Evaluation of Cochlear Implant Noise Management Technologies

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The Problem

- Cochlear implant recipients experience difficulty with:
  - Understanding speech in noise
  - Understanding speech in reverberant environments
  - Understanding speech from a distance
Potential Solutions

• Adaptive gain reduction for channels with poor SNR
  – Improve SNR by 1 dB (Mauger et al., 2014; Wolfe et al., 2015)

• Directional microphone systems
  – Likely to improve SNR by 2-4 dB in realistic situations (Ricketts & Hornsby, 2003)
    • More improvement w/ greater attenuation of rear hemisphere?
  – Must be within critical distance of source (Ricketts & Hornsby, 2003)

• Conventional remote microphone
  – Can improve SNR by 10-15 dB in real world situations (Wolfe et al., 2013)
  – Requires talker-of-interest to wear remote microphone
What about small group situations?
What about traditional classroom situations?
Questions

• In a **café situation**, how much improvement in speech recognition in noise may be obtained from:
  – Adaptive channel-specific gain reduction (**SNR-NR**)?
  – Adaptive directional microphone (**Scan**)?
  – Fixed directional microphone with significant attenuation of rear hemisphere (**ForwardFocus**)?
  – Wireless accessory remote microphone system (**Mini Mic 2+**)?

• In a **classroom lecture situation**, how much improvement in speech recognition in noise may be obtained from:
  – Adaptive channel-specific gain reduction (**SNR-NR**)?
  – Adaptive directional microphone (**Scan**)?
  – Fixed directional microphone with significant attenuation of rear hemisphere (**Forward Focus**)?
  – Wireless accessory remote microphone system (**Mini Mic 2+**)?
Study

• 20 Bilateral Cochlear Nucleus cochlear implant recipients
  – Ages ranged from 10 to 79 years old

• Evaluated with the Nucleus 7 sound processors
Study

• AzBio sentences (1 list of 20 sentences per condition) in three listening situations:
  – Simulated café +10 dB (72/62 dBA) at subject location
  – Simulated café +5 dB (75/70 dBA) at subject location
  – Simulated classroom lecture +4 dB (70/66 dBA) at location
    • Signal at remote microphone was 80-85 dBA for all situations

• 5 Technology Conditions
  – Standard mic mode (SNR-NR off)
  – Adaptive channel-specific gain reduction (SNR-NR)
  – Adaptive directional microphone (Scan and SNR-NR)
  – Fixed directional microphone with significant attenuation of rear hemisphere (ForwardFocus and SNR-NR)
  – Wireless accessory remote microphone system (Mini Mic 2+ and SNR-NR)
Simulated Café Environment

Distance from each loudspeaker to subject = 4’3”

AzBio from front and Noise from remaining loudspeakers
Simulated Classroom Lecture Environment
Directional Microphone or Remote Mic?

Cafe: +10 dB SNR

AzBio % Correct

n=20
Directional Microphone or Remote Mic?

Café: +5 dB SNR

AzBio % Correct

- SNR Off Omni
- SNR On Omni
- SNR On Scan On
- SNR On Forward Focus
- SNR ON MM2

n=20
Directional Microphone or Remote Mic?

Classroom: +4 dB SNR

AzBio % Correct

n=20
Take-home Summary

- Adaptive channel-specific noise reduction offers modest improvement in noise.

- Adaptive directional mics provides significant benefit and good overall performance for favorable SNR (+10 dB SNR) when talker is nearby (café).

- Fixed directional microphone with aggressive attenuation of rear hemisphere is likely to be helpful at more adverse SNR (+5 dB SNR) when talker is nearby.

- Remote mic optimizes performance for café with poor SNR.

- Remote mic is imperative for classroom in which talker may not always be nearby to the listener.
Thank you for your attention!

• Great outcomes are probable when we do what it takes.

• Shoot for the moon!