COMMUNICATION ACCESS FOR CHILDREN VIA PERSONAL REMOTE MICROPHONE SYSTEMS: WHAT DOES RESEARCH TELL US? – 7 PM ET

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COMMUNICATION ACCESS FOR CHILDREN VIA PERSONAL REMOTE MICROPHONE SYSTEMS: WHAT DOES RESEARCH TELL US?

Dawna Lewis, PhD, Research Scientist, Boys Town National Research Hospital, Omaha, Nebraska

June 29th, 2021

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Canadian Academy of Audiology is a professional association dedicated to enhancing the role of audiologists as primary hearing health care providers through advocacy, education and research.

Host – Marlene Bagatto

Marlene Bagatto is an Assistant Professor in the School of Communication Sciences and Disorders and the National Centre for Audiology at Western University in London, Ontario. The research in her Pediatric Audiology Strategies and Systems Laboratory focusses on policy and practice integration for infant and child hearing. Dr. Bagatto is Past President of the Canadian Academy of Audiology and Chair of the Canadian Infant Hearing Task Force.

Speaker: Dawna Lewis, PhD

Dawna Lewis, PhD, is a Research Scientist at Boys Town National Research Hospital in Omaha, Nebraska. She has presented and published on topics involving pediatric audiology/amplification and hearing assistance technologies, including remote microphone systems. Dr. Lewis served on the AAA Task Force on Guidelines for Remote Microphone Hearing Assistance Technology. She is involved in research addressing issues related to amplification and speech perception in children.

Recent work has examined the impact of mild bilateral and unilateral hearing loss on children's speech understanding in complex environments by manipulating acoustic and visual characteristics of the environments and tasks.

Communication Access for Children Via Personal Remote Microphone Systems: What Does Research Tell Us?

Dawna E. Lewis, PhD

Canadian Academy of Audiology Webinar
June 29, 2021

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Disclosures

- **Financial Disclosure(s):**
  - I am an employee of Boys Town National Research Hospital.
  - I have received honoraria for invited talks from a variety of organizations in the past and may continue to do so in the future.
  - I serve on the Phonak Pediatric Research Advisory Board. However, that relationship does not impact the information to be presented.
  - One of the studies I will discuss today was supported by Oticon.
  - My research has been supported by NIH/NIDCD/NIGMS.
- **No non-financial disclosures.**

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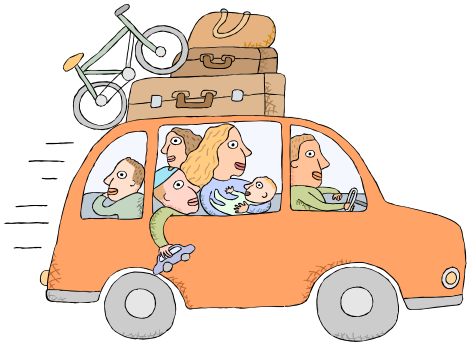
Effective listening is compromised by

- Distance
- Noise
- Reverberation



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Poor acoustics have implications beyond audibility…

- Decrease incidental learning
- Increase fatigue
- Reduce retention

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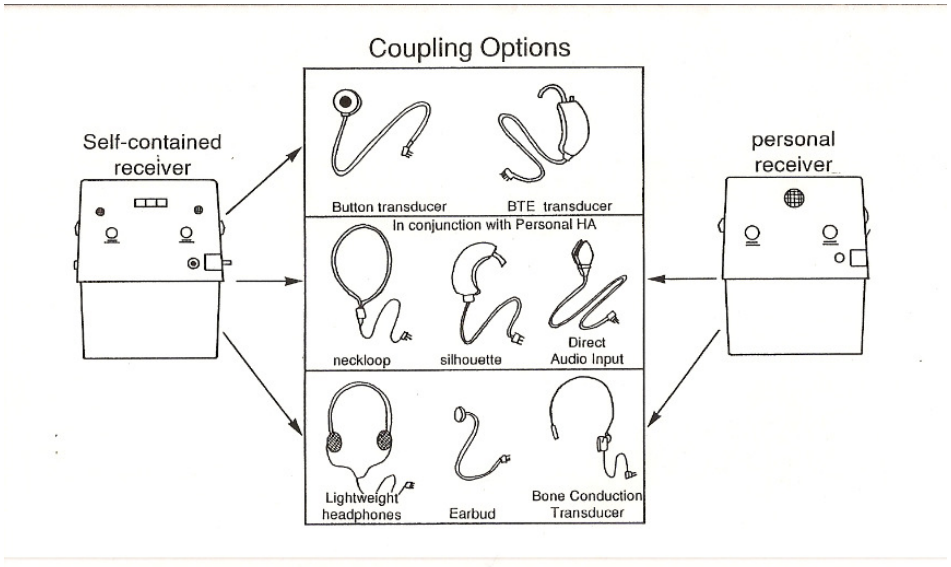
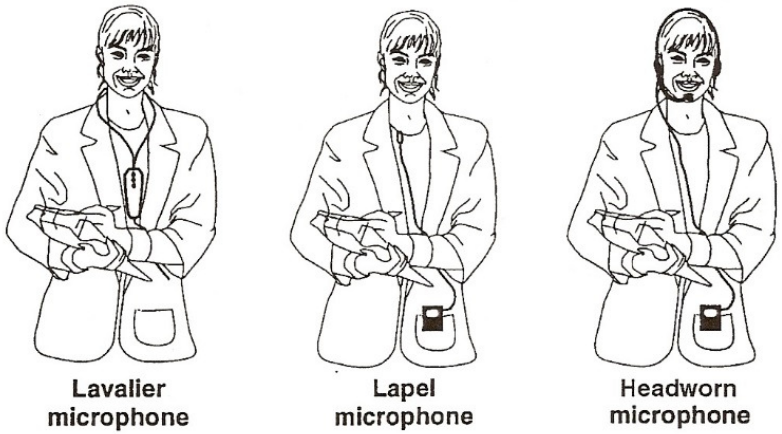
Remote microphone (RM) systems

- Designed to lessen acoustic effects on communication access
- Body-worn RM systems using FM technology were first introduced in the 1960s





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Early Studies

- Evidence of RM-benefit for children who are hard of hearing

Improved speech recognition when compared to unamplified or HA-only conditions in noise and reverberation
(Blair, 1977; Hawkins, 1984; Ross & Giolas, 1971; Updike, 1994)

Visual cues improved performance both for hearing aids and FM systems (Blair, 1977)

- Activating both FM and HA microphones could reduce FM benefit (Hawkins, 1984)

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Use of FM systems in young children (Moeller et al., 1996)

Potential benefits

- Language development
- Listening skills and communication access

Preferred situations for Use

- Background Noise
- TV/Audio recordings
- Group situations with primary talkers
- Parents---stores, parks, zoo, etc.
- Children---when caregivers were not visible

Possible Deterrents

- Size
- Social issues
- Complexity/Ease of Use
- Appropriate Use
- Interference

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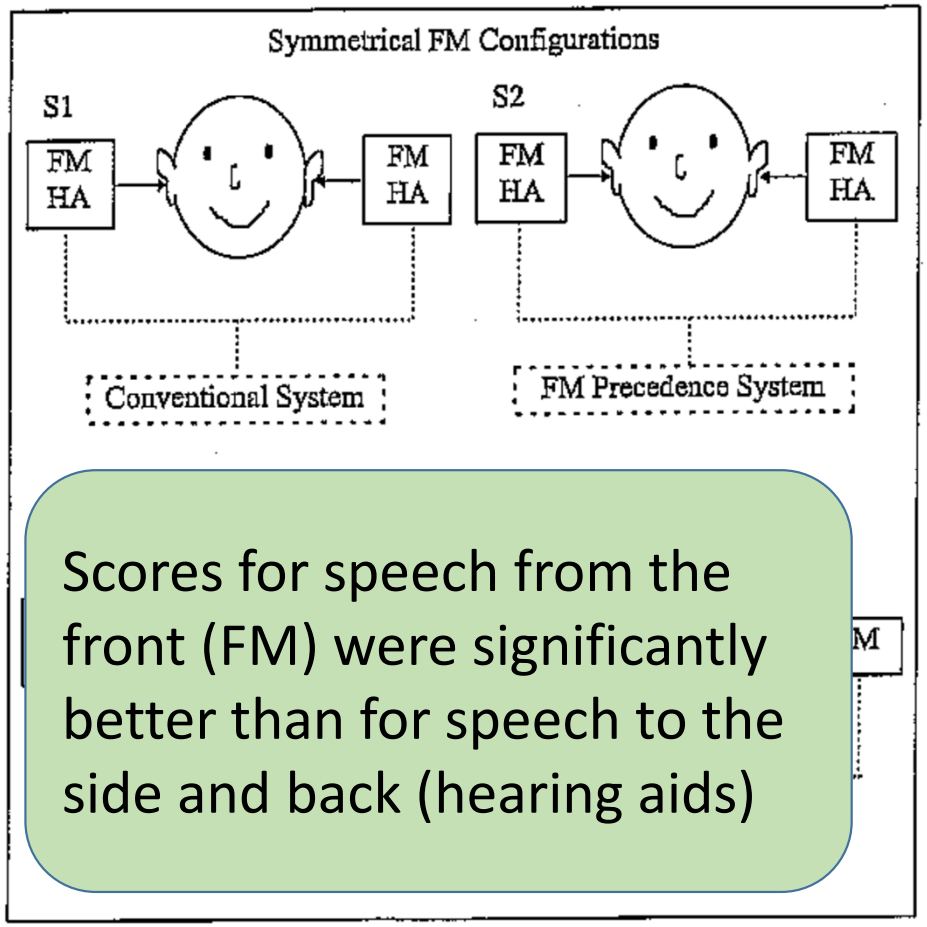
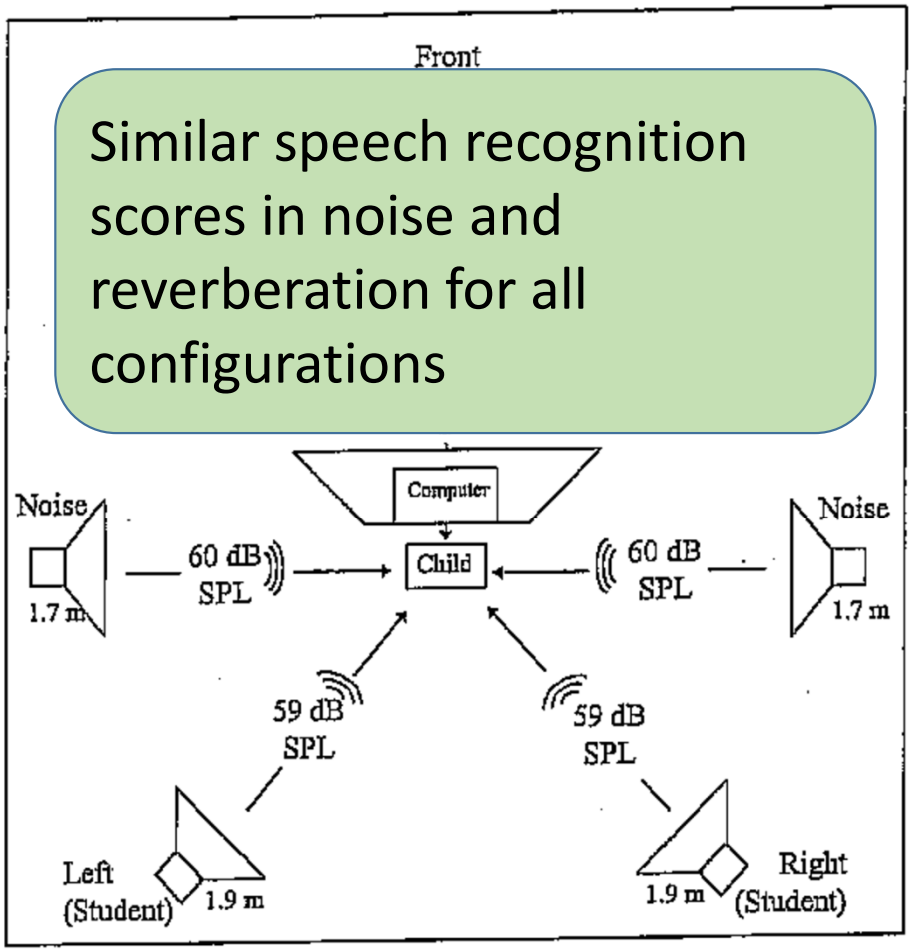


Scores for speech from the front (FM) were significantly better than for speech to the side and back (hearing aids)



Similar speech recognition scores in noise and reverberation for all configurations

Pittman et al., 1999

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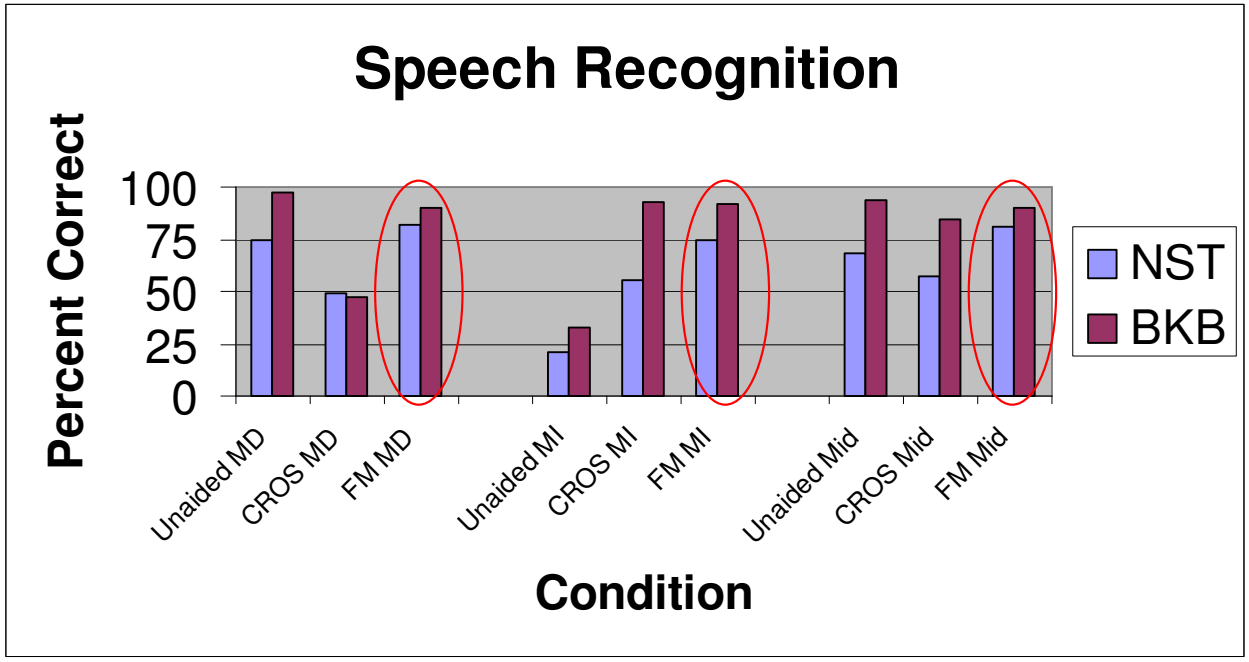
- FM benefits shown for children with unilateral hearing loss
  (Kenworthy et al., 1990; Updike, 1994)

- For example….



Kenworthy et al., 1990

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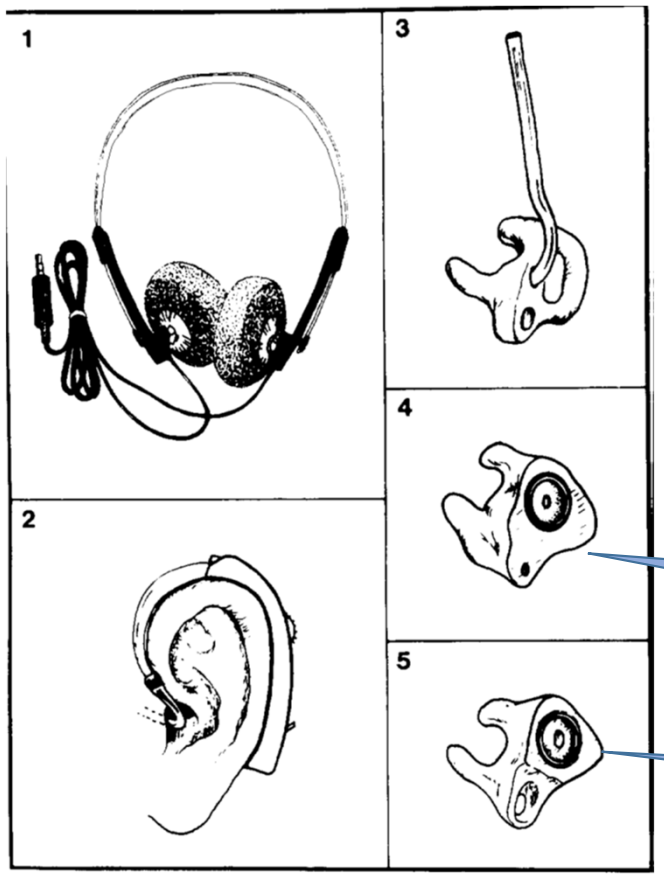
Fitting a RM to an ear with NH (Kopun et al., 1992)



1. Lightweight headphones
2. Tube fitting
3. CROS earmold with tubing
4. Snap-ring earmold with vent
5. CROS earmold with a snap-ring

Full shell with small vent

Full shell with large vent

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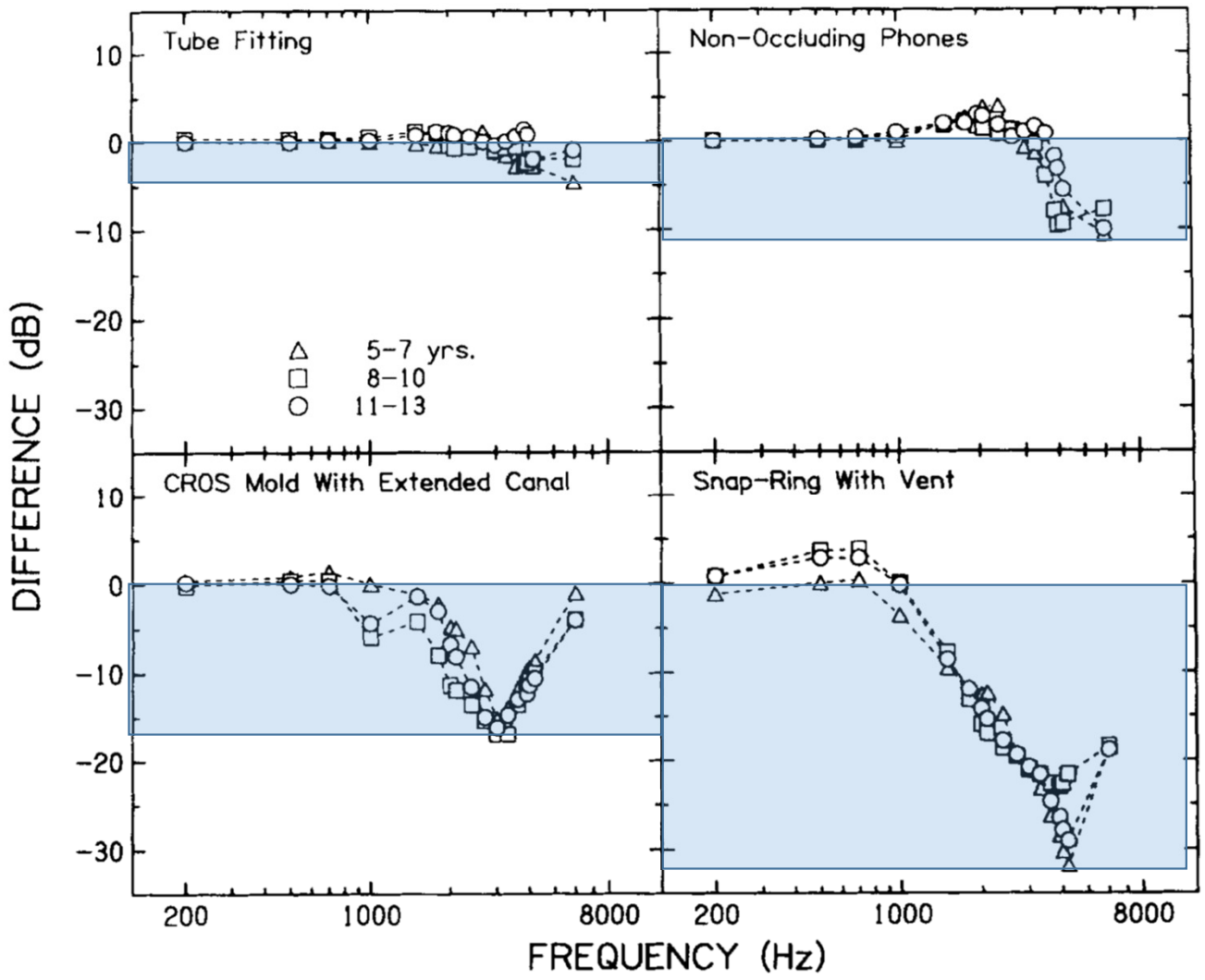

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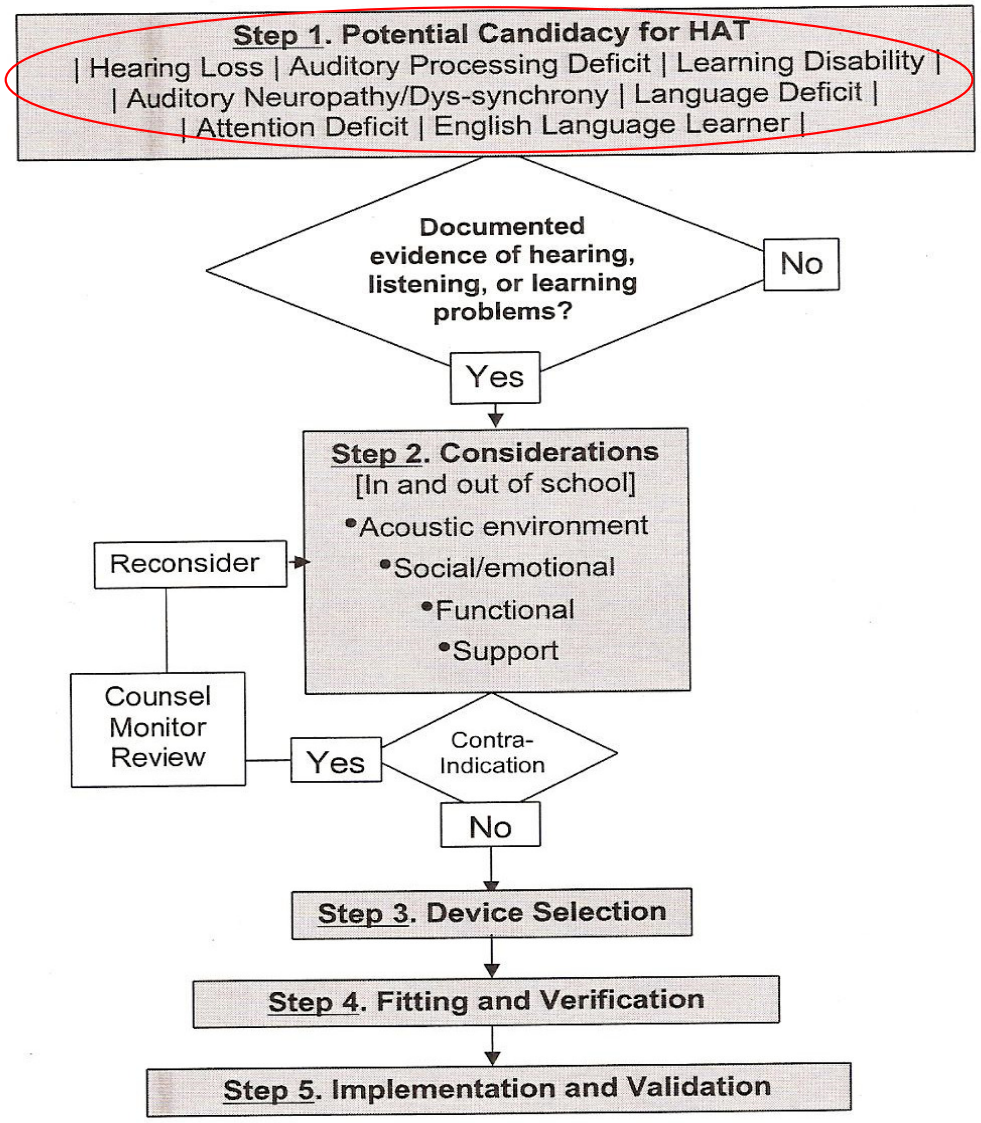

- AAA Guidelines for Remote Microphone Hearing Assistance Technologies for Children and Youth Birth-21 Years (2008; updated 2011)

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Technology Considerations for Device Selection

- Convenience
- Wearability
- Reliability
- Maintenance
- Ease of monitoring
- Manufacturer and dispenser support
- Compatibility with other devices
- Signal interference
- Multiple FM frequencies
- Bluetooth compatibility
- Electromagnetic compatibility

Advances in hearing-instrument and remote-microphone technology continue to address many of these issues

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Beyond Body-Worn… RM systems have continued to advance physically/technologically

BTE FM/HA

Miniature
FM Receiver

Universal
FM Receiver

FM-only
Receivers

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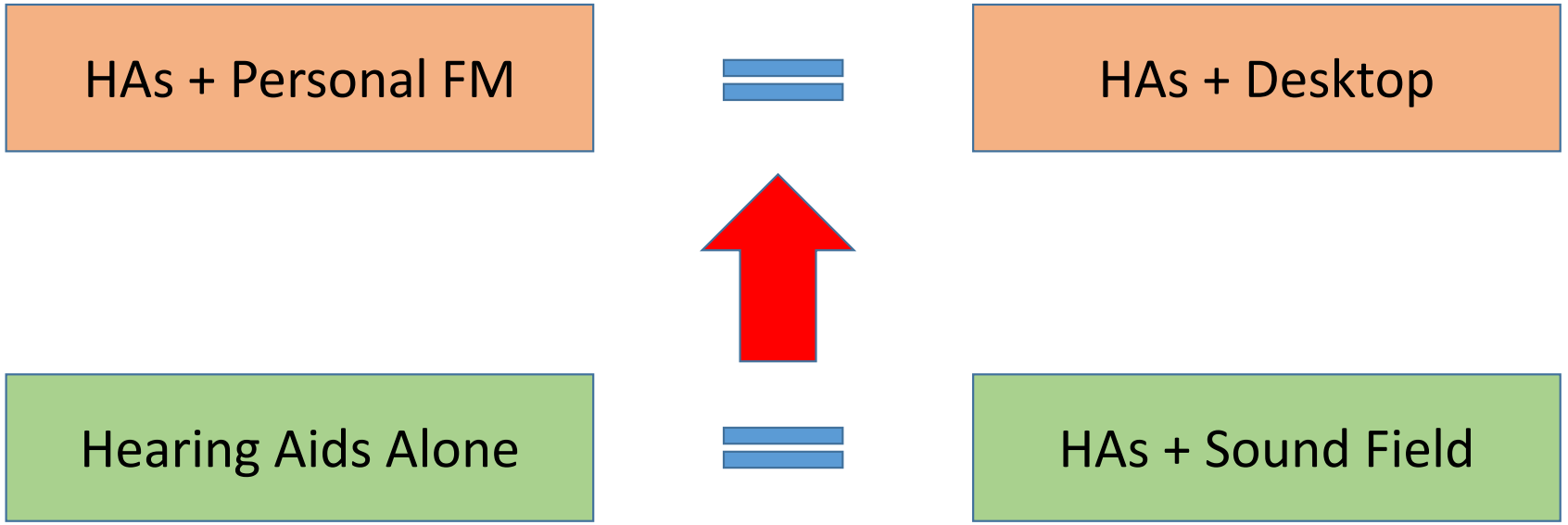
Children who use hearing aids

- Comparing speech recognition across HAT (Anderson & Goldstein, 2004)



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Children who use hearing aids

- Impact of advances in signal processing on speech-in-noise benefits obtained with RM

Smart Dynamic DM > Standard DM
Wolfe, 2021 [presentation]

Digital Modulation (DM) > Adaptive FM > Fixed-gain FM
Thibodeau, 2014

Adaptive FM > Fixed-gain FM
Thibodeau, 2010

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RM Benefit in Noise and Reverberation for Children Who are Hard of Hearing (Lewis et al, in prep)

- Does a recently developed RM system improve speech recognition in noise and in noise + reverberation over HAs alone for children with HL?
- How do children who are hard of hearing using HAs alone or HAs + RM compare to peers with NH in noise and in noise + reverberation?
- Participants
  - 22 children with mild to severe HL (7-18 yrs)
  - 17 age-matched children with NH

Supported by funds from Oticon

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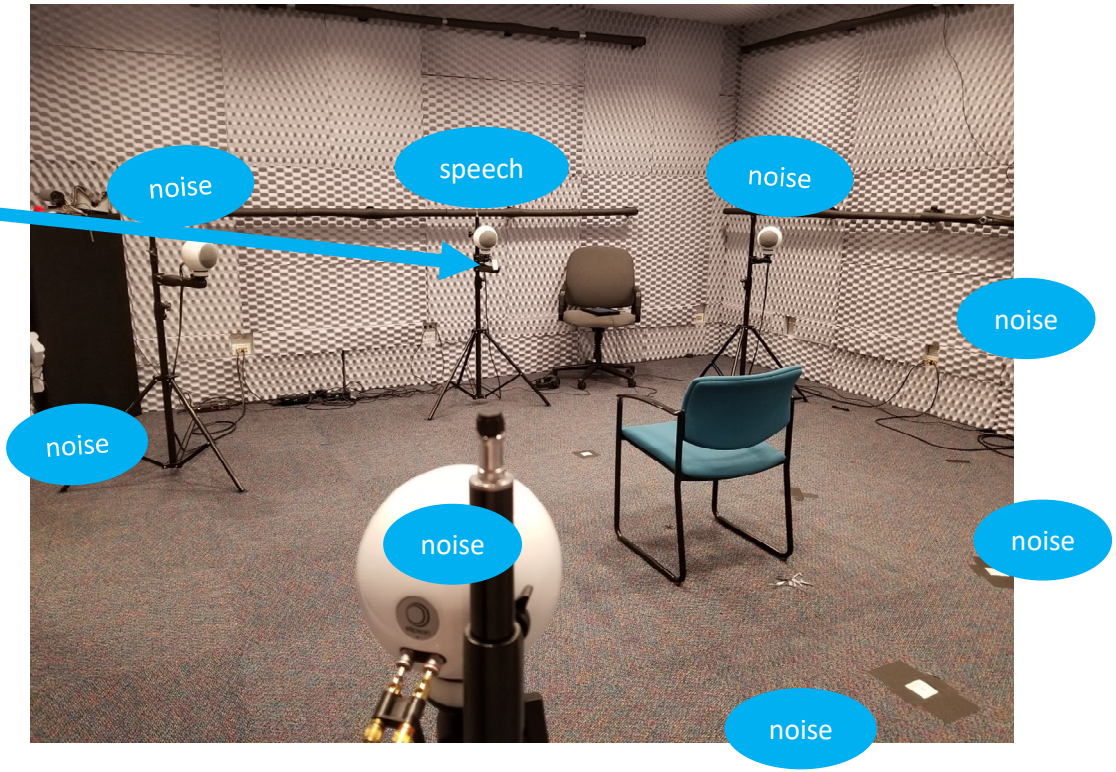
Test Conditions

SNR50 from adaptive sentence recognition task (Pediatric AZ Bio)

Noise	Noise + Reverberation
HA	HA
HA + RM	HA + RM
NH	NH



Speech = 60 dB SPL; RT = 300 ms

Lewis et al., in prep

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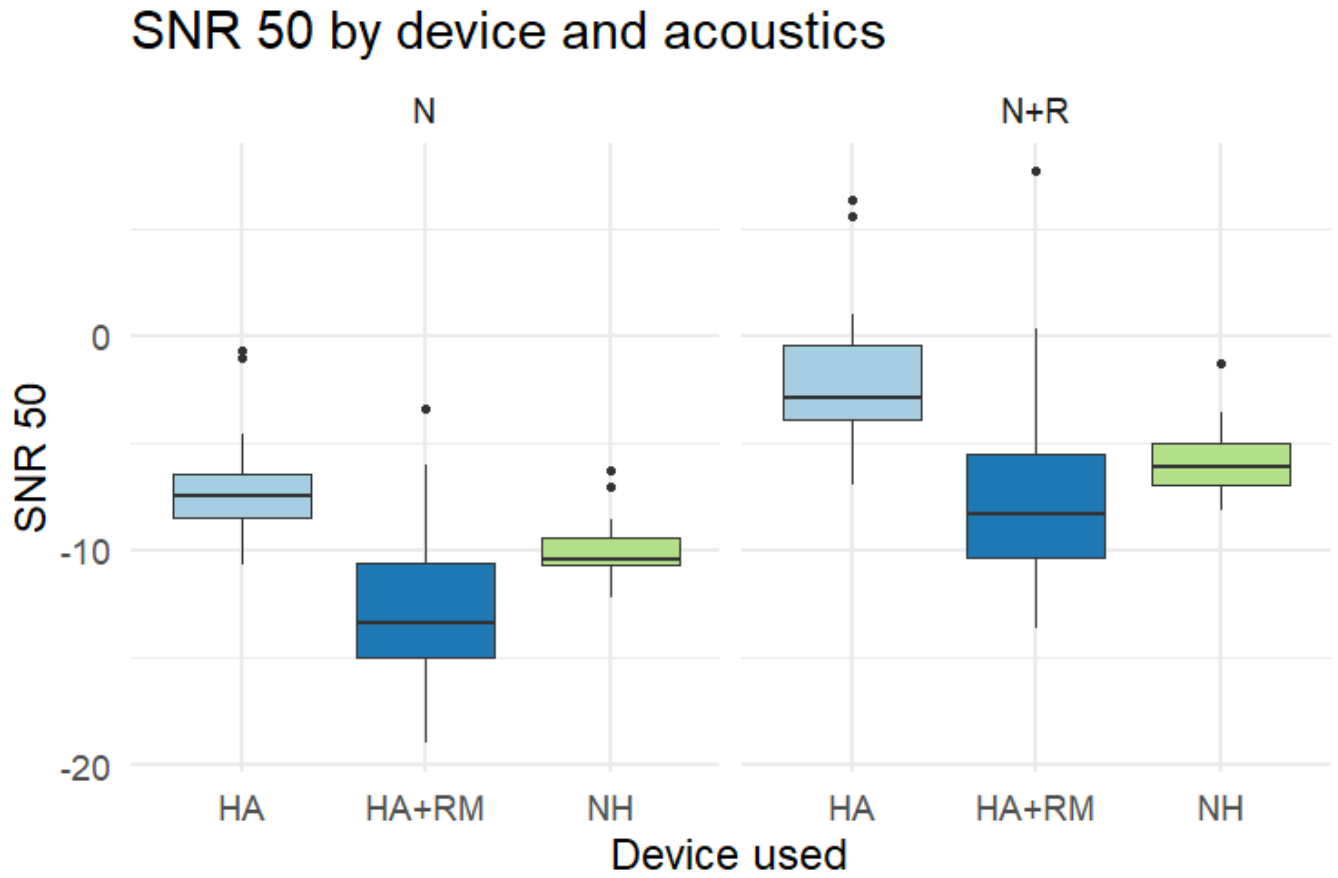
Results



Lewis et al., in prep

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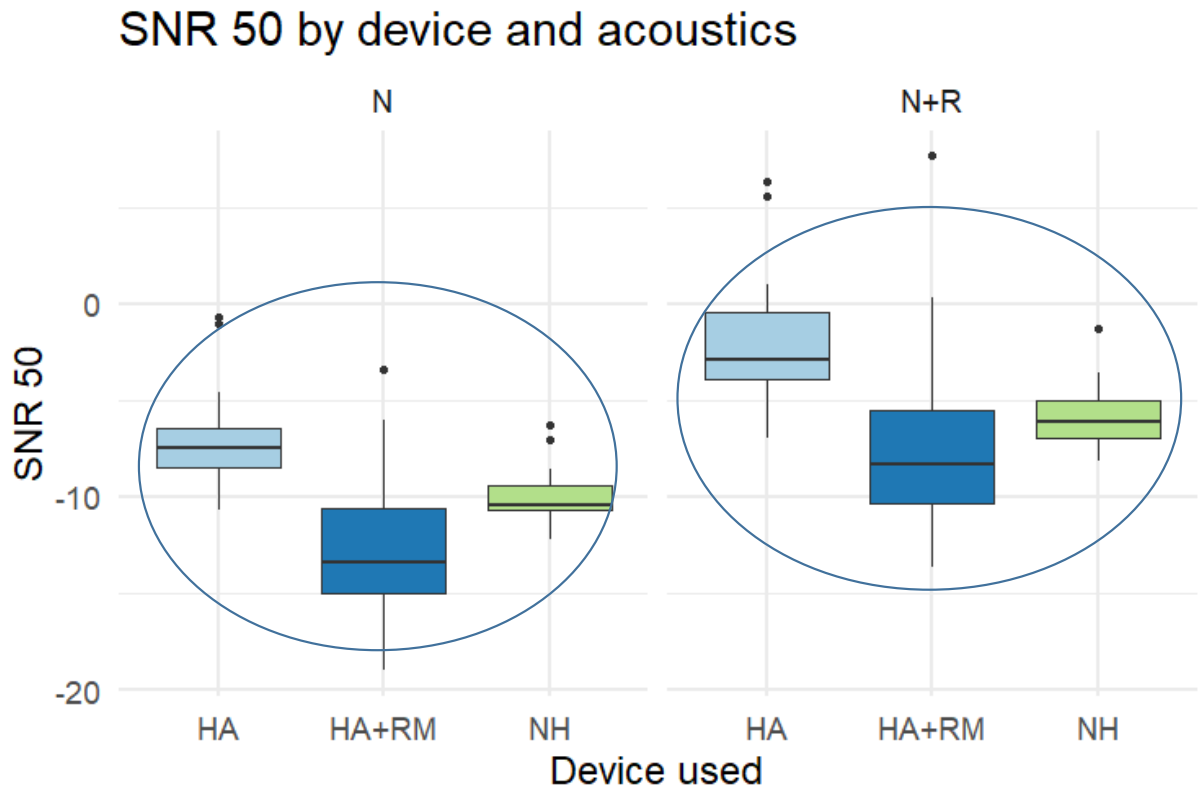
Effect of Reverberation

- Children demonstrated an almost 5 dB advantage in noise (left) when compared to noise + reverberation (right)



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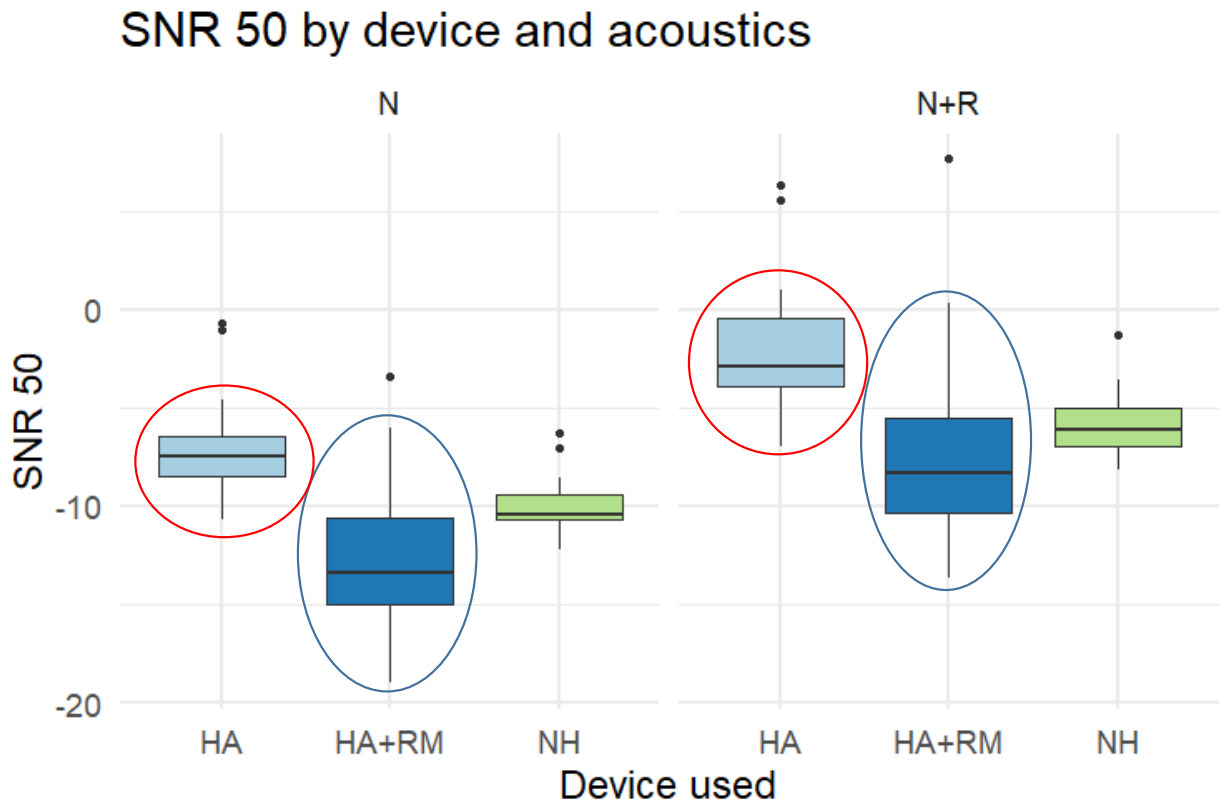
Effect of RM in CHH

- CHH demonstrated a 5.8 dB advantage with HA + RM (blue circles) when compared to HA alone (red circles)



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Effect of Audibility in CHH

- Better audibility led to lower SNR50 overall
  - Approximately 1 dB improvement in SNR50 with every 10% increase in audibility (as measured by SII)
- Effect was greater in noise + reverberation than noise alone
- RM benefit was similar across degrees of HL (audibility)

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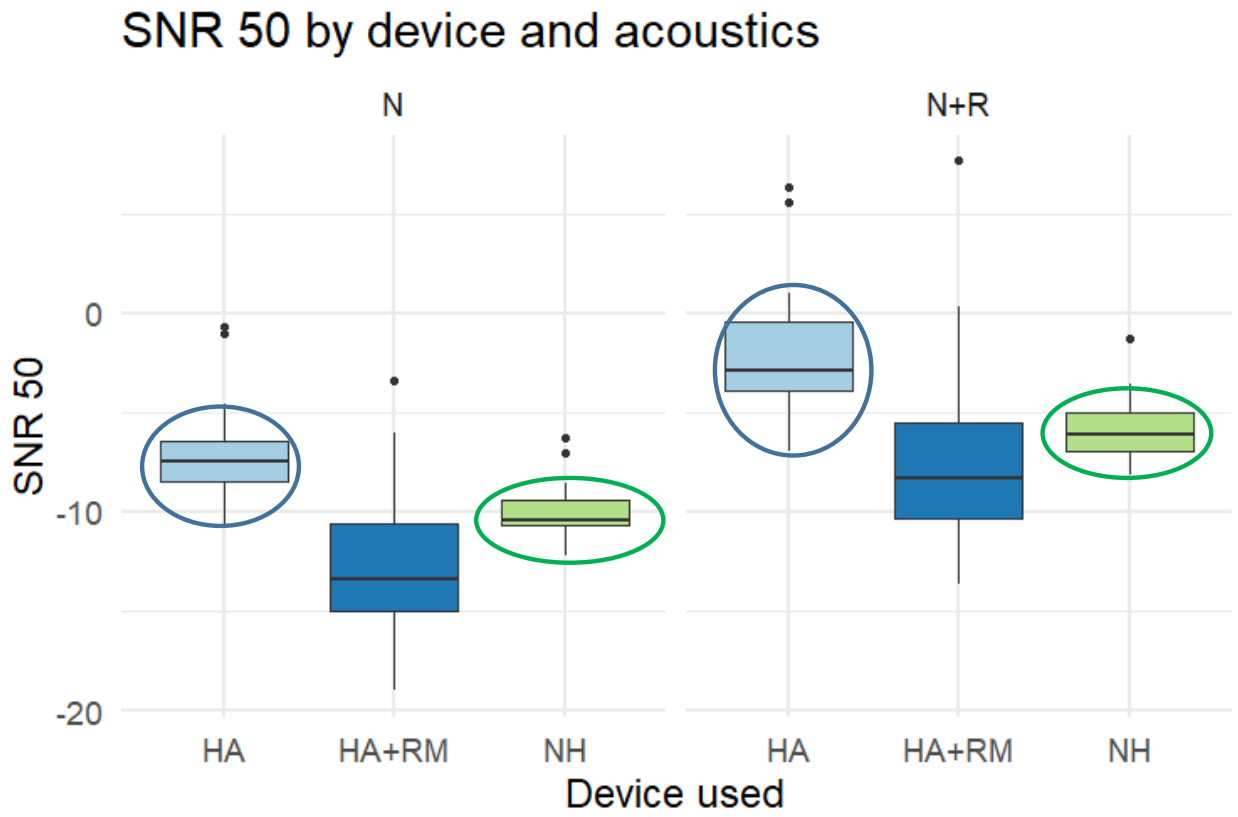
CHH with HA alone versus CNH

- CNH (green circles) showed almost 4 dB advantage when compared to CHL using hearing aids alone (blue circles)



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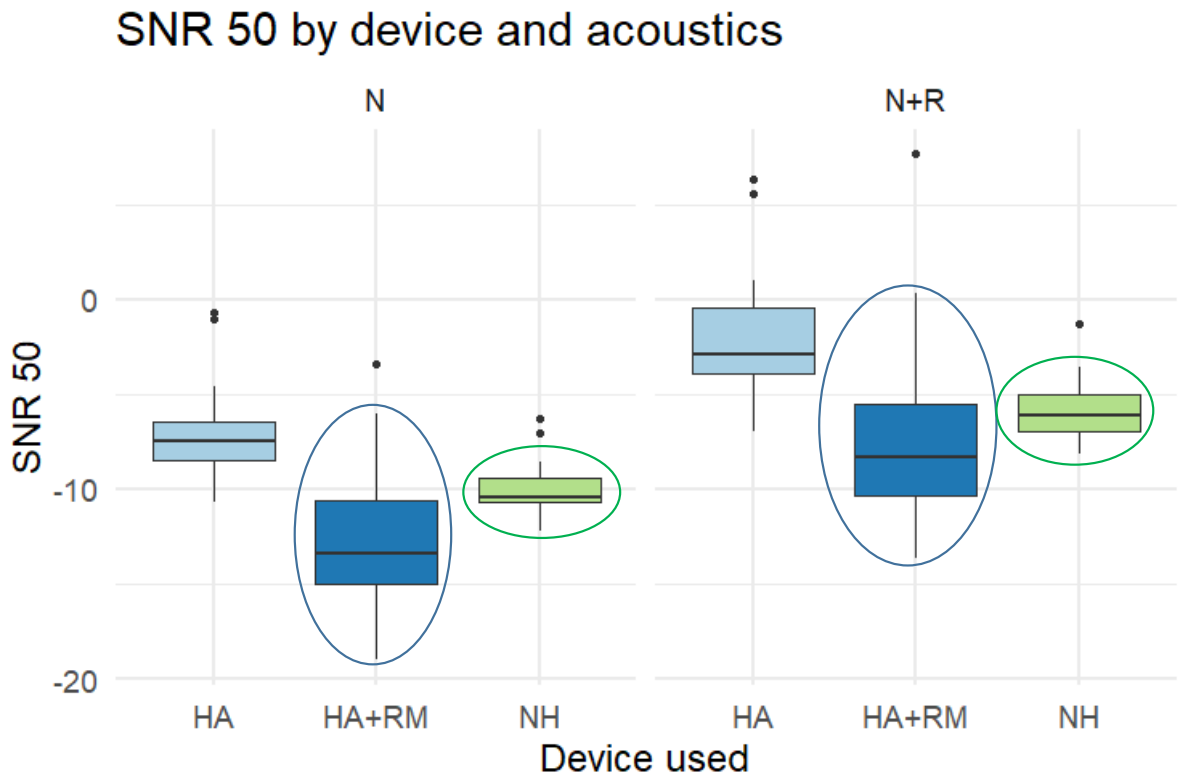
CHH with HA + RM versus CNH

- CHH using HA + RM (blue circles) demonstrated approximately 2 dB advantage over CNH (green circles)



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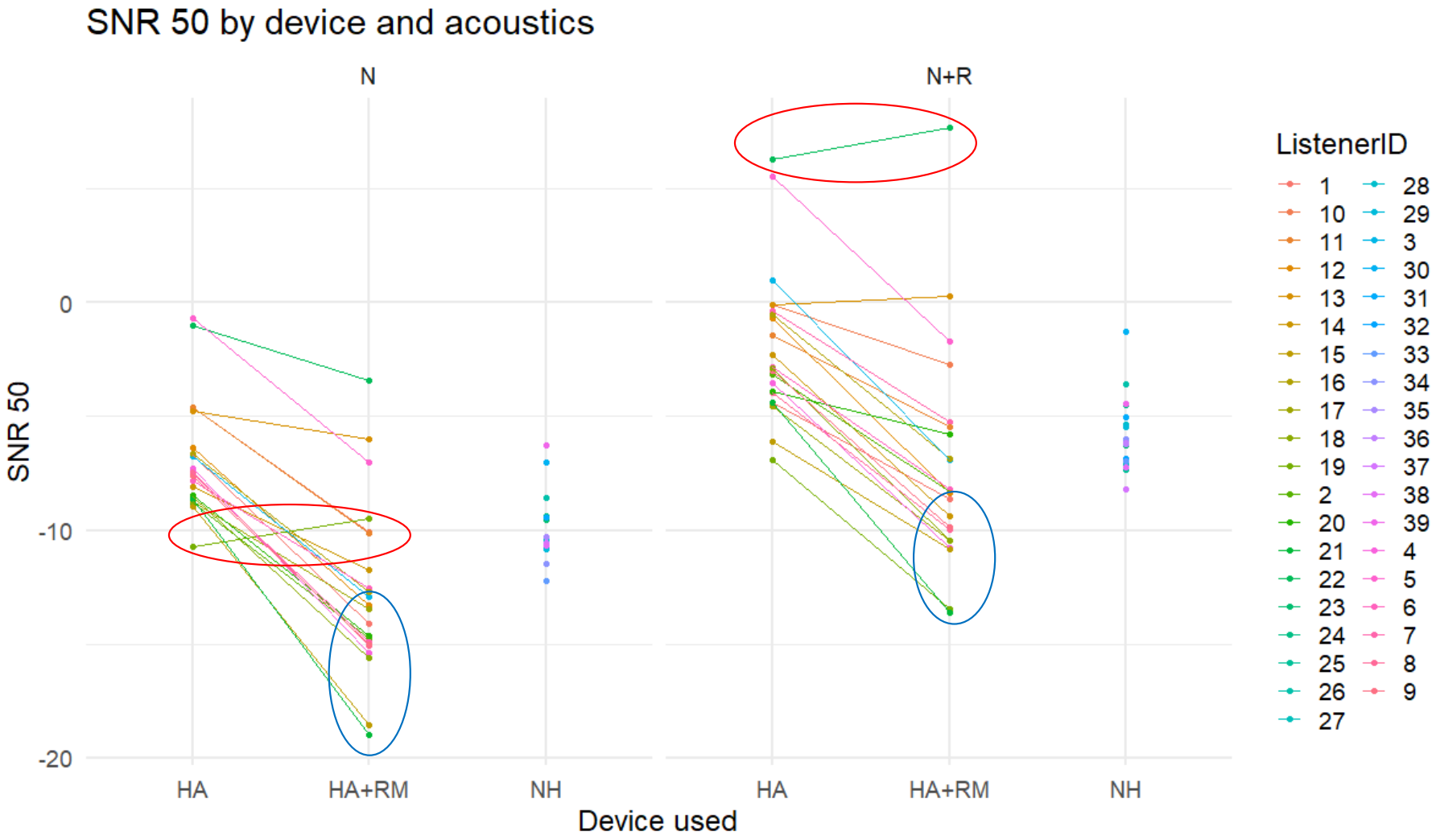

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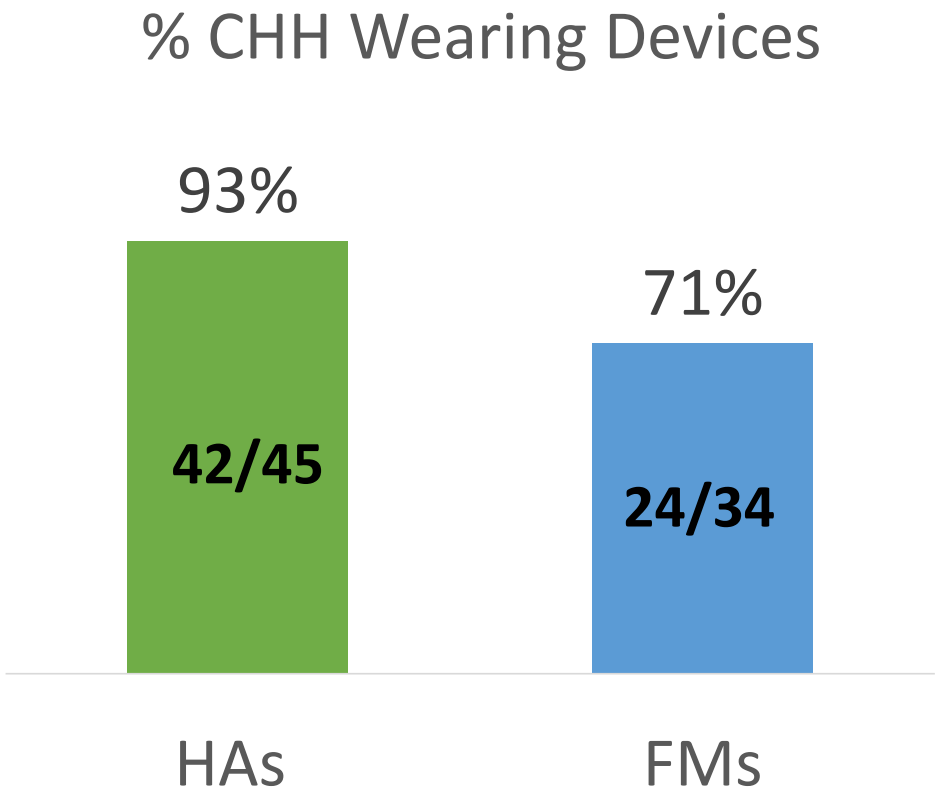
Are CHH wearing RM devices at school?



Aunan et al., 2015, poster

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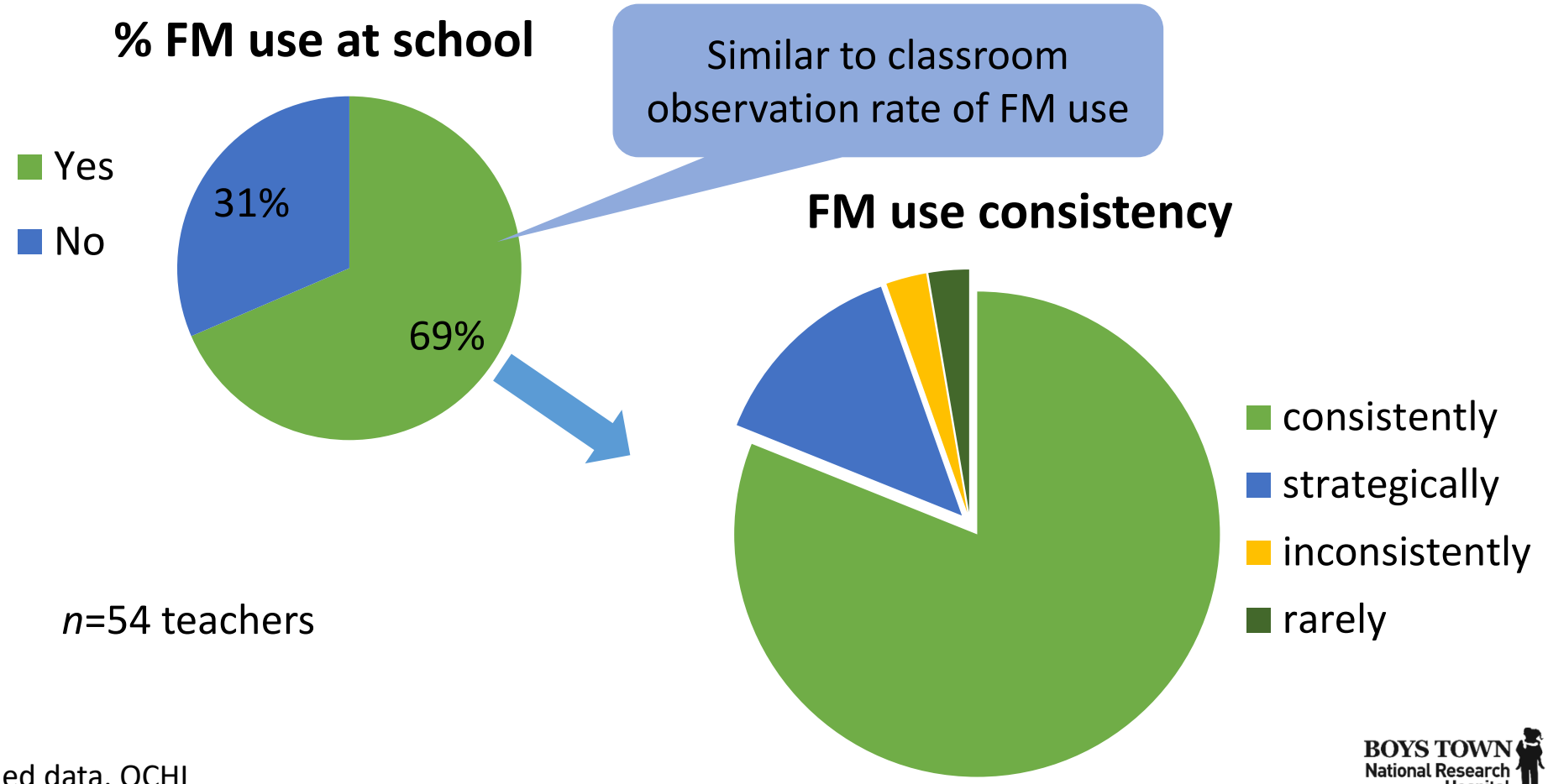
FM use at school from teacher perspective



n=54 teachers

Unpublished data, OCHL

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Children with UHL

Picou et al, 2020	Oosthuizen et al, 2021	Wolfe presentation, 2021
• No RM benef[illegible] speech reco[illegible] or compreh[illegible] over CROS, u[illegible] • CROS better f[illegible] some locations • RM always at front position	• RM benefit for [illegible] specific conditions • RM always at talker location	• Speech recognition [illegible]eased with [illegible]asing distance [illegible]n uamplified [illegible]ery small change with digital RM • Potential occlusion issues

Importance of talker and RM location when considering potential RM benefit for speech understanding

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Children who use cochlear implants

Schafer & Thibodeau 2006	Wolfe et al. 2009	Johnstone et al. 2017
• Better speech recognition across a range of CI/HA combinations with FM • Poorest FM performance when FM was added to second CI	• Better speech recognition across a range of noise levels for adaptive over fixed-gain as noise levels increased	• Across a range of mixing ratios, SNR for 80% correct was similar to that of CNH when using FM • Without FM, CNH able to tolerate a poorer SNR

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Children with normal hearing and special listening needs/auditory differences

Sound-field amplification systems have been recommended for many years (Crandell, 1991, 1996; Crandell et al., 2005)

Personal RM technology specifically designed for individuals with NH

Occlusion issues

Improvements seen in

- speech recognition/comprehension in noise
- Psychosocial/psychoeducational areas
  (Johnston et al., 2009; Rance, 2010; 2014; Schafer, et al., 2013; 2014)

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Young Children

- Auditory learning environments – homes, childcare/preschool settings

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Auditory learning environment at home

- Speech and noise levels in homes of young children with hearing loss (Benitez-Barrera et al, 2020)

Speech Plus Noise

Median = 67.5 dBC

Range = 42.8 – 83.6 dBC

SNRs were below +15 dB 84% of the time (mean = 7.9 dB)

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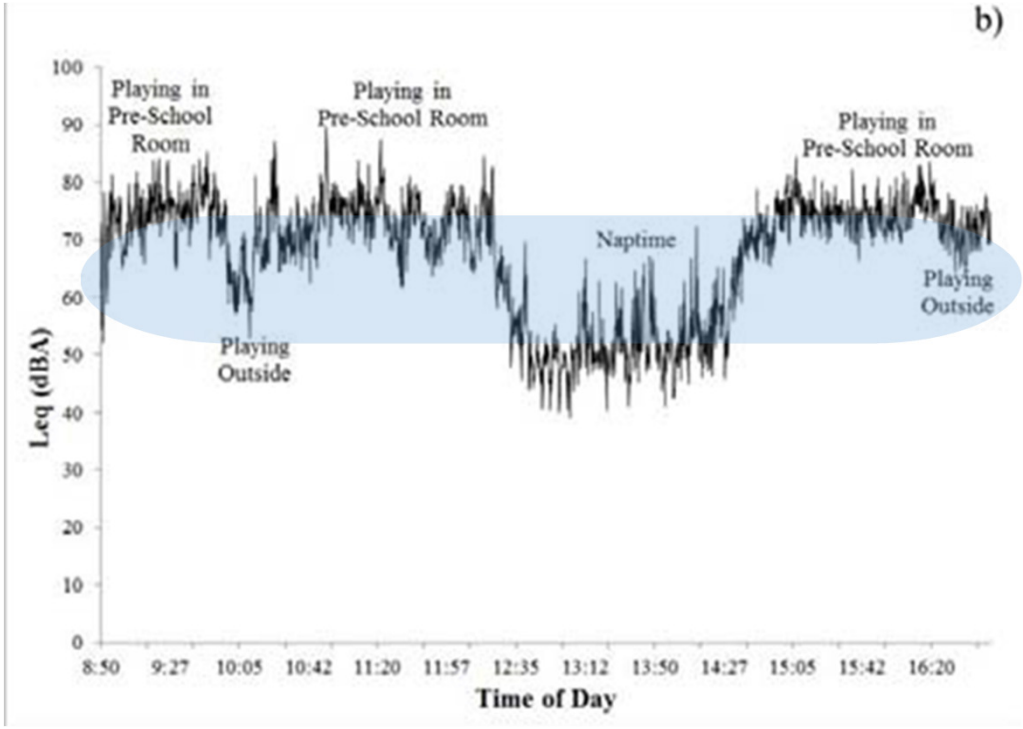
Auditory learning environment in a preschool



Crukley, Scollie, Parsa 2011

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RM Systems and Young Children

Longitudinal study of benefits of FM technology with preschoolers with hearing aids (Mulla & McCracken, 2014)

Average Daily FM Use
About 3 hrs (1.33-4.12)

Improved listening skills
Quiet
Noise
Distance
Auditory only

- Children whose language skills were low, and who used their FM systems consistently, showed substantial growth over the course of the study

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Assessing RM benefit during home use

- Children could access more words/minute with the RM system than without it. Parents rated their child as more responsive when using the RM (Benitez-Barrera et al, 2018)

- The amount of child-directed speech was the same with or without RM use. However, access to that speech was potentially greater due to reduced effects of distance (Benitez-Barrera et al., 2019)

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Examining RM system use in a large sample of preschool CHH
(Walker et al, 2019)

- 36% received a personal RM for home use

50 reporting

Use (hrs)	0	1-2	3-4	5-6
Toddlers (1-2 yrs)	54%	31%	15%	0%
Preschoolers (3-4 yrs)	32%	57%	5%	5%

41 reporting

Listening Environments	Car	Meal Times	Book Sharing	Playground	Public
Toddlers (1-2 yrs)	44%	19%	25%	49%	81%
Preschoolers (3-4 yrs)	24%	22%	42%	59%	59%

Approximate values for ratings of always/often/sometimes, adapted from Fig 2

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- Half of participants in preschool received an RM system for school and 43% of those also had one at home

39 reporting

Use (hrs)	School
0	0%
1-2	15%
2-4	62%
4-6	8%
6-8	15%

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- Examining the impact of RM systems on language outcomes in a large group of CHH who received RM systems for home use by 4 yrs of age (Curran et al, 2019)
  - Two groups (RM vs no RM in home settings), matched on a range of baseline characteristics
  - Predictors of RM receipt:
    - Better ear PTA
    - Testing site
  - Home receipt of a RM system had a significant positive effect on receptive and expressive discourse measures but on not vocabulary or morphosyntax at 5 yrs of age

Some Take Home Messages

- As RM- and HA-technology advance, RM benefits for access to speech from talkers using the microphone continue to improve
  - Continued research is needed to address issues related to access to those with and without a RM
- RM systems can improve communication access for a diverse group of children who experience difficulties accessing speech (and other sounds) in noise, distance, and reverberation
  - Continued research is needed for children with normal hearing and special listening needs
- RM systems have the potential to improve communication access for young children in a range of environments
  - Continued research is needed

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Questions?

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Thank you