LOCALIZATION TRAINING FOR CROS HEARING AID USERS

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ABOUT THE PRESENTER

I have the following financially relevant relationships in the service and/or product communicated, compared, evaluated and/or reviewed in this presentation.

Employee – Widex – Office of Research in Clinical Amplification
Lisle, IL
ABOUT THE PRESENTER

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- Bachelor of Science and Doctor of Audiology from University of Illinois at Urbana-Champaign
- Research Audiologist at the Widex Office of Research in Clinical Amplification – Lisle, IL
- Previously clinical audiologist in Chicago area
WHAT WILL WE DISCUSS?

- Unilateral/Asymmetrical hearing loss
- CROS/BiCROS hearing aids
- Widex CROS Dex
- Widex ORCA CROS Study
  - Localization training
UNILATERAL/ASYMMETRICAL HEARING LOSS

- Binaural advantages:
  - Binaural squelch
  - Binaural summation
  - Relief from head shadow effect

- Loss of binaural advantages leads to difficulty understanding speech in noise and localization of sounds.
UNILATERAL/ASYMMETRICAL HEARING LOSS

- When there is enough hearing loss, traditional hearing aids may not be appropriate
  - Profound hearing loss
  - Very poor word recognition abilities
  - Distortion
WHAT DO WE DO NOW?

- **Contralateral Routing of Signals (CROS)**
  - One ear is unaidable
  - The other ear is normal/does not require amplification

- **Bilateral Contralateral Routing of Signals (BiCROS)**
  - One ear is unaidable
  - The other ear requires amplification
BINAURAL ADVANTAGES AND CROS

- Loss of binaural squelch leads to greater challenge understanding speech in noise
- Loss of binaural summation decreases the perceived loudness
- The head shadow results in loss of high frequency audibility

- CROS/BiCROS does *not* restore binaural cues

- CROS/BiCROS *does* provide audibility for sounds originating on the poorer side
CROS DEX

- Widex CROS DEX uses Widexlink, an efficient bit-true transmission with 25 kHz sampling rate
- Long-lasting battery life (0.89 mA) during transmission
- The transmitter allows for either omnidirectional or directional microphone
CROS DEX

- The CROS DEX features a volume control and an on/off switch located on the transmitter.
- These features allow the user more control over the transmitted signal.
- These controls can aid speech understanding in noise and localization.
MODELS AND COMPATIBILITY

- Receiving hearing aids: all UNIQUE models
Preliminary CROS studies
CROS BENEFIT: SPEECH TO POOR EAR IN QUIET (ORCA-NST TEST)
CROS BENEFIT: SPEECH TO POOR EAR IN SURROUND NOISE (HINT)
CROS BENEFIT FOR SPEECH

- The CROS has been shown to provide benefits, including speech understanding in quiet and noise
- 10% increase in consonant scores in quiet compared to unilateral fitting
- 5 dB SNR improvement for speech in noise comparing BiCROS to unilateral fitting
We can improve speech, but what about localization?
WHY IS LOCALIZATION IMPORTANT?

- Safety
- Spatial feeling – externalization – 3D hearing
- Listening experience (i.e. bird watching)
- Source identification
- Potential improvement of speech understanding in noise
  - Complaints such as “I have difficulty hearing in noise” may mean “I have difficulty hearing in noise because I do not know who is talking to me” (from a distance)
  - Being able to locate the source of a speaker in a crowded place and pair visual cues may improve intelligibility/communication in noise
  - Focus attention (e.g., Kidd et al (2005))
  - More relaxed hearing
- Localization and speech in noise may be linked somehow (Hirsch, 1950; Noble et al, 1995; Potts et al, 2009; Ching, 2004)
LOCALIZATION REVIEW

- Horizontal - Left-Right – depends on interaural differences
  - Interaural level or intensity difference (ILD) for sounds above 1500 Hz
  - Interaural time difference (ITD) for sounds below 1500 Hz
- Horizontal - front-back – depends on spectral cues
  - Pinna shadow provides spectral differences
- Head movement by listener helps to identify source location
- Visual cues helps localization
LOCALIZATION WITH CROS

- What happens to localization ability with a CROS/BiCROS?

- Should localization ability improve with the CROS?

- What if localization does not improve? What now?

- Do we have tools to improve localization ability?
CROS/BICROS STUDY - PARTICIPANTS

- 9 participants (6 female, 3 male)
- Varying etiologies (idiopathic, Meniere’s, et al)
- Most participants had no previous CROS experience
- All participants were BiCROS fittings
LOCALIZATION WITH CROS

- **Aidable ear side**
- **Unaidable ear side**
- **Front**
- **Back**

Localization Accuracy (%)

![Graph showing localization accuracy under different hearing aid conditions: Unaided, Aided, BiCROS fixed. The graph compares the accuracy on the aidable ear side, unaidable ear side, front, and back.](graph.png)
LOCALIZATION WITH CROS

- Poorer localization performance with CROS compared to unaided and unilateral aided condition

- Why did performance decrease?
  - CROS eliminates shadow, resulting in all sounds heard in the aidable ear at the same or very similar level
  - i.e. sounds from the right and the left sound very similar
LOCALIZATION WITH CROS

- What happens to localization ability with a CROS/BiCROS?
- Should localization ability improve with the CROS?
- What if localization does not improve? What now?
- Do we have tools to improve localization ability?
RATIONAL FOR TURNING OFF THE CROS

- Turn off the CROS???
- The CROS introduces a potential limitation in localization
- Selective deactivation of the CROS may introduce a level difference, particularly for left-right localization

- For example –
  - Right ear unaidable; left ear aidable
  - Repetitive signal at right ear → CROS transmitter
  - The signal is heard in the left ear
  - If the CROS is turned off, the signal should be heard at a lower level than before
    - Sound must now overcome head shadow instead of being transmitted
ARRANGEMENT FOR LEFT/RIGHT DISCRIMINATION
ADJUSTING THE CROS CONTROLS

- Action: Turn OFF the CROS microphone
- Ask: Is there a change to the sound loudness?
- Answers:
  - NO, same loudness – sound from HA side
  - NO, or slightly softer – sound from front/back.
  - YES, can’t hear sound or very soft – sound from CROS mic side
- Practice until familiar
LOCALIZATION BICROS WEARERS

- Aidable ear side
- Unaidable ear side
- Front
- Back
- Aidable (2-direction)
- Unaidable (2-direction)

Localization Accuracy (%)

Hearing Aid Conditions

- Unaided
- Aided
- BiCROS fixed
- BiCROS adjust

Localization Accuracy (%)
LOCALIZATION BI-CROS WEARERS

- Aidable ear side
- Unaidable ear side
- Front
- Back
- Aidable (2-direction)
- Unaidable (2-direction)

Localization Accuracy (%)

Hearing Aid Conditions

- Unaided
- Aided
- BiCROS fixed
- BiCROS adjust

Localization Accuracy (%) vs Hearing Aid Conditions
RESULTS

- Approximately 80-90% localization accuracy for adjusted BiCROS condition for left-right only condition

- Training can be completed during a single appointment – 10 minutes

- Training can incorporate many devices that are used in the clinic (i.e. audiometer, sound field loudspeakers, computers, desktop speakers)
ON/OFF FOR SPEECH UNDERSTANDING IN NOISE

- When noise is concentrated to the side of the CROS transmitter, and speech is to the side of the receiver

- The CROS transmits noise, which interferes with the speech signal that was already entering the better ear
ON/OFF FOR SPEECH UNDERSTANDING IN NOISE

- By turning off the CROS transmitter when noise is to the side of the transmitter, one could avoid having the unwanted noise interfere with the already available speech signal.
- Participants practiced turning the CROS on and off, and learned when to turn off the device when appropriate.
  - This process was learned in 5-10 minutes.
DEMONSTRATION
SPEECH IDENTIFICATION (NU-6) UNDER VARIOUS CONDITIONS

- Unaided
- Aided (good)
- CROS fixed
- CROS adjust

Conditions:
- Speech poor ear
- Speech good ear
- Speech front
- Speech poor ear quiet
- Speech good ear quiet
Will my patients actually use the controls??
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. How often do you turn off the CROS?</td>
<td>A: Three or more times each day</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>B: Once or twice each day</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>C: Three or more times during the week, but changes are not made every day</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>D: Once or twice during the week</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>E: Never</td>
<td>1</td>
</tr>
<tr>
<td>Question</td>
<td>Response</td>
<td>Frequency</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
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</tr>
<tr>
<td>4. When do you turn off the CROS?</td>
<td>A When sounds are too loud</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>B When sounds are too soft</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>C When speech is to the side of my good ear</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>D When noise is to the side of my good ear</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>E When speech is to the side of my bad ear</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>F When noise is to the side of my bad ear</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>G When speech is not clear</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>H When I can't tell where sound is coming from</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>I Other—“Driving with window down”</td>
<td>1</td>
</tr>
</tbody>
</table>
**One study participant did not use hearing aids on her own**
CONCLUSIONS

- CROS/BiCROS does not restore true binaural hearing, but it does provide audibility for sounds originating from the CROS side that were previously unavailable.
- Improvements in speech understanding in quiet and noise have been documented using the CROS.
- A CROS device on its own may be very helpful, but the CROS can be enhanced with a convenient on/off switch and volume control located on the transmitter.
- Use of these on-board controls can improve speech understanding in noise and localization performance for those using the device compared to the CROS device without use of the controls.
CONCLUSIONS

- **Training** can not be overlooked
- A simple, office-based training can be completed in 5 to 10 minutes
- Common clinical equipment (audiometer, sound field loudspeakers, CD player, computer, desktop speakers) can be used
- If the patient can experience the difference in loudness between the CROS on and off, they may be more likely to use the functionality
  - There is a wealth of information provided to patients during a fitting
  - Remembering why we want them to turn off the CROS may be lost unless they experience the effect
QUESTIONS??

Thank you!!

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