Beyond hearing aids – Benefits of using remote microphone technology and other solutions for children

Jace Wolfe, Ph.D., CCC-A
# The Hearts for Hearing Team

<table>
<thead>
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Shoot for the Moon!

REPORT CARD
ENGLISH... D
MATH ...... C-
HISTORY .... D+
SPANISH .... F
SOCIAL STUDIES C
PHYS. ED .... B

66% 73% 69% 56% 78% 87%

REPORT CARD
MATH SKILLS A+
LANGUAGE ARTS A+
SCIENCE A+
SOCIAL STUDIES A+

99% 98% 100% 98%
Road Map

• Adaptive Digital Broadband Wireless Technology
  – Introduction
  – Study with CI Users
  – How about Hearing Aid Users?

• Audio Streaming
A Noisy World!

The SNR in these environments is typically -5 to +5 dB

- 42 dB A (with A.C. = 52 dBA)
  - Classroom:
    - 66 dBA
  - School Assembly:
    - 76 dBA
  - School Cafeteria:
    - 82 dBA
  - OKC Thunder Basketball:
    - 100 dBA

Children with hearing loss need a +15 dB SNR!
Sentence Recognition in Noise

% Correct vs. dBA

Quiet
50
55
60
65
70
75

Nh Adults
Nh Children
Children with Hearing Loss

5 dB SNR
The Evolution of Technology

- 1996  First miniaturized ear-level FM receiver
- 2000  Universal ear-level FM receiver
- 2003  Frequency-flexible FM system
- 2008  Dynamic FM - the first adaptive FM system
What about Dynamic FM?

No FM

Traditional FM: Gain is fixed

Dynamic FM: Gain increases as ambient noise increases
Thibodeau -- Dynamic FM

Thibodeau (2010), American Journal of Audiology
• What is a digital RF system?
Frequency Modulation Radio Transmission

- **Input Sound**

- **Carrier Frequency**

- **Amplitude Modulation**

- **Frequency Modulation**
Amplitude (v) vs. Time (s)

Digital Code (3-bit system)

<table>
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<th>Time</th>
<th>Digital Code</th>
<th>Fours</th>
<th>Twos</th>
<th>Ones</th>
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Digital Radio Frequency Transmission
Amplitude Shift Keying

Carrier Frequency

```
1 0 1 0 1 1 0 1 0 1
```
Digital Radio Frequency Transmission
Gaussian Frequency Shift Keying
• Does an adaptive digital wireless system offer benefit for CI users?
Roger 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
  - The 2.4 GHz ISM (Industry, Science and Medical) band is globally license free

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

- The frequency hopping is adaptive, both receivers and transmitters are searching continuously to find free channels and to avoid occupied channels

- End-to-end audio delay is well below 25 ms – 7500 Hz BW

- Digital control of adaptive (Dynamic) gain changes
Roger Technology

Does it work for cochlear implant users?

What about hearing aid users?
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
  – Adaptive 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
What about hearing aids?

Speech Recognition Benefits of Digital Adaptive Broadband Wireless Transmission Technology

Linda M. Thibodeau
AAA, 2013
Annaheim, CA
Research outline

- Dr. Linda Thibodeau
- University of Texas at Dallas
- Speech in noise testing
- 11 listeners using their own BTE’s
- Ages 15 to 78
- Traditional FM vs Dynamic FM vs Roger
- Randomized, blinded
- Different noise levels
The test set-up
HINT Results (N=10)

Thibodeau, 2013
Hearing Aid & CI Users

Hearing Aids

Cochlear Implants
Roger Pen
Roger Pen in detail

Micro USB socket
Mic mode
Connect
On / Off
Bluetooth for cell phone connection
Roger Pen in detail

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

- Up to 8 paired phones
- Up to 2 connected phones (Multipoint)
- Only one active phone call at a time
How to use the Roger Pen

- Interview style
- Hand held or lanyard
- Conference
Best use for Clip-On Mic
Roger Pen and Clip-On Mic docking station
Forming a multi-talker network
Design integrated Roger receivers for CI

- Roger 17
• What about Roger versus wireless streaming?
Evaluated sentence recognition both with and without wireless technology
Study of Wireless Technologies

Sentence Recognition
Quiet & Noise at
55 dBA
65 dBA
75 dBA
80 dBA

22 ft, 4 in
15 ft, 5 in
Results

n = 15

- Phonak Bolero with Roger
- Resound Verso with Unite Mic
Conclusions/Clinical Implications

• Great outcomes are possible when we properly use the best hearing technology available today.

• Roger > Dynamic FM > Fixed-gain FM

• Roger likely beats wireless streaming because of adaptive increases in gain.

• Shoot for the moon!
Thank You for Your Attention!

www.heartsforhearing.org