Connecting Patients to Their Favorite Activities:

With ReSound's Multi and Micro Mics

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GN Making Life Sound Better

Welcome!

Quick Bio:

- **Neil Wright, AuD**
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- **Received AuD from Northwestern University**
- **Financial Disclosure: I am an employee of GN ReSound**

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Outline

- **(0-5) – Introductions**
- **(5-10) – Introduction to remote microphone technology**
- **(10-20) – Restaurants: Improving SNR**
- **(20-30) – Cars: Compensating for lack of visual cues**
- **(30-40) – Classrooms and lectures: Listening at a distance**
- **(40-50) – Meetings and Large groups: When its all working against you**
- **(50-55) – Other functions and scenarios of benefit**
- **(55-60) – Conclusions and Q&As**

Learning Goals

- **To quantify the benefits of Remote Microphone Technology**
- **To identify environmental factors that negatively impact hearing aid user performance**
- **To demonstrate programming strategies to maximize hearing aid and remote microphone user performance in difficult listening environments**

ReSound Micro Mic

ReSound Multi Mic

Remote Microphone Technology

The Current State of Hearing Aid Users

- **Performance of hearing aid technology has perceivably improved overall**
  - Marketrak IX[1]: 80% satisfaction rate across all environments for devices <5 years old
- **BUT, many environments still cause hearing aid users problems**
  - Marketrak VIII[2] (2010): Satisfaction by environment →
  - Marketrak IX (2015): Listening in noise: lowest satisfaction
- **The Usual Suspects**
  - Noise
  - Distance
  - Reverberation
  - Limited Visual Cues / Multiple Talkers
  - Often in combo

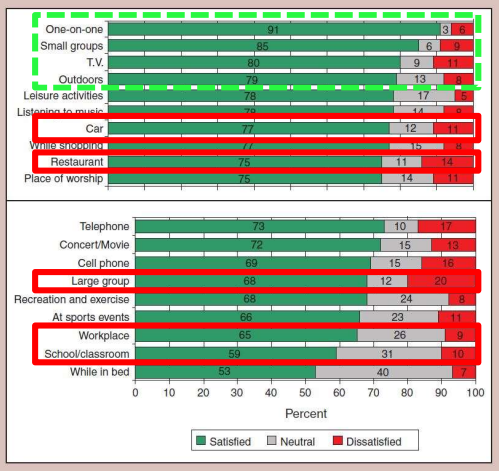

Figure 9. *Consumer satisfaction with hearing aids in various listening situations where hearing aids are </=4 years of age.*

Kochkin S. MarkeTrak VIII: Consumer satisfaction with hearing aids is slowly increasing. *Hear Jour.* 2010:63(1):19-27

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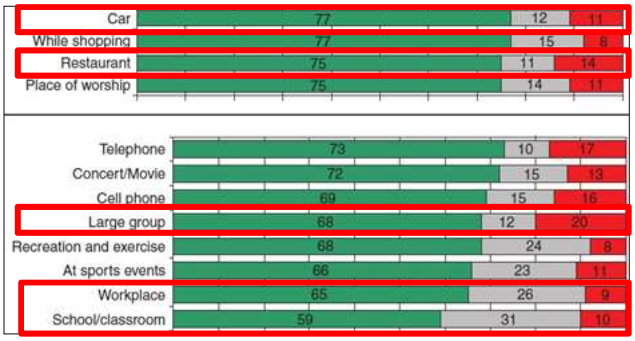
How do we address these environmental struggles?

HA Programming Options

- Directional Microphones[3]
- Digital Noise reduction
- Gain Reduction
- Environment-specific programs
- **Measureable benefits, but have limitations**

When these aren't enough, what now?

- **Remote Microphones!**



Kochkin S. MarkeTrak VIII: Consumer satisfaction with hearing aids is slowly increasing. *Hear Jour.* 2010:63(1):19-27

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Remote Microphone Technology: At a Glance

- **Worn by conversation partner**
  - Improves SNR in noise, speech perception and understanding in noise and at a distance
- **History: a wired connection**
- **Key piece of FM systems**
  - First wireless remote microphone
  - Significant benefits in noise[4]
  - Universal but more expensive
- **Digital Wireless has made them more affordable, practical, & accessible**

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1st Generation: The Mini Mic

- **Released: Spring 2012**
- **Omni directional remote mic**
- **Line-in functionality**
- **Truly Wireless connectivity**
  - 2.4 GHz wireless connection
  - No intermediate device
  - 30 ft. range
- **Significant speech perception benefit in noise[5,6]**
- **Significant benefit at a distance[5,6]**

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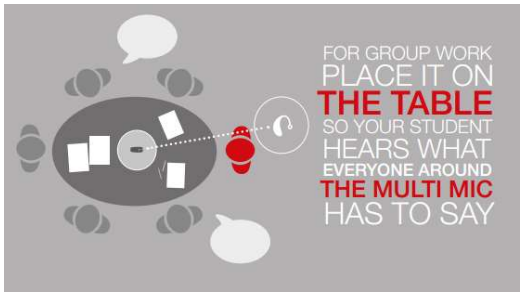
Next Generation: Multi Mic and Micro Mic

- **Multi and Micro Mic advantages over 1st Gen Mini Mic**
  - Directional mic towards the speaker's mouth
  - Longer distance of transmission: 90 feet – clear line of sight
  - Drop Detection
- **Multi Mic Advantages**
  - Omni Directional Table Mode
  - Built-in Telecoil
  - DAI compatible
  - Line in functionality
- **Micro Mic**
  - small, discrete size

ReSound Micro Mic

ReSound Multi Mic



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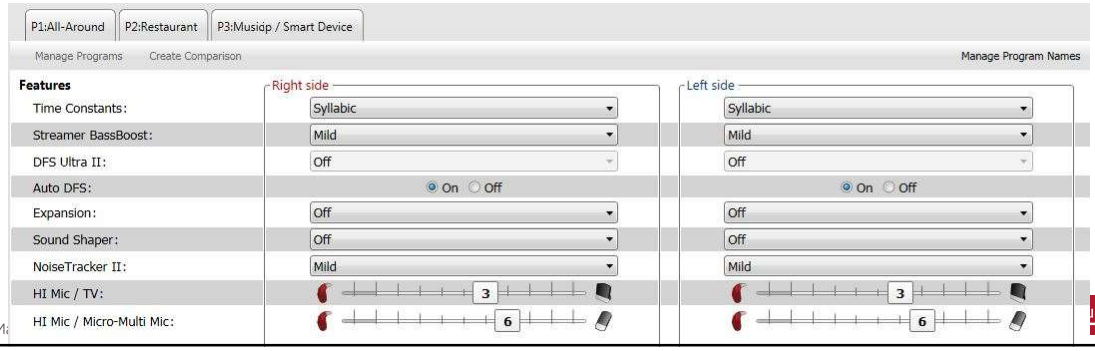
Streaming Program Default Settings

- **Hearing aid mics always in Omni**
- **Mic Balance function: defaults to +6 towards the Remote Mic**
- **Wireless-specific programming: Gain settings mimic All-Around program**
  - Independent Gain Settings
- **Most advanced features default "OFF"**
- **Noise reduction defaults to "Mild"**



Listening in Restaurants:

Improving the Signal to Noise Ratio

Restaurant: Challenges

Biggest Challenges

- **Signal to Noise Ratio (SNR)**
- **Background noise comes from multiple directions**
- **Poor room acoustics**
- **Poor lighting**

Why They Matter

- **Hard to pick out target speech from background**
- **Background noise typically speech**
- **Fixed directionality may not be enough**
- **Sound rebounding, reverberation adds to noise**
- **Can impact visual cues**

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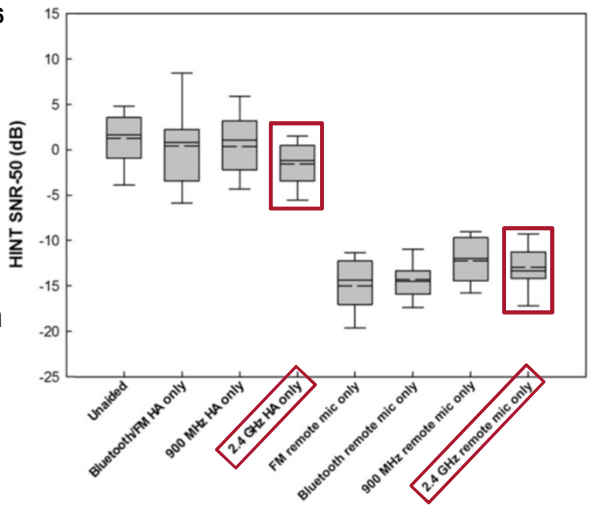
Remote Mic Benefits in Noise

- **Data from Rodemerk and Glaster(2015)[6]**
- **HINT measurement tested across different types of remote microphones**
  - 6' from speaker and remote microphone
  - Hearing aid mics muted
- **Remote microphone technology provides significant SNR and speech perception benefit over HAs alone**
- **HA mics were set to Omni**
  - What about directionality?



Rodemerk K, Galster J. The benefit of remote microphones using wireless protocols. *J Acad Audiol*. 2015:26:724-731.

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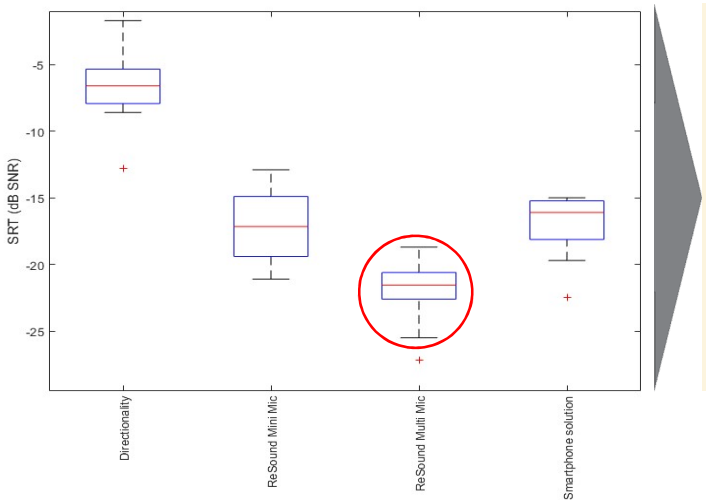
Improving SNR: Improvement over Mini Mic



- The new ReSound Multi Mic on average provides 15dB of SRT benefit above what directionality provides.
- It provides a significantly better SRT improvement (Tukey's Honest Significant Difference) than the existing ReSound Mini Mic and an available smartphone solution.
- The new Multi Mic on average provides 5 dB more SRT benefit compared to the first generation Mini Mic.

Jespersen & Kirkwood, 2016

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Programming Recommendations for Restaurants

- **Low Frequency Gain Settings**
  - Decrease overall gain at 750 Hz & below
- **Microphone Balance**
  - Slide balance towards the remote microphone
  - Will increase input from remote mic relative to hearing aid microphones
- **Mid & High Frequency Gain Settings**
  - Increase mid level gain in mid & high frequencies to increase target speaker's voice clarity
    - 1000-6000 Hz, less increase at 6 kHz
    - Similar gains to restaurant program, but in mid-level gain instead of soft gain

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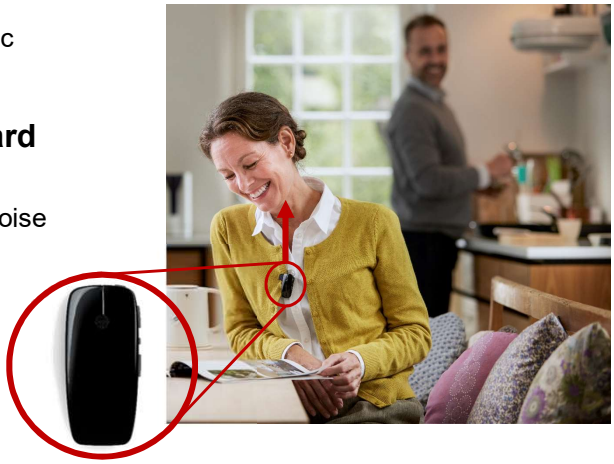
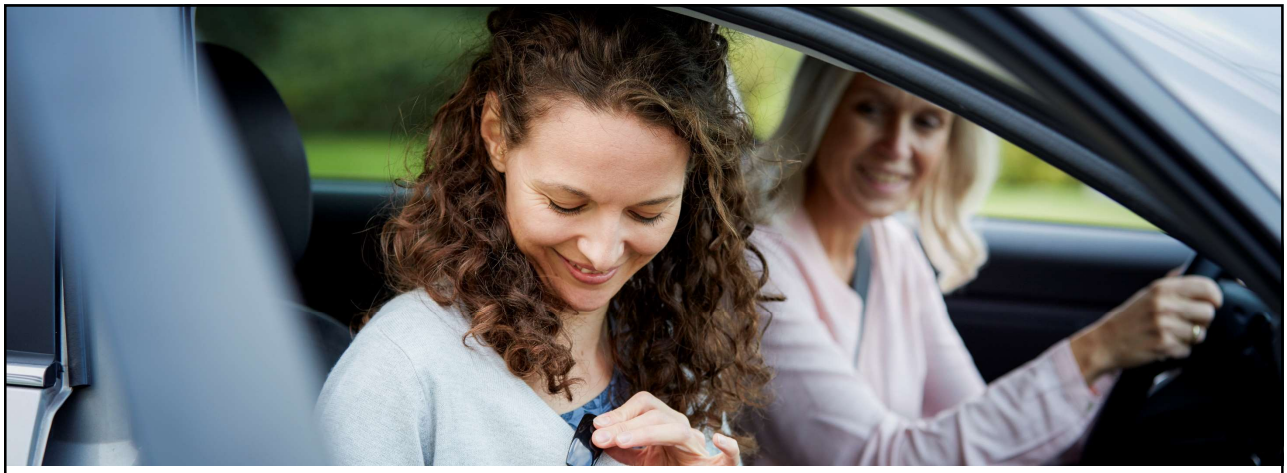
Programming Recommendations for Restaurants: Continued

- **Increase Noise Tracker**
  - Some built in noise reduction in Multi Mic
- **Utilize Expansion**
- **Vertical Orientation key for lanyard (clipped on) usage**
  - Directional Microphone will activate in noise for Multi Mic
  - Micro Mic always in directional





Listening in the Car:

Compensating for a Lack of Visual Cues

Listening in the Car: Challenges

Biggest Challenges

- **Signal to Noise Ratio (SNR)**
  - High levels of background noise[7]
- **Driving demands high level of attention**
- **Limited Visual Cues**
- **Indirect Speech – coming from behind or side of patient**

Why They Matter

- **Where the rubber meets the road: makes for a high noise level**
- **Driver cannot turn to speaker, and/or driver should not turn to listener**
- **Visual Cues contribute to speech understanding for hearing impaired**
- **Fixed directionality – a conventional approach to noise reduction – is detrimental to speech understanding from back/side**

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Importance of Visual Cues

- **Visual cues critical for speech understanding**
  - Lipreading and Speechreading
- **Visual cues can contribute up to +4-6 dB SNR benefit[8]**
  - Often missing in car listening environment
- **Face-to-face conversations uncommon in the car**
  - Negative impact on speech perception
- **Speakers often to the side, in front, or behind the listener**
  - Fixed directionality will decrease speech understanding in this scenario

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Programming Considerations for the Car

- **Reducing road noise input**
  - Decreasing wideband loud input gain
  - Decrease low frequency (below 1 kHz) gain
- **Noise Reduction**
  - Some built-in noise reduction in Multi Mic
  - Can increase Noise Reduction setting in fitting software
- **Microphone balance**
  - Advanced settings can be ear-specific in streaming program
  - Window-facing ear slide towards remote mic further than inward facing ear

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Programming Considerations for the Car: Continued

- **Seating arrangement**
  - Depending on seating, ear-specific programming could be beneficial
  - No Wind reduction in streaming program
- **App-based favorites**
  - DON'T HEARING AID PROGRAM AND DRIVE!
  - Make specific favorites that are easy to select prior to getting on the road
- **Can make very specific driving or seat-specific settings**
  - Mute left hearing aid mic for driver
  - Increase Multi Mic input
  - Save as labeled Favorites

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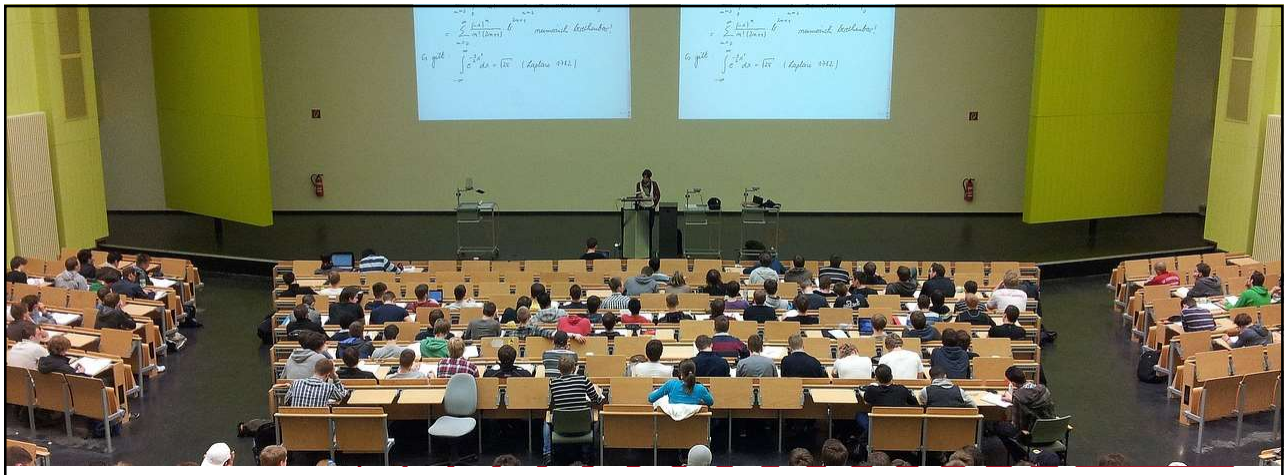

Lectures and the Classroom

Listening in the Classroom/Lecture: Challenges

Biggest Challenges

- **Long distance between speaker and HA user**
- **Speaker may move around, increasing distance or turning away from HA user**
- **Signal to Noise Ratio (SNR)**
  - High levels of background noise
  - Levels of reverberation

Why They Matter

- **Increased distance reduces speaker volume at listener**
  - Limits visual cues
- **Moving speaker may negate conventional approach to noise reduction – may introduce distraction**
- **Noise and reverberation increase listening difficulty and decrease speech understanding**
  - Directionality alone may not be enough

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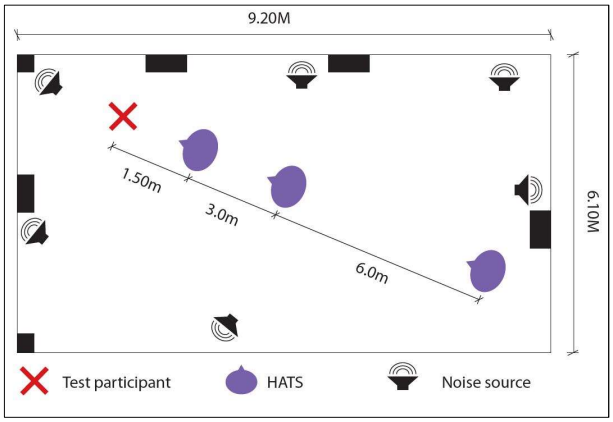
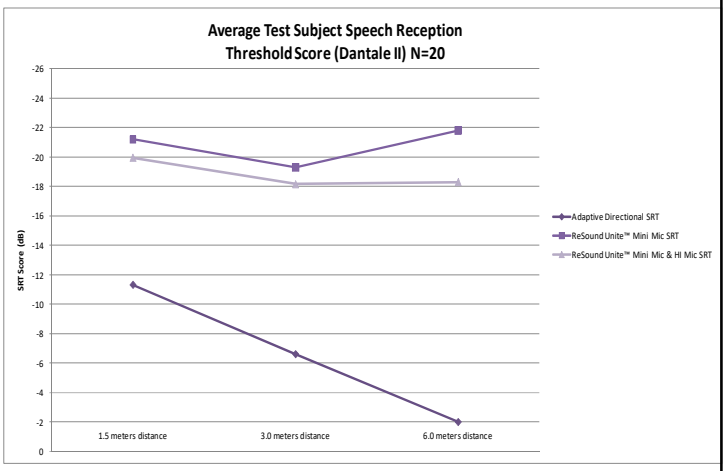
Remote Microphone Benefits at a Distance

- **Directional Mics have a near-field effect**
  - Directional benefit diminishes quickly over longer distances
- **Remote Microphone technology allows for SNR benefits in noise to be preserved across distance**
- **Research by Jespersen & Laureyns (2012)[5] measured SRT in noise through ReSound's Mini Mic**
  - Distances: 1.5m, 3m, & 6m
  - 3 Conditions: Directional Microphones alone, HA Mic + Mini Mic, Mini Mic with HA Mic Muted



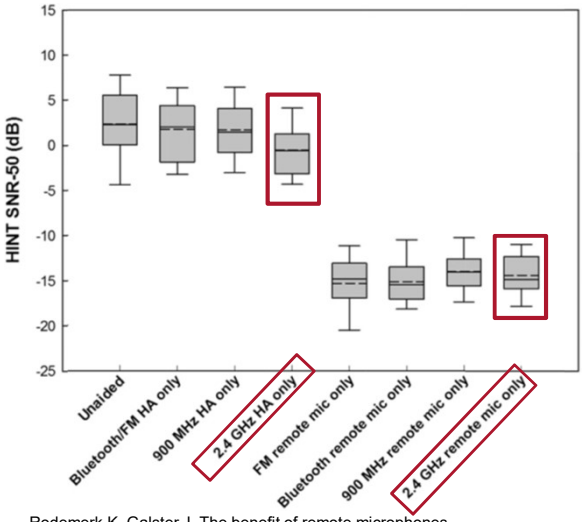
Remote Mic Benefits at a Distance

- **Results show significantly better SRT results using Mini Mic compared to directional microphones alone[5]**
  - Multi Mic improved range (90 feet)
- **Benefit shown with Mini Mic does not significantly decline with increased distance**
  - Directional microphone performance drops with increased distance



Remote Mic Benefits at a Distance

- **HINT results show similar performance improvements with remote mic technology** (Rodemerk and Glaster (2015)[6]
- **Testing completed with different remote mic transmission methods**
  - ReSound Mini Mic Highlighted in red boxes
- **Testing performed at 6' and 12'**
  - Remote Microphone Improves performance in noise over HA alone even at 12 feet from target speaker



Rodemerk K, Galster J. The benefit of remote microphones using wireless protocols. *J Acad Audiol.* 2015:26:724-731.

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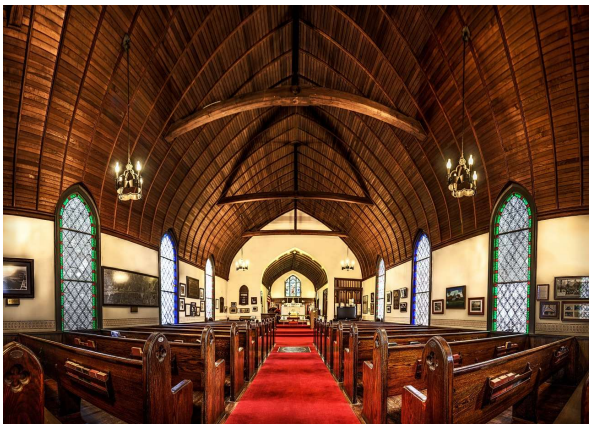
Programming Considerations for Worship Settings

- **Mic Balance**
  - Speaker often not sole sound source (ex: Music) – predictable turn taking
  - Slide Mic balance to center
- **Seating Arrangement**
  - Advice on seating arrangement to ensure hearing aid microphones can pick up music if desired
- **Noise reduction off**
- **BassBoost as needed**
- **<u>Preach self-advocacy!</u>**



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Programming for Lecture Settings

- **Mic Balance**
  - Slide mic balance towards Multi/Micro Mic
    - One target speaker
- **Expansion**
  - Increase expansion to reduce room noise
- **Seating arrangement**
  - Seating closer preferable if possible for visual cues as needed
- **<u>Preach Self-Advocacy!</u>**

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ReSound Pediatrics: Special Recommendations for Kids

- **Classroom environments will have similar challenges to church and lecture environments**
  - Reverberation
  - Background Noise
  - Good SNR critical for speech development
- **But also have unique considerations**
  - Benefits of incidental learning[9]
  - Moving target speaker
  - Transparency measures for remote mics

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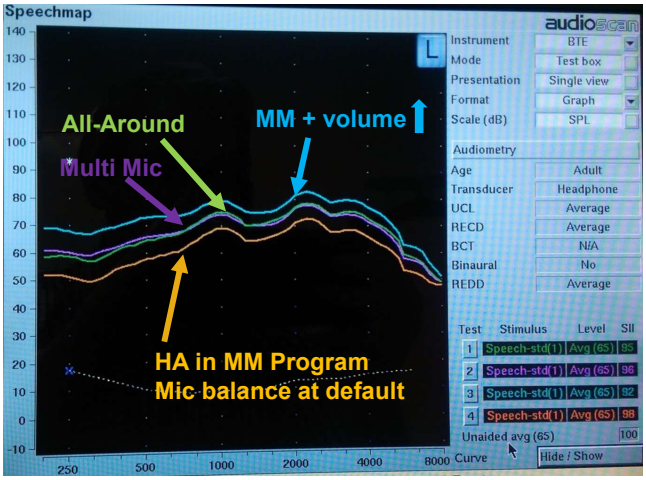
ReSound Pediatrics: Special Considerations for Kids

- **Mic Balance**
  - For pediatrics, defaults to mic balance setting of 3 not 6 (adult)
  - May slide to middle (0 setting) to facilitate incidental learning
- **FM input option**
- **Multi Mic Volume Independent of HA gains[10]**
  - Allows wearer to adjust volume without impacting hearing aid gains
- **Volume Lock**
  - Volume settings on Multi Mic can be locked for mic-specific or FM-specific input



Listening in Meetings and Large Groups:

Multiple Speakers, in Noise, at a Distance – the perfect storm!

Challenges in Groups

Biggest Challenges

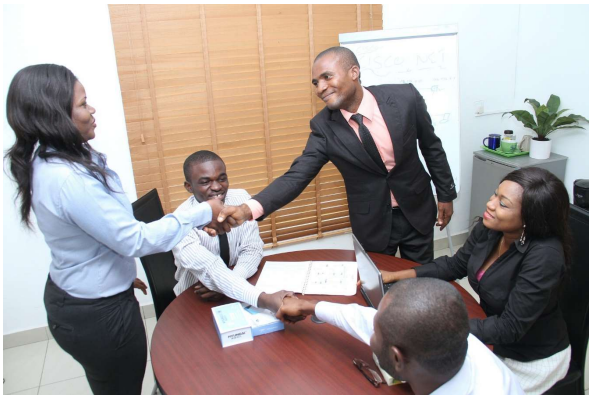
- **Multiple Noise Sources**
  - From different directions
- **Multiple target speakers**
  - May limit visual cues
- **Some distance from speakers**
  - Larger groups, bigger tables

Why They Matter?

- **Noise sources are people – similar frequency content in noise compared to speakers**
- **Divided attention, overlapping speakers**
- **Decreased target speaker volume due to distance**

Programming Considerations for Large Group Environments

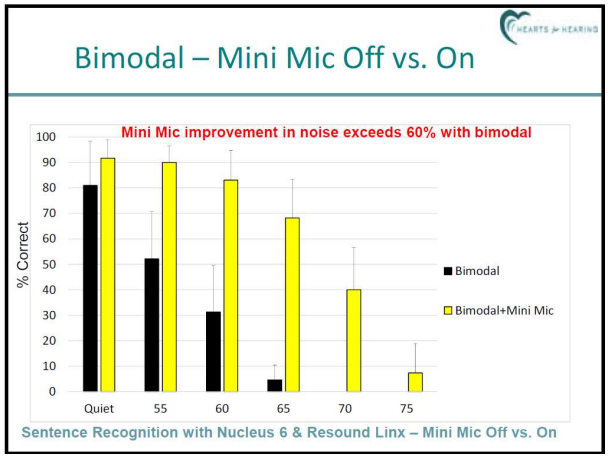
- **Remote Microphone Placement**
  - Horizontal placement to enable Multi Mic table mode
  - Should be as close to equidistant from all speakers as possible from small tables
  - Longer table may require mic to be placed further from hearing aid user
- **Room and table dimensions**
  - For longer tables: Slide mic balance to 0 and place multi mic further away from listener
- **Presence of noise**
  - Slide balance more towards Multi Mic
  - Increase noise reduction



Other Usage Scenarios: Flexibility Through Functionality

Remote Microphone Benefits for Bimodal Patients

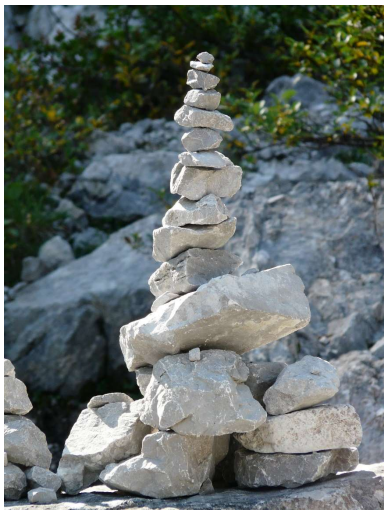
- **Bimodal patients struggle in difficult listening situations**
- **Research shows bimodal patients benefit from bilateral streaming**
  - 1st studies used FM
  - Proprietary connections proven effective
- **Benefits from Remote Microphones in noise[11]**
  - Significant improvements in sentence recognition in noise
  - Speech: 65 dBA at test patients



Wolfe, J. Cochlear Wireless Accessories for Bimodal Users. Presentation, San Antonio, TX, 2015

Programming Considerations for Bimodal Patients

- **Mic Balance**
  - Independent mic balance controls for HA & CI
  - Research proving effectiveness mic balance settings[10]
    - CI at 2:1 Accessory Mixing Ratio
    - HA Mic balance at 6 towards Remote Mic
- **Loudness balancing[12]**
  - Research shows best results for bimodal patients when ears are loudness balanced
- **Residual hearing in HA ear**



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Other Usage Scenarios

- **Tcoil**
  - For looped environments
  - Multi Mic should be vertically aligned (right)
- **Line In**
  - Conventional 9mm jack
  - Plug into headphone jack for easily listening to music and videos
- **FM**
  - Conventional 3-pin DAI port
  - Only requires one FM receiver to stream audio to both ears

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Other Usage Scenarios: Tips

- **Tcoil**
  - Multi Mic needs to be placed within the loop, even if listener is not
- **Line In**
  - Turn off Noise Reduction
  - No expansion for music
- **FM**
  - Multi Mic can remain with HA user, act as volume control for FM input

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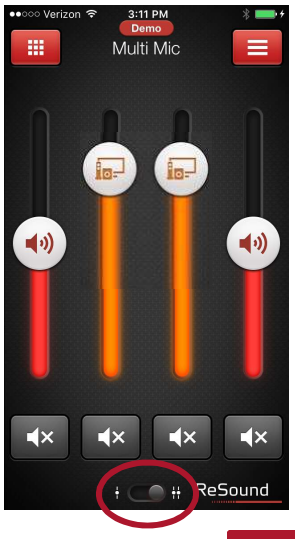
Using the ReSound Smart App & Control App

- **Ear-specific volume control**
- **Hearing aid mic & Multi Mic independent volume controls**
  - Mute Controls
- **Discrete way to adjust devices on the fly**
- **Requires MFi connection to use Smart App**
  - MFi compatible devices required (iPhone 5 & beyond)
  - Now available for Samsung Galaxy devices (S5 & beyond)
- **Similar controls through ReSound Control App for non-MFi & Samsung smartphones**
  - Requires Phone Clip +



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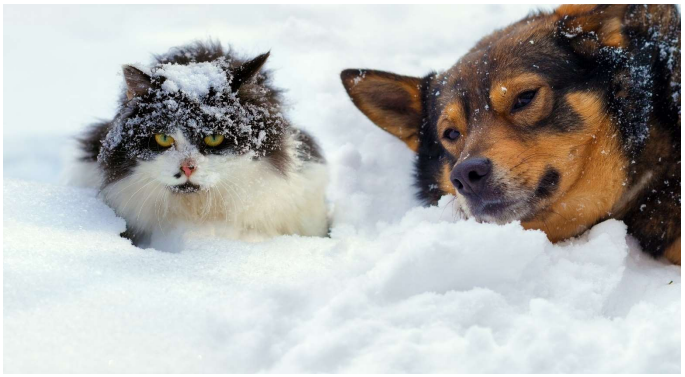
Conclusions

- **Remote Microphone technology can help patients access target speech in more difficult listening situations**
  - Improved SNR
  - Improved listening at a distance
  - Improved listening in groups
- **Different environments require different programming considerations**
- **Utilizing clinical programming flexibility for best results**

Thanks for Listening!

Questions?

Email: nwright@gnresound.com



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