Taking CI Recipients to the Next Level with Hearing Assistance Technology

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The Hearts for Hearing Team

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From Good to Great!

All too often, good is the enemy of great. – Jim Collins
Good!

HINT % Correct in Quiet

- Adults - Normal Hearing: n = 20
- Cochlear Implant Users: n = 20
But not Great!

Most adult CI users need at least a 10 to 15 dB SNR to hear well in noise.
Good but not Great

17% decline from Soundfield (60 dBA) to Landline Telephone

CNC Words (% Correct)
Real-Life Impact

• Struggle to hear in social and occupational interactions
  – Restaurants/Family Dinners
  – Meetings
  – Travel
  – Multiple talkers
  – Social Outings, Church, etc.
  – Telephone
  – Television

• Withdrawal, Depression, Dementia, Deterioration of Fitness

• The Answer?
  – Hearing Assistance Technology – Why not for adults?
Road Map

• Hearing Assistance Technology
  – Contemporary Considerations

• Wireless Radio Frequency Systems

• Induction Technologies
Hearing Assistance Technology

• Hearing Assistance Technology
  – Devices or technologies that are beyond the function of a conventional hearing aid or CI processor and that help a person with hearing loss to function better in daily situations.

• Considerations
  – Noisy and reverberant environments
  – Telephone
  – Television
  – Multiple talkers
  – Signal of interest originates from a distance
Hearing Assistance Technology

• Mode of Operation
  – Radio Frequency Technology
    • FM technology
    • Digital RF
      – 900 MHz
      – Bluetooth (2.4 GHz)
      – Proprietary System (2.4 GHz)
    • Combination of digital RF & near-field inductive systems
  – Induction/Inductive systems
    • Near-field digital magnetic induction
Personal FM Technology

Naida with Phonak Roger 17 Receiver

Phonak inspiro transmitter
Improvement with FM for CI Users

FM improves performance in noise by over 40% points!

Wolfe & Schafer, 2008
What about Dynamic FM?

No FM

Traditional FM: Gain is fixed

Dynamic FM: Gain increases as ambient noise increases
Does Dynamic FM work for CI Users?

- 13 Advanced Bionics, 11 Cochlear Recipients

- HINT sentences: 85 dBA at FM microphone

- Assessed in quiet & classroom noise at:
  - 55 dBA
  - 65 dBA
  - 70 dBA
  - 75 dBA

- Traditional, fixed-gain FM vs. Dynamic

Wolfe et al. (2009)
Speech Recognition in Noise Results –
Advanced Bionics

Wolfe et al. (2009)
• What about digital RF HAT?
Digital Radio Frequency Transmission
Amplitude Shift Keying

Carrier Frequency

1 0 1 0 1 1 0 1 0 1
Digital Wireless Characteristics

• Audio signals are sampled, digitized and packaged in very short (160 µs) digital bursts of codes (packets) and broadcast several times, each at different channels between 2.4000 and 2.4835 GHz

• Frequency hopping between channels, in combination with repeated broadcast, avoids interference issues

• Digital control allows for more precise provision of adaptive/Dynamic gain

• Digital RF allows for wider bandwidth than analog
Study Objectives

• Evaluate speech recognition in quiet and in noise with speech (HINT) at 85 dBA at transmitter and classroom noise at 50, 55, 60, 65, 70, 75, 80 dBA

• Evaluated 3 RF remote microphone systems:
  – Fixed-gain FM – MLxS
  – Dynamic FM – MLxi
  – Digital RF – Roger

• Ensure consistency of signal and a lack of interference.
Results
Advanced Bionics Recipients (n = 16)

Wolfe et al., in press, JAAA

Adults with normal hearing score 95% correct here!
Results
Cochlear Recipients (n = 21)

Wolfe et al., in press, JAAA
MED-EL and Roger

Wolfe et al., (2013), Hearing Journal
Roger Solutions for Cochlear Implants

Roger microphones

$786.40

Design integrated Roger receivers

Roger X

Roger receivers

$740.80

Roger MyLink
Roger Pen

$660

Supports wideband Bluetooth – 7000 Hz

Micro USB socket
Mic mode
Connect
On / Off
Bluetooth for cell phone connection
Roger Clip-On Mic

- Micro USB socket
- Connect
- On-Off

$512
Forming a multi-talker network
Resound Unite

- Airlink Mic: $175
- Phone Clip: $185
- Unite TV: $295
Bluetooth & Near-field Digital Induction

ComPilot/Remote Mic TVLink Bundle: $349

Great for Bimodal Phonak/AB Naida users

HiBAN 10.6 MHz Digital Induction

Bluetooth

Phonak Remote Mic

TVLink
Case Study
Remote Mic Streaming vs. Roger
Who needs what?

- “Streaming” HAT for adults with “mild” difficulty in noise?
- Roger for adults with substantial difficulty in noise?
- Speech in noise testing
  - BKB-SIN
  - Acceptable Noise Level Test
  - LiSN
- Cost
- Cosmetics
- Physical Concerns
- Ease of Use
- COSI?

### Modified COSI

<table>
<thead>
<tr>
<th>Areas of improvement (Goal #)</th>
<th>Present ability</th>
<th>Expected ability</th>
<th>Agreed ability</th>
<th>Final ability</th>
<th>Degree of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing grandkids on Phone</td>
<td>1</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Hear Billy Bob at Hooters</td>
<td>0</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

**Keys:**

- **Ability:**
  - 1 - Hardly ever (10%)
  - 2 - Occasionally (25%)
  - 3 - Half the time (50%)
  - 4 - Most of time (75%)
  - 5 - Almost always (95%)

- **Degree of change:**
  - 1 - worse
  - 2 - no difference
  - 3 - slightly better
  - 4 - better
  - 5 - much better
Why use a streamer?
Bluetooth & Near-field Digital Induction

ComPilot/Remote Mic/TVLink Bundle: $349

HiBAN
10.6 MHz Digital Induction

Bluetooth

TVLink

Phonak Remote Mic
Near-field Inductive Transmission

- Allows for efficient transfer of audio signal in near-field → Between ears
- Low power requirements
- Can transfer substantial amount of information when paired with Codec (similar to MP3)
Near-field Digital Inductive Transmission

- To share audio information between ears

- Phonak HiBAN — Hearing Instrument Body Area Network
- Digital inductive transfer at 10.6 MHz
  - Transfer of telephone signal -- DuoPhone
  - Binaural directionality -- StereoZoom
  - Focused listening – Focus to the left/right -- ZoomControl
  - Wind noise management
  - Bilateral adjustments – Quick Sync

- Oticon Binaural
  - Preservation of binaural cues → localization
Evaluating DuoPhone for telephone use

• Tested word recognition on the telephone in quiet and in noise for children with hearing aids

  – 14 children (6-14 years-old)
    • Recorded CNC words

  – 10 children (2-5 years-old)
    • NU-CHIPs words via live voice (open-set)
Mean CNC word recognition scores for older children (6-14 years-old)

- **Quiet**
  - Monaural: 50
  - DuoPhone: 70

- **Noise (50 dBA)**
  - Monaural: 40
  - DuoPhone: 60
DuoPhone for CI Users

- Adult bilateral Naida CI Q70 processor with DuoPhone
  - CNC Words in Quiet – T-Mic2
    - Monaural = 72%
    - DuoPhone = 82%
  - CNC Words in 60 dBA Noise – T-Mic2
    - Monaural = 36%
    - DuoPhone = 52%
  - CNC Words in 60 dBA Noise – Telecoil (30/70 Mixing Ratio)
    - Monaural = 56%
    - DuoPhone = 80%
11 bilateral CI patients

Speech at 90°

*In collaboration with MHH, Geissler et al., 2013

ZoomControl Clinical Results

<table>
<thead>
<tr>
<th>Device</th>
<th>dB SRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omni</td>
<td>-4.5</td>
</tr>
<tr>
<td>ZoomControl</td>
<td>-5.7</td>
</tr>
<tr>
<td>ZoomControl plus ClearVoice</td>
<td>-6.9</td>
</tr>
</tbody>
</table>

1.2 dB improvement for ZoomControl
2.4 dB improvement for ClearVoice
• Conventional Induction Systems

An affordable, simple to use option for telecoil-equipped hearing technology
Induction HAT

- Clearsounds CLA7BT Bluetooth Induction Loop
  - $200

- Noizfree Beetle Induction Silhouette
  - $50

- Clearsounds CLA7V2 Amplified Neckloop
  - $100
Induction HAT for Bilateral CI Users

- Standard Telephone Use
- Clearsounds Bluetooth Neckloop

CUNY Sentences (% Correct)

n = 6
Mobile Telephone & Induction HAT Subjective Preference Ranking

Better

Average Ranking

N = 11

Standard Use
Bluetooth Loop
Hard-wired Loop
Silhouette
Bluetooth Headset

Poorer
Affordable Induction HAT for the Telephone and Noisy Situations

Clearsounds Quattro 4.0 Bluetooth Neckloop

$300

-- May be paired to Bluetooth enabled mobile telephone, laptop, etc.

-- Possesses a removable Bluetooth remote omni-directional microphone

Affordable solution for those who have hearing technology that is not capable of streaming
Affordable Induction HAT for the Television

Clearsounds Quattro 4.0 Bluetooth Neckloop

Universal Bluetooth Transmitter

$300

$25-50

Intolerable delay?
Phonak FM & Nucleus 5

Phase 1

Freedom MicroLink

Micro MLxS

Euro adaptor
FM option (not included)

Build A/B

ZoomLink+

MyLink+
FM and the Nucleus 5
Directly Coupled vs. Neckloop

- 14 Cochlear Recipients
- HINT sentences: 85 dBA at FM microphone
- Sentence Recognition:
  - Quiet
  - 65 dBA
  - 75 dBA
- Traditional, fixed-gain FM vs. Dynamic
- Neckloop vs. Directly Coupled

Wolfe et al. (2013), Ear and Hearing
Nucleus 5

Wolfe et al. (2013), Ear and Hearing
Conclusions/Clinical Implications

• Forget good, only settle for great. Shoot for the moon!

• We should encourage and support adults to use HAT effectively
  – COSI

• Directly coupled, Dynamic, digital RF likely provides the best performance

• A variety of options at a wide range of prices are available

• More work is needed to determine a protocol for determining who needs what
  – COSI, Patient Assessment
  – Speech in Noise Assessment
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Thank You for Your Attention!

www.heartsforhearing.org