Wireless Hearing Assistance Technologies for Bimodal Users

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Hearts for Hearing
The Problem

• Bimodal users (cochlear implant on one ear and a hearing aid on the other) experience difficulty with:
  – Understanding speech in noise.
  – Understanding speech in reverberant environments.
  – Understanding speech from a distance.
  – Understanding speech on the telephone.

• Hearing assistance technologies may help but may be challenging to use because of cost or inconvenience.
Study Objectives

• Purpose:
  – Evaluate performance of bimodal users
    • CI sound processor (Nucleus 6) and hearing aid (Resound LiNX) designed to simultaneously receive audio streaming from accessory devices
  – Evaluate benefit obtained from the use of wireless audio streaming accessories.
Subjects

- 16 Adults
  - Age
    - Range: 22-89
    - Mean: 70.7
  - Full-time users of unilateral CI and hearing aid
    - Nucleus CI24R, CI24RE, CI422, and CI512
    - Participants used a variety of BTE hearing aids prior to study.
  - Duration of Hearing Loss: 31.2 years
  - Duration of Severe to Profound Hearing Loss: 5.4 years
Equipment

Nucleus 6 Sound Processor (CI920)

Resound LiNX BTE

Cochlear Mini Mic

Cochlear Phone Clip+
Equipment

• Nucleus 6 sound processor programmed with participant’s program:
  – ASC+ADRO
  – 2:1 Accessory Mixing Ratio
  – 3:1 Telecoil Mixing Ratio
  – Volume Control set to participant’s MCL

• Cochlear Mini Mic at default setting.
Assessment – Mini Mic

• Measured sentence recognition in **quiet** and in **noise**, with and without Cochlear Mini Mic:
  – AzBio Sentences (Spahr et al., 2012).
    • Presentation Level:
      – 85 dBA at Mini Mic (6 inches from loudspeaker used to present sentences)
      – 65 dBA at location of participant.
  – Uncorrelated Classroom Noise (Schafer & Thibodeau, 2006)
    • Quiet & Noise at 55, 60, 65, 70, and 75 dBA
    • Noise level identical at Mini Mic and at subject location
  – One list per condition (20 Sentences):
    • HA Only, CI Only, Bimodal.
    • With and without Mini Mic.
Equipment Setup

[Diagram showing equipment setup with distances indicated: 24 ft, 8 in, 17 ft, 6 in, 15 ft, 6 in, 8 ft, 6 in, 25 ft, 3 in]
Assessment – Phone Clip+

• Measured word recognition in quiet and in noise with and without Cochlear Phone Clip+
  – Recorded CNC Words (Lehiste & Peterson, 1962)
    • Presentation Level: Set telephone volume to MCL.
  – Uncorrelated Classroom Noise (Schafer & Thibodeau, 2006)
    • Quiet & Noise at 65 dBA.
    • Noise level measured at subject location.

– One full list (50 words) per condition in quiet and in noise:
  • Telephone held next to microphone of Nucleus 6 sound processor
  • Phone Clip+ streaming signal to Nucleus 6 and Resound Linx BTE
Telephone Equipment

- iPhone 4S
- Cochlear Phone Clip+
Equipment Setup

Ambient Noise Level: 44 dBA  
Reverberation (RT60): 0.6 sec
Results
Sentence Recognition in Quiet – No Mini Mic

- Resound Linx
- Nucleus 6
- Bimodal

8% points
Sentence Recognition in Noise – No Mini Mic

Approximately 15% point bimodal improvement in noise
Mini Mic in Quiet

Sentence Recognition in Quiet – Mini Mic On

- Resound Linx
- Nucleus 6
- Bimodal

6% points
Mini Mic in Noise

Sentence Recognition in Noise – Mini Mic On

Bimodal benefit in noise ranges from 10-25%
Bimodal – Mini Mic Off vs. On

Sentence Recognition with Nucleus 6 & Resound Linx – Mini Mic Off vs. On

Mini Mic improvement in noise approaches 60% with bimodal
Telephone Assessment
Telephone Assessment – Phone Clip+

CNC Word Recognition – Nucleus 6 vs. Bimodal Phone Clip+

20-25% point improvement with Phone Clip+
Music Appreciation – Nucleus 6 vs. Bimodal Phone Clip+

- **Sound Quality**
- **Ease of Listening**
- **Lyric Recognition**

- Hearing Aid
- Cochlear Implant
- Bimodal
Conclusions

• Bimodal use results in better speech recognition than CI use alone.

• Bimodal users achieve significantly better sentence recognition in quiet and in noise with the Mini Mic audio streaming accessory.

• Bimodal users achieve significantly better speech recognition on the telephone with use of the Phone Clip +.

• Music appreciation improves with bimodal use and wireless audio streaming.
Thank you for your attention!