in ability for spatial hearing (p < .05)
- Significant improvement in quality of hearing (p < .05)

CROS results for BKB-SIN

- Data (Figure 7) were analyzed with a repeated measures ANOVA, post-hoc Tukey Kramer Multiple Comparison Tests

- %BKB-SIN: significant effect of condition, no significant effect of CROS, and significant interaction effect

BKB-SIN Results

- Post-hoc analyses:
- significant effect of CROS
- significant effect of condition

BKB-SIN APHAB Results

- Data (Figure 8) were analyzed with a repeated measures ANOVA, post-hoc Tukey Kramer Multiple Comparison Tests

- BKB-SIN: significant effect of condition, no significant effect of CROS, and no significant interaction effect

BKB-SIN APS-SSD Results

- Data (Figure 9) were analyzed with a repeated measures ANOVA, post-hoc Tukey Kramer Multiple Comparison Tests

- BKB-SIN: significant effect of condition, no significant effect of CROS, and no significant interaction effect

Summary & Discussion

Following a trial period, the digital CROS/BiCROS hearing instruments provided significant improvements in fixed-intensity speech perception in noise performance and subjective ratings of participants relative to an unaided condition. Participants reported significantly improved hearing with the instruments, which provided a louder, clearer, and more salient signal in various environments. Given the lower cost and ease of use associated with the CROS/BiCROS device as compared to surgical implants, the CROS/BiCROS should be considered as a first step in the management of individuals with single-sided deafness or asymmetrical hearing loss. When evaluating the benefit of CROS/BiCROS instruments, subjective questionnaires may be more sensitive for determining patient benefit than speech recognition measures in noise.

References


Figure 1: Average audiograms for each group.