
Noise Technologies: What do kids need, and what do they want?

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Shoot for the Moon!



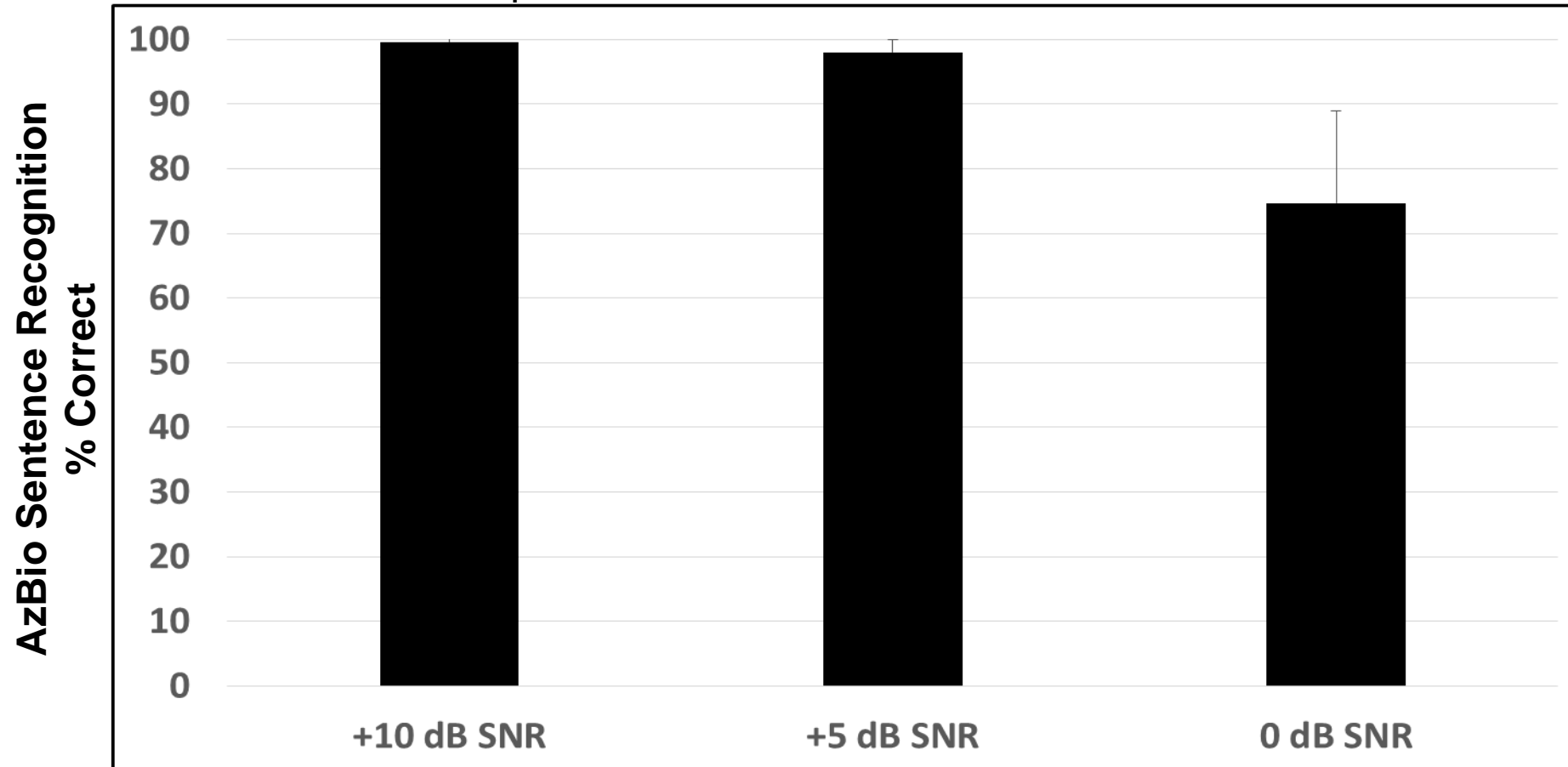
*Shoot for the Moon! Even if you miss,
you will land among the stars!*

-Norman Vincent Peale



Shooting for the Moon

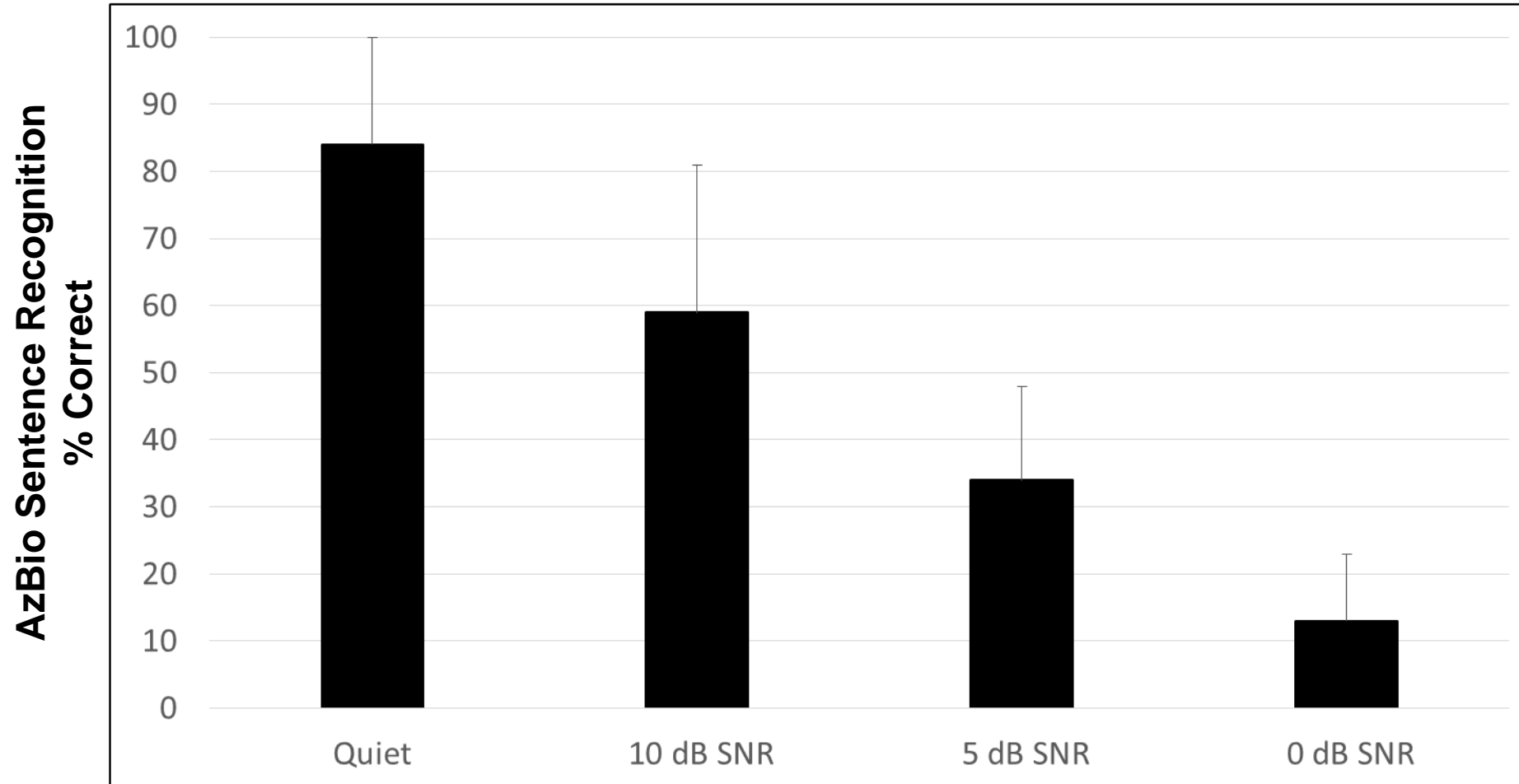
Wolfe et al., 2015, Unpublished Data



n = 10 Young Adult Normal Hearing Listeners

Houston, we have a problem!

These are adults. Children will have greater difficulty.



A Noisy World!

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

- Living Room:
 - 37 dB A (with A.C. = 52 dBA)
- Classroom:
 - 63 dBA
- Dr.'s Waiting Room (4:00 pm):
 - 76 dBA
- Public Transportation:
 - 79 dBA
- Family Restaurant:
 - 84 dBA
- OKC Thunder Basketball:
 - 103 dBA



Imran Mulla, 2013

- LENA Data Logging in Infants/Toddlers
 - Car seat (70 mph): -10 dB SNR
 - Bus: -10 dB SNR
 - Stroller: -8 dB SNR
 - Shopping cart: -6 dB SNR
 - Car seat (30 mph): -5 dB SNR
 - Wind Noise: -3 to -10 dB SNR



For children with hearing loss, we can shoot for the moon!



Road Map

- Points of Discussion
 - Identifying noise management technologies that allow children to shoot for the moon
 - Results of studies evaluating modern noise management technologies



Noise Management Technologies

- Adaptive Noise Reduction (Adaptive Gain Reduction)
- Directional Microphone Technology
 - Automatic, adaptive directionality (UltraZoom)
 - Binaural beamforming (StereoZoom)
- Changes in gain-frequency response
 - e.g., Phonak Noise frequency response
- Remote Microphone Technology (Roger)

Studies supporting use of Noise Reduction (NR)

- NR use resulted in no change in speech recognition in noise

– Stelmachowicz et al., (2010) Ear and Hearing

- No degradation in speech recognition in noise with the use of NR

f

That's
what
kids
want!!!!

se

- N

– Pittman (2011b) J Speech Language Hearing Research

- Shorter verbal response time with use of NR

– Gustafson et al. (2014) Ear and Hearing

Directional Technology for Children

- Experts are divided as to whether directional technology should be used with young children
- Historically, guidelines have varied in recommendation for use/non-use of directional technology in children
 - Ontario Infant Hearing Program Amplification Protocol (2014)
 - American Academy of Audiology Pediatric Amplification Guideline (2013)
 - Australian National Protocol for Paediatric Amplification (King, 2010)
 - Harvey Dillon's Hearing Aids textbook (Dillon, 2012)

3 Studies looking at Noise Management Features of the Venture Platform and beyond

Automatic Noise Management Technology for Children

- 15 Children
 - Moderate to severe hearing loss
 - Pure Tone Average (Better Ear): 53.9 dB HL
 - Ages 9-14 y.o. (mean = 12 y.o.)
- Compared performance across 3 conditions:
 - Default pediatric program (Real Ear Sound-RES)
 - Automatic, adaptive noise management (AutoSense)
 - Manual noise management (e.g., Speech in Noise)

Automatic Noise Management Technology for Children

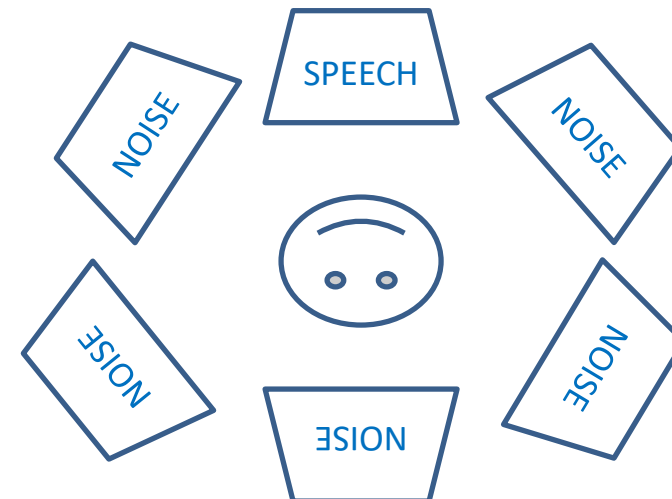
- Phonak Audeo V90 hearing aids fitted to DSL v5.0 target
- Children wore hearing aids for 2-4 weeks with default pediatric program

Testing was completed in 3 phases:

- Phase 1
 - Speech recognition in noise across three technology conditions
- Phase 2
 - 4-week real-world trial with journaling to capture technology preference in everyday use
- Phase 3
 - Speech Intelligibility Rating Index (Cox & McDaniel, 1989)-wont review in interest of time.

Automatic Noise Management Technology for Children

- AzBio Sentences (Spahr et al., 2012) & Classroom Noise (Schafer & Thibodeau), 2006)
- Four Acoustic Situations (Pearsons et al., 1977)
 - **Speech in Noise**
 - Speech: 60 dBA/Noise: 55 dBA
 - **Speech in Loud Noise**
 - Speech: 72 dBA/Noise: 70 dBA
 - **Car**
 - Speech: 55 dBA/Noise: 50 dBA
 - **Quiet**
 - Speech: 60 dBA
- Three Hearing Aid Programs
 - RES vs. Manual vs. AutoSense
 - Double blinded – Counter-balanced

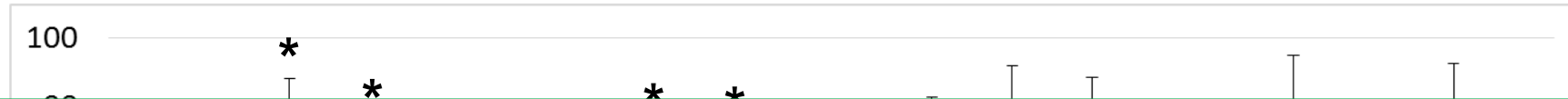


Automatic Noise Management Technology for Children

- 3 Hearing Aid Programs:

1. Calm: minimal noise reduction; microphone mode set to Real Ear Sound (RES), **which attempts to mimic natural directionality of the ear**
2. AutoSense OS: contains an environmental classifier to select the noise management technologies that would optimize hearing performance (e.g., in noisy situations, adaptive directional mode active, and gain attenuation provided by noise reduction (NR) processing).
3. Manual directional program: Condition-specific that was manually selected by the clinician.
 - Speech in Quiet: NR set to weak setting, microphone set to RES
 - Speech in Noise: NR set to weak, microphone set to UltraZoom (adaptive beamformer) – **1st-order Dual Mic**
 - Speech in Loud Noise: NR set to moderate, microphone set to StereoZoom, (binaural beamforming) – **3rd-order Binaural Beamformer**

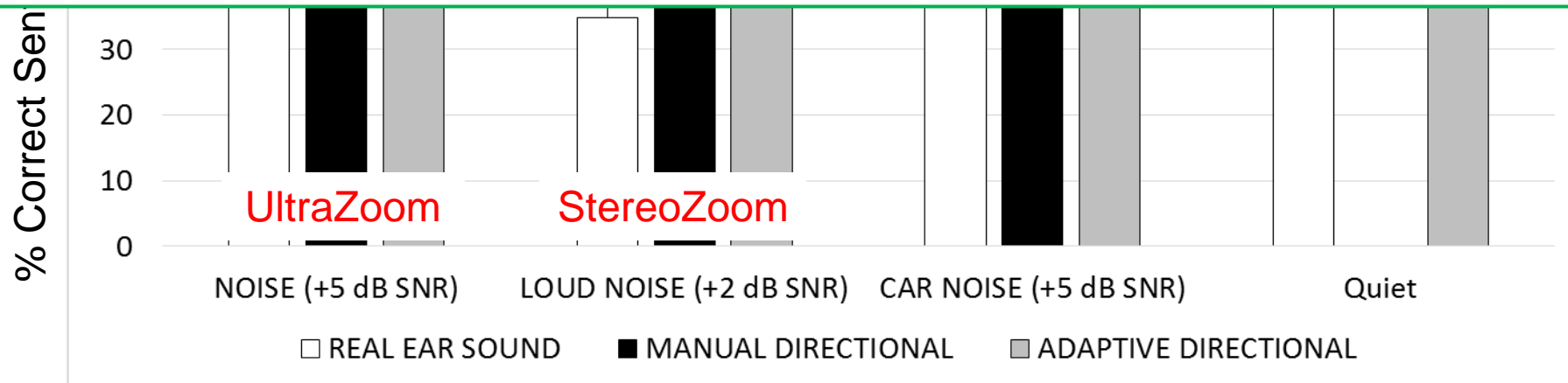
Sentence Recognition Results for Automatic Noise Management Technology for Children



Kids are busy!

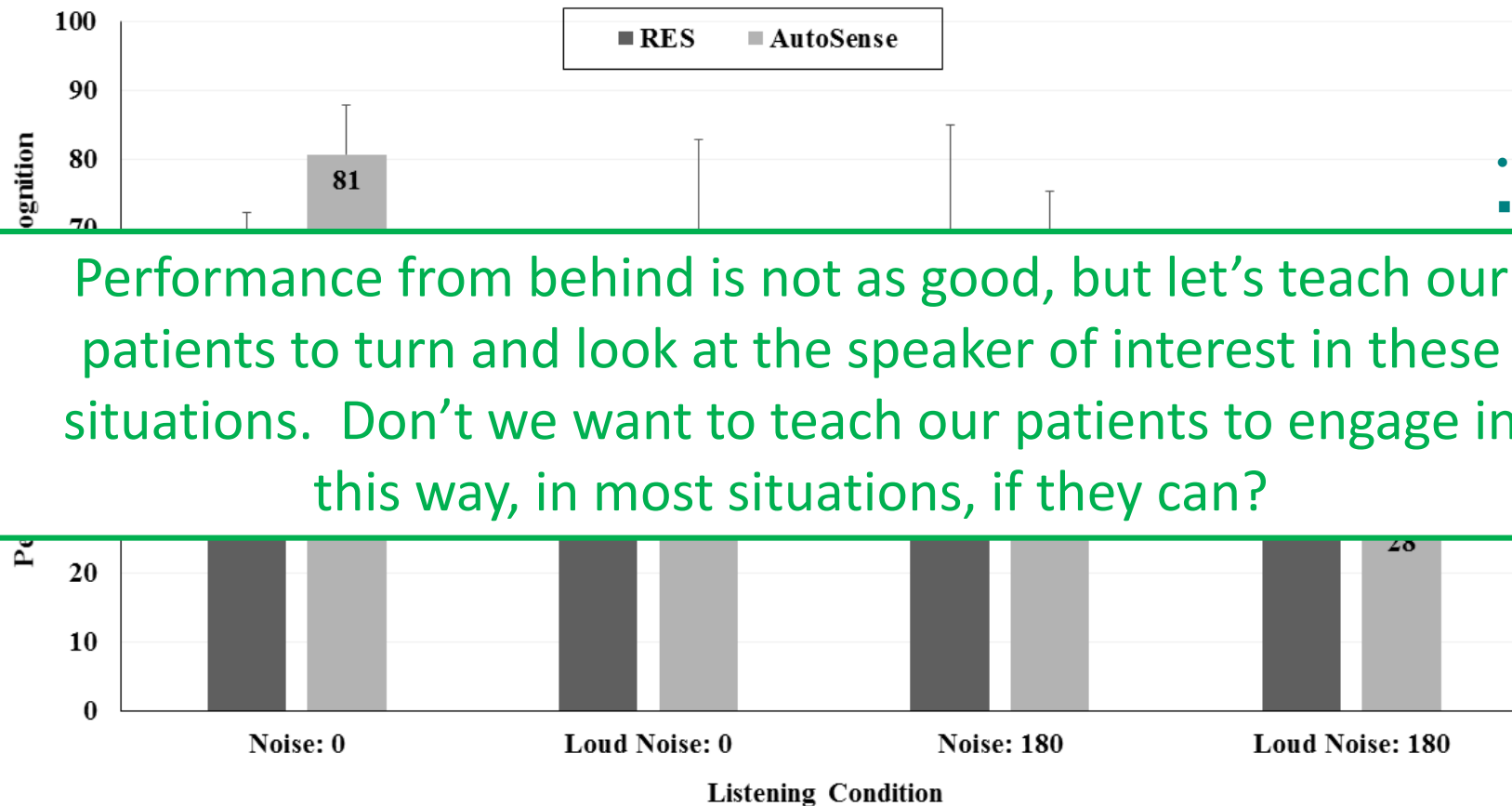
They don't want to have to remember to change their program.
They don't want to draw attention to themselves to change a program!!

They want it to be EASY!



Automatic Noise Management Technology for Children

Wolfe et al, (2017) JAAA



- **Design – Test Session 2:**
 - Examined effects of directional technology when the talker is behind the listener (speech at 0 vs. 180° azimuth)
 - Speech intelligibility ratings & journals
- **Session 2 Results:**
 - Speech at 0 better than speech at 180
 - AutoSense better than RES for in the speech at 0 condition
 - RES better than AutoSense in 180 conditions

Automatic Noise Management Technology for Children

- **Participant Journals:**
- **Most participants preferred AutoSense (positive ratings) over RES**
- **Not a single child preferred the pediatric default over AutoSense**

Date: _____

Location: Restaurant

1- Which program sounds best?

A_B A_B AB B_A B_A

2- Which program is more comfortable?

A_B A_B AB B_A B_A

3- Which program helps understand speech better?

A_B A_B AB B_A B_A

4- Which program makes the noise go away the most?

A_B A_B AB B_A B_A

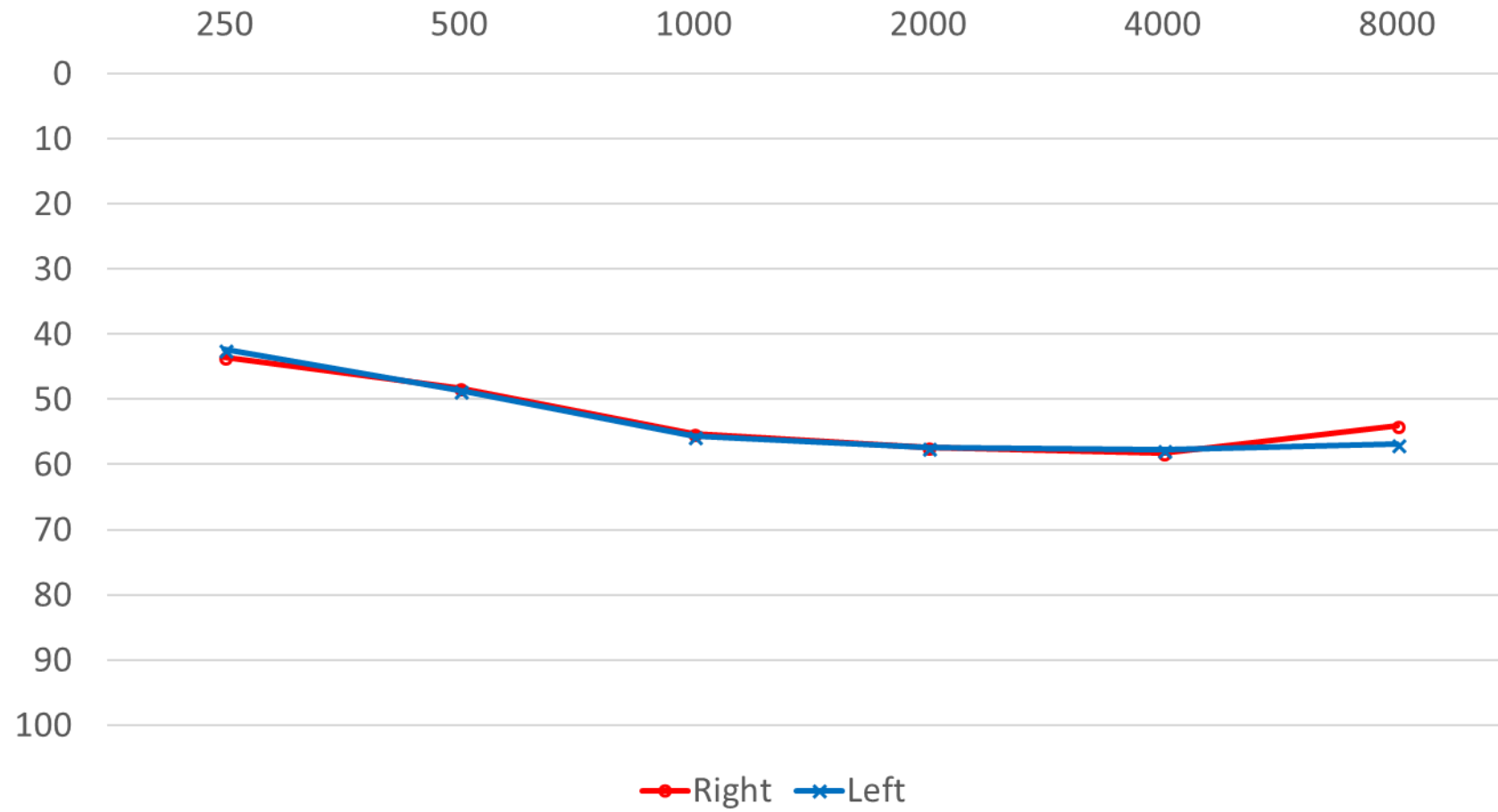
New Noise Technology Study

Primary Objectives

- Primary Objectives
 - What contribution do various noise management technologies make to speech recognition in noise?
 - What is the impact of various microphone modes on the localization abilities of pediatric hearing aid wearers?
 - What noise management technologies do children prefer to use in a classroom setting?

- 14 school-age children with moderate to moderately-severe hearing loss fitted with Phonak Sky V-90 hearing aids with occluding earmolds
- Hearing aids fitted to DSL 5.0 targets
 - 55, 65, 75 dB SPL “Standard Speech” signal
 - RESR85

Mean Audiogram



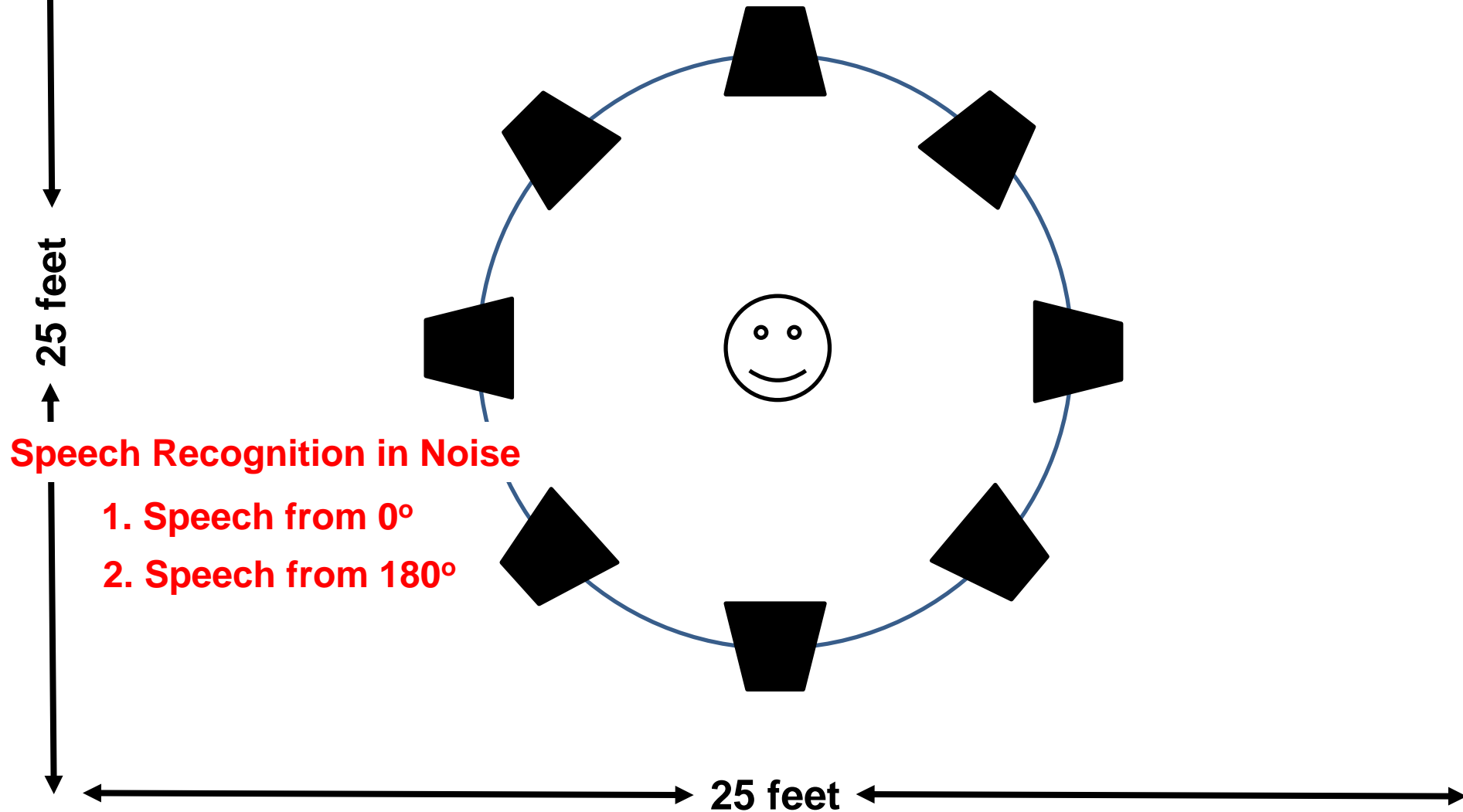
- 5 Hearing Aid Programs (simulated classroom)
 - 1. DSL 5.0 Frequency Response, Omni Mic, NR Off
 - 2. “Noise” Frequency Response, Omni Mic, NR On
 - 3. DSL 5.0 Frequency Response, Adaptive Directionality (UltraZoom), NR Off
 - 4. DSL 5.0 Frequency Response, Real Ear Sound, NR Off
 - 5. “Noise” Frequency Response, Adaptive Directionality (UltraZoom), NR On
- 3 Microphone Modes (localization task)
 - Omnidirectional
 - Phonak Real Ear Sound
 - Adaptive Directional (Phonak UltraZoom)

Assessments

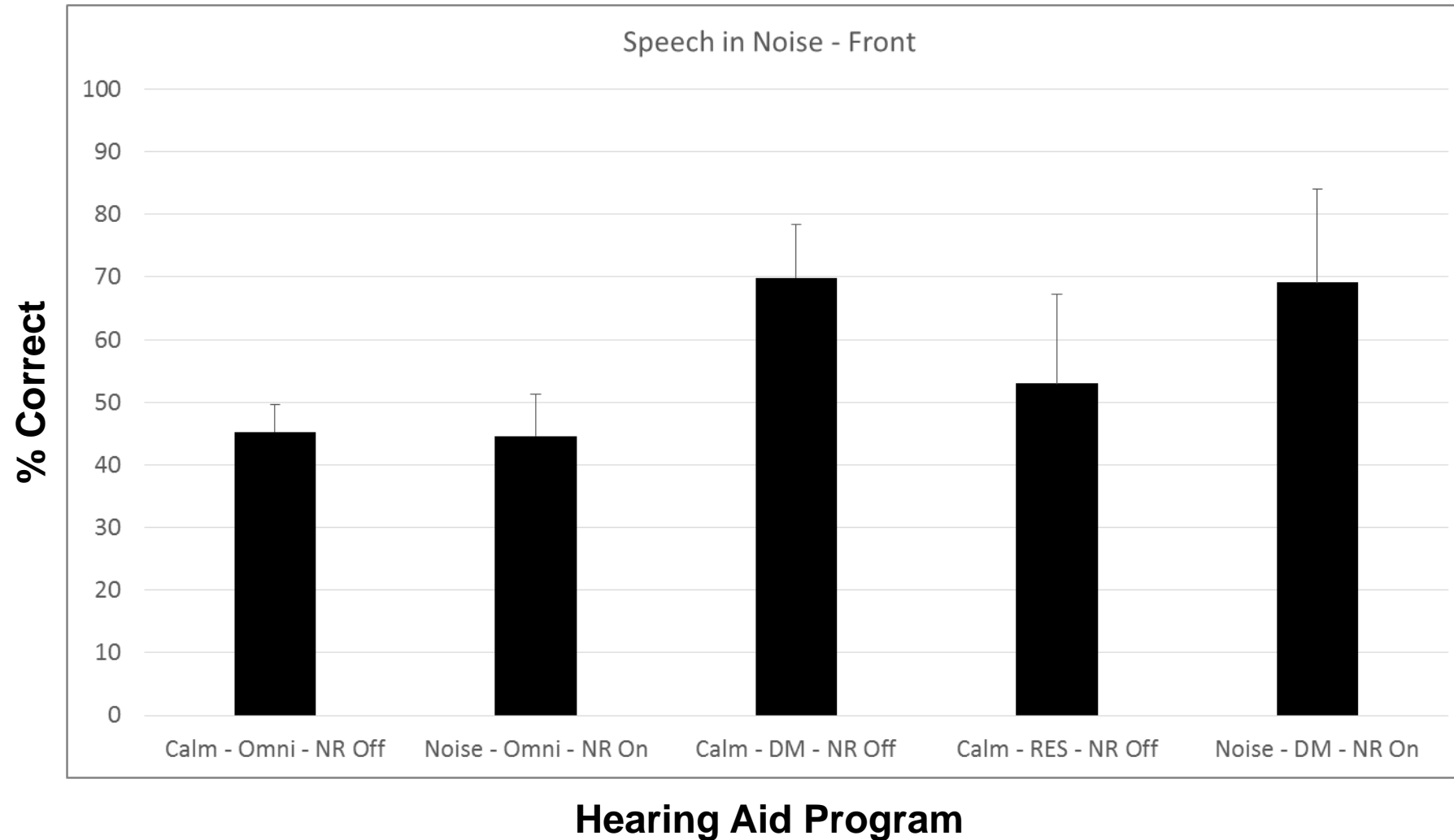
- **Speech Recognition in Noise**
 - AzBio Sentences at 73 dBA
 - Classroom Noise presented at level resulting in score of 30-50% correct in default program (**DSL freq response, Omni, NR off**)
 - Speech from 0° and 180°
- **Localization**
 - “Dog bark” at 70 dBA in classroom noise at 62 dBA
- **MUSHRA Preference Task**
 - Rank-order each program for “Carrot Passage” at 73 dBA at noise level used in speech recognition in noise task
 - Comfort, speech recognition, and overall favorite
 - Speech from 0° and 180°

Simulated Classroom Environment

Distance from each loudspeaker to subject = 4'3"



Speech Recognition in Noise – Speech 0°

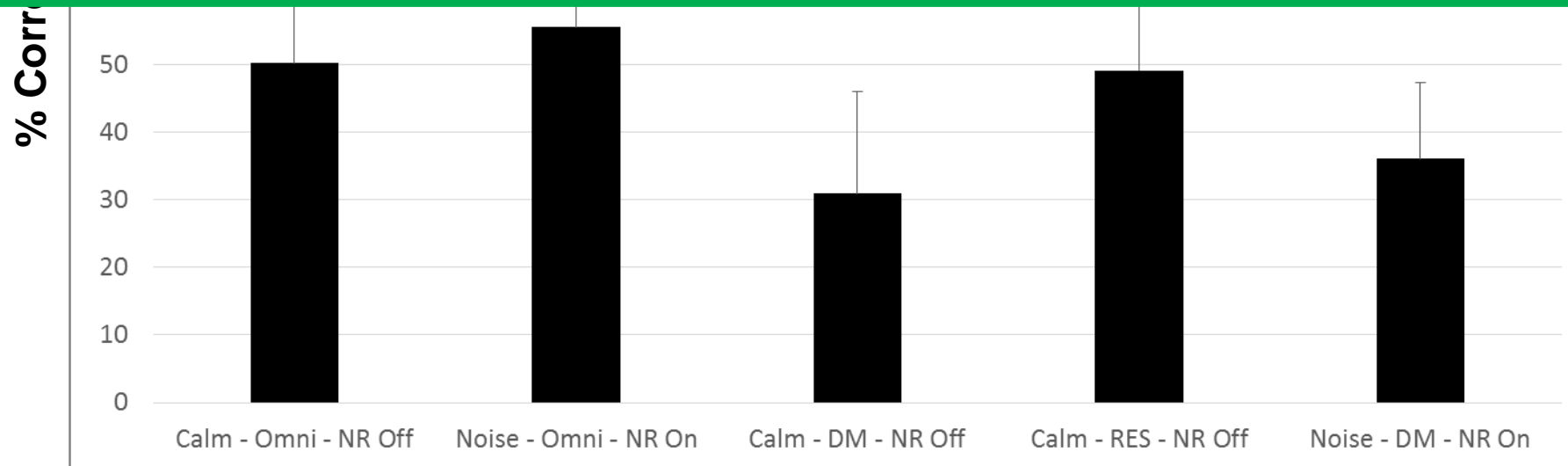


Speech Recognition in Noise – Speech 180°

Speech in Noise - Behind

100

When we teach children to orient to the speaker of interest, their benefits continue to outweigh the decrement when listening to speech from behind.

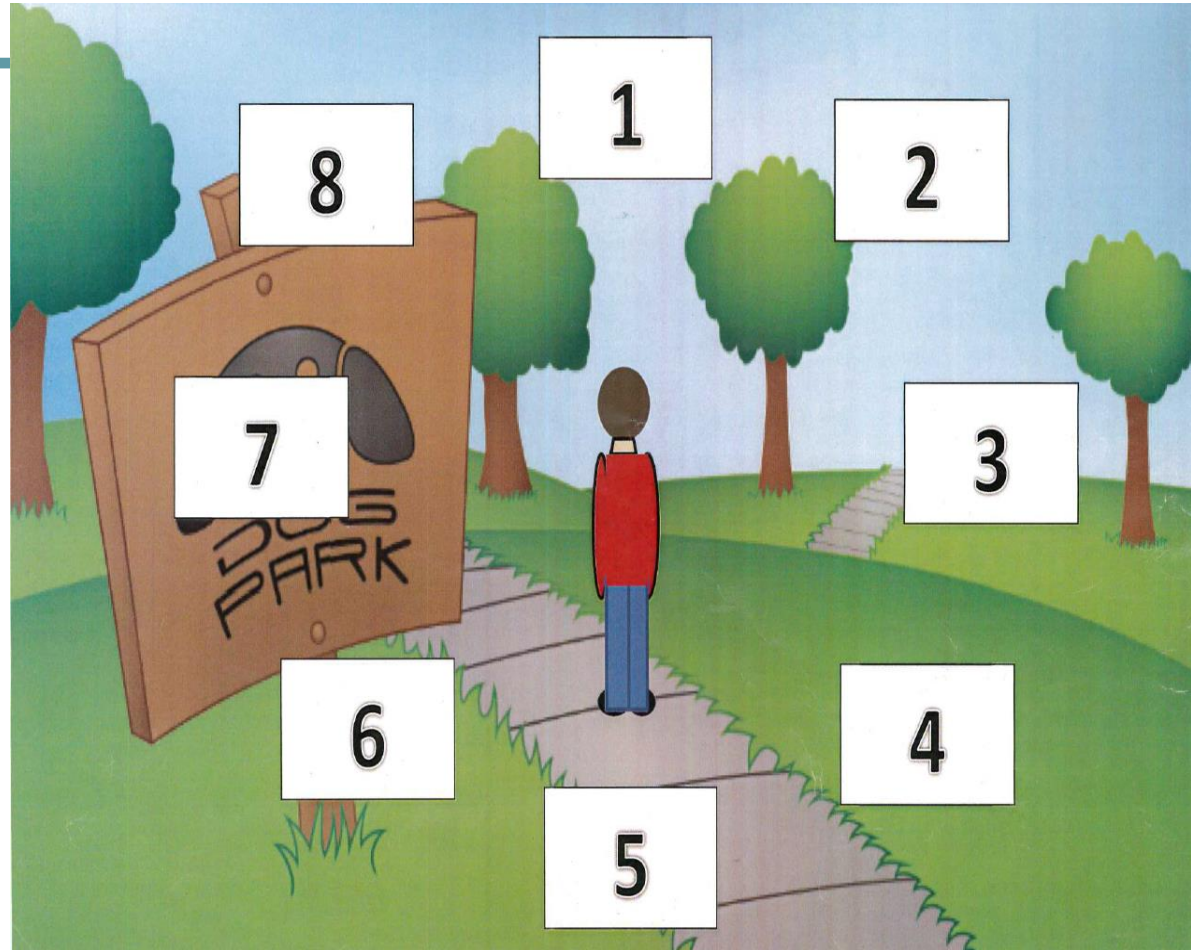


Hearing Aid Program

Assessments

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 - AzBio Sentences at 73 dBA
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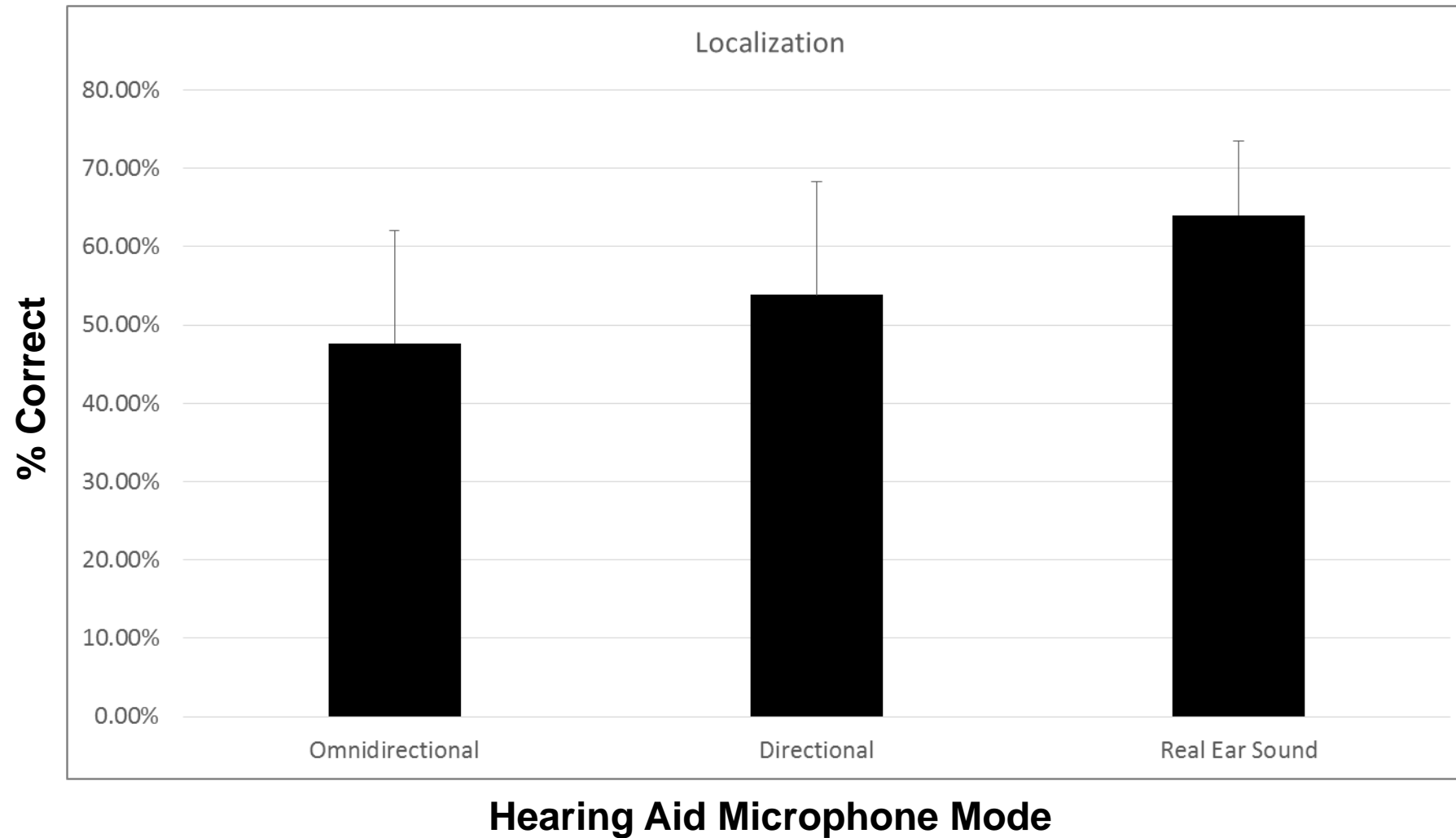
Localization Task



3 Microphone Modes

1. Omnidirectional
2. Real Ear Sound
3. Adaptive Directional

Localization

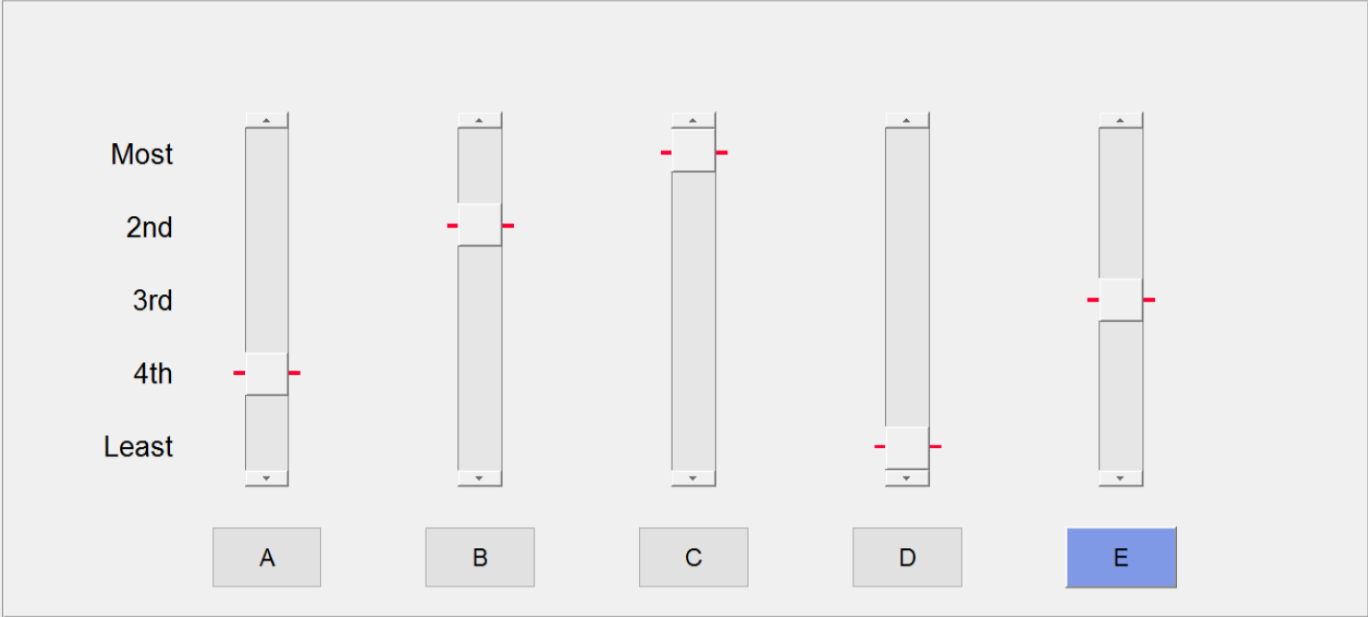


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MUSHRA Task

Which program is most comfortable?



The interface displays five vertical sliders, each representing an audio program (A, B, C, D, E). The sliders are positioned on a scale from 'Least' at the bottom to 'Most' at the top. Red dashed lines indicate the current selection for each program. Program E is highlighted with a blue background, indicating it is the selected answer.

Program	Ranking (Least to Most)
A	4th
B	2nd
C	3rd
D	4th
E	1st

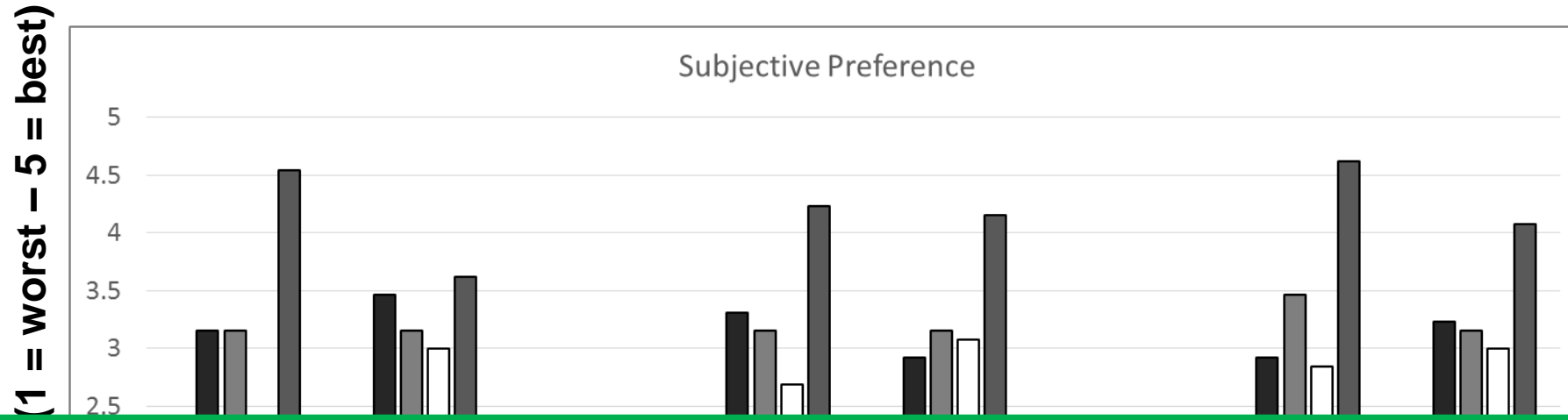
Most
2nd
3rd
4th
Least

A B C D E

Trial

>>
Next

“Noise” Frequency Response with Ultra Zoom was preferred over all other settings with hearing performance and comfort!



When we account for preference and teach children to orient to the speaker of interest, they will likely experience satisfaction with hearing performance and comfort.

Subjective Preference

Comfort Comfort Speech

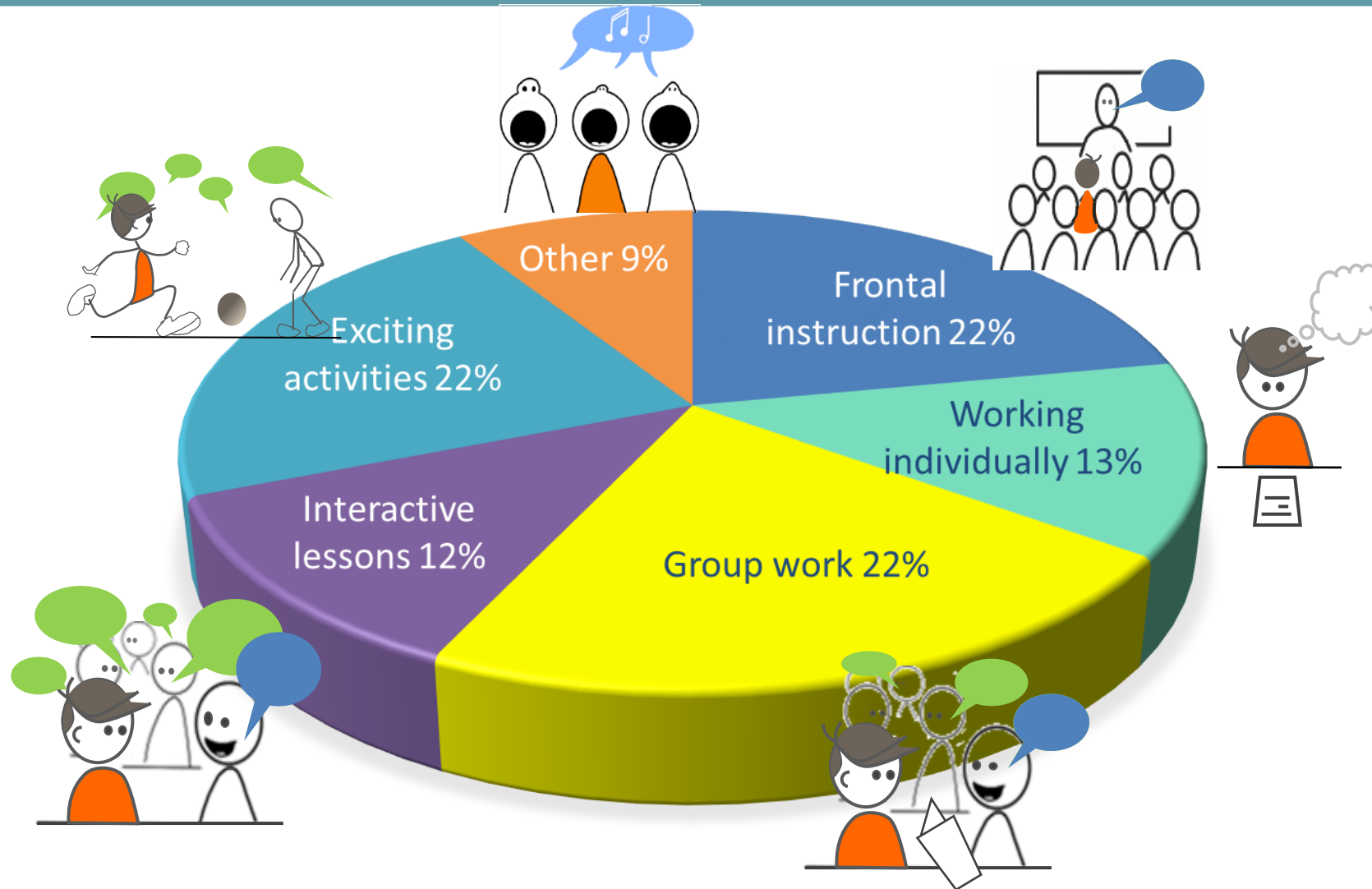
Calm - Omni - NR Off
 Noise - Omni - NR On
 Calm - DM - NR Off
 Calm - RES - NR Off
 Noise - DM - NR On

Hearing Aid Program

But, that's not all....

What about a truly typical classroom situation in today's settings?

Acoustics of a child's school day



New Study with Phonak Sky Venture Noise Management Technology for Children

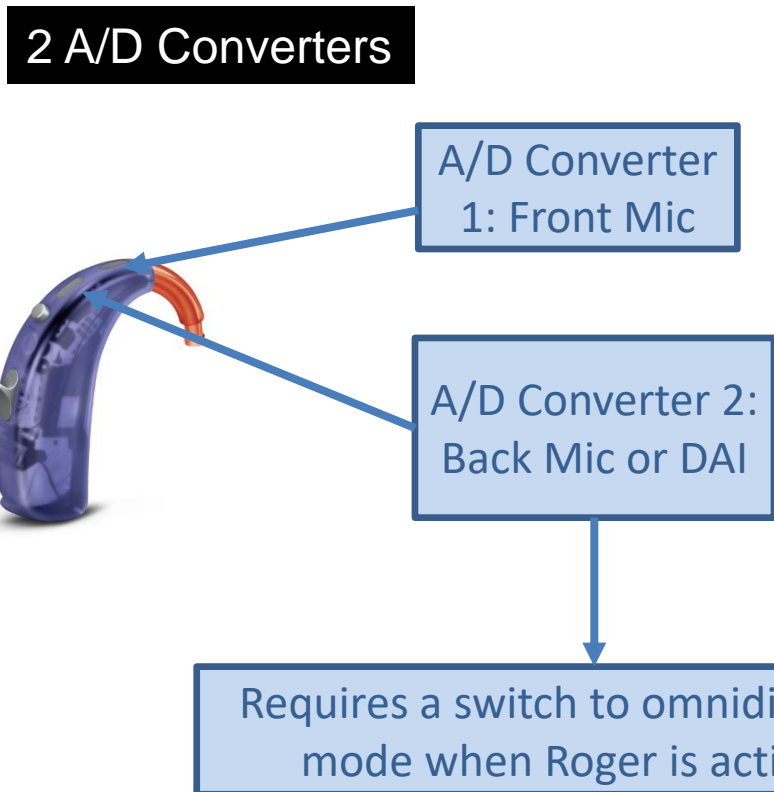
Evaluation of Roger + Adaptive Directional

Automatic Noise Management Technology for Children

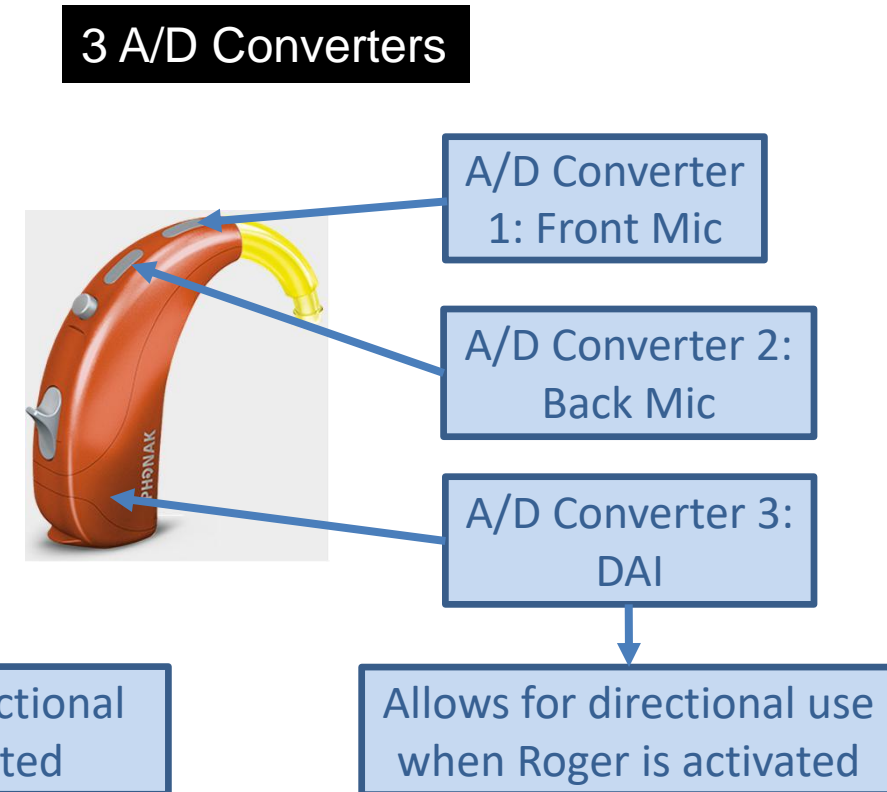
- Wolfe et al., in press
- Participants:
 - 15 children, ages 8-17 years old
 - Mild to severe hearing loss
 - Previous users of digital behind-the-ear hearing aids
- Methods
 - Evaluated speech recognition across different conditions with Roger+Omni and Roger+Adaptive Directional

Automatic Noise Management Technology for Children

- Phonak Quest

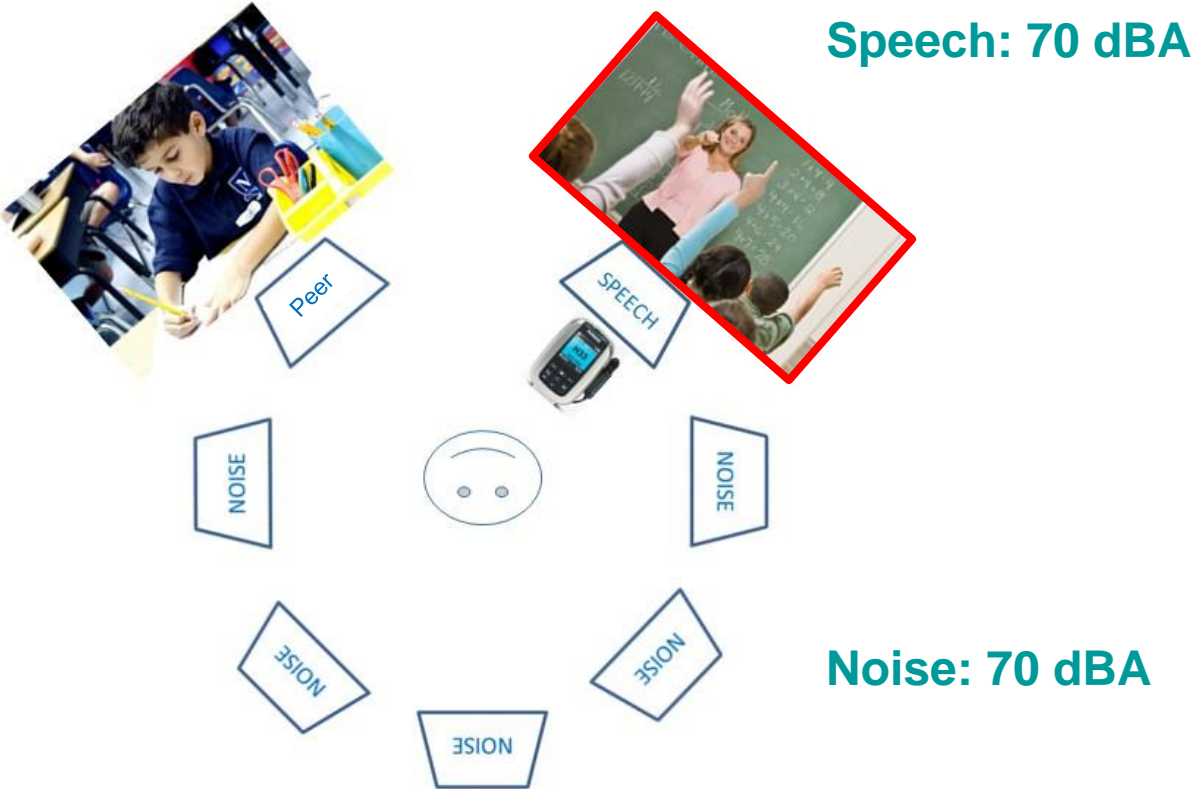


- Phonak Venture



Automatic Noise Management Technology for Children

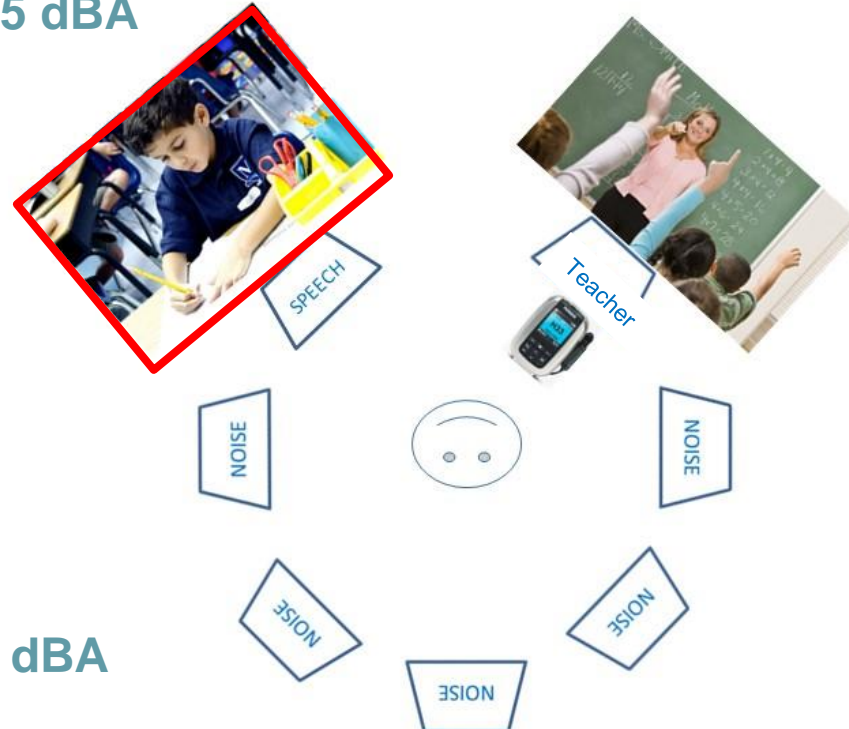
Talker: Teacher – Remote Mic



Automatic Noise Management Technology for Children

Talker: Peer – Front

Speech: 65 dBA



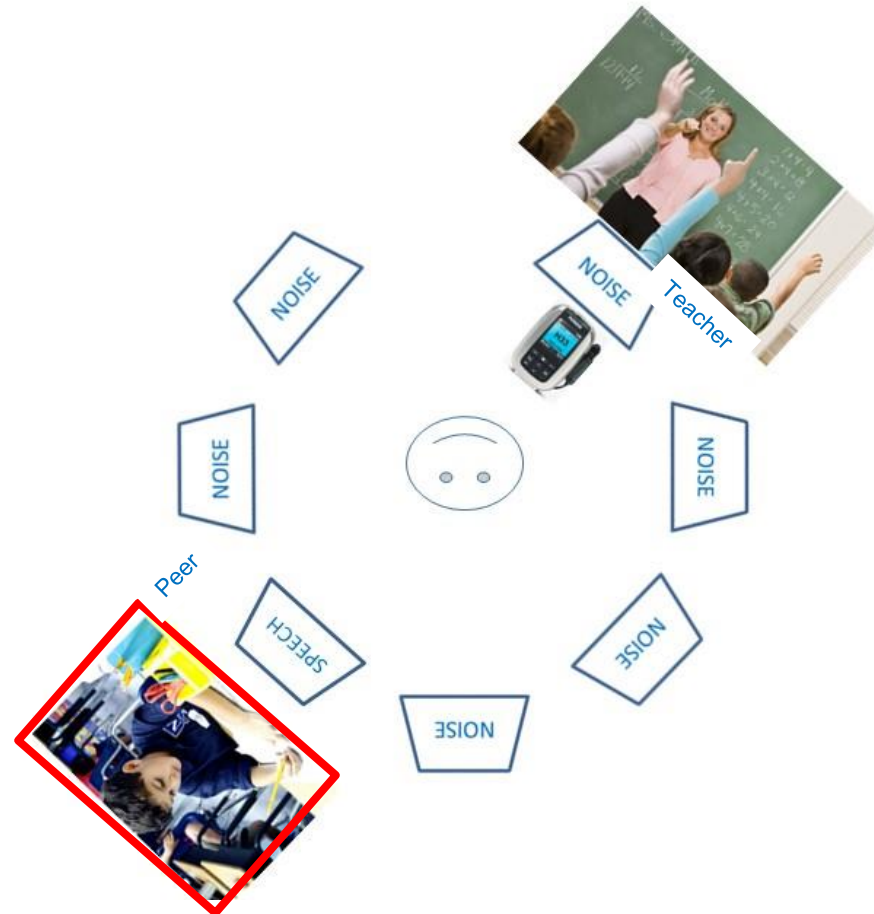
Noise: 65 dBA

Automatic Noise Management Technology for Children

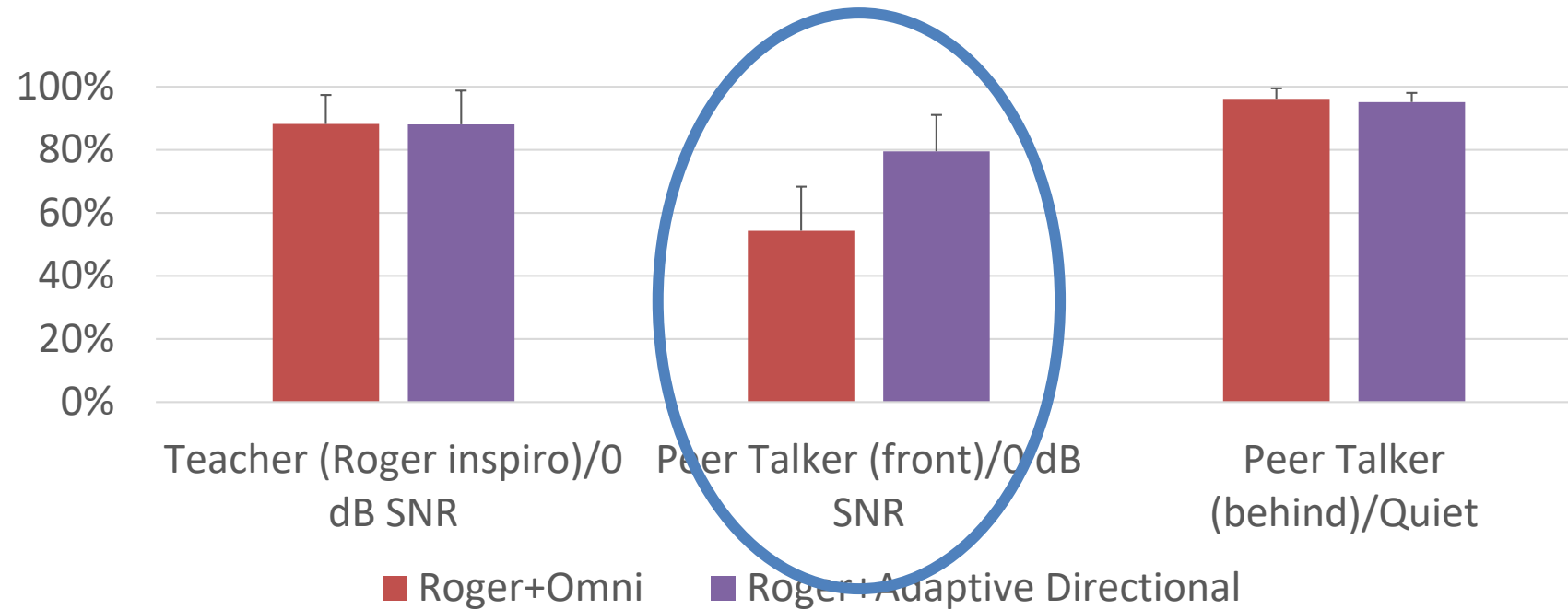
Talker: Peer – Behind

Quiet

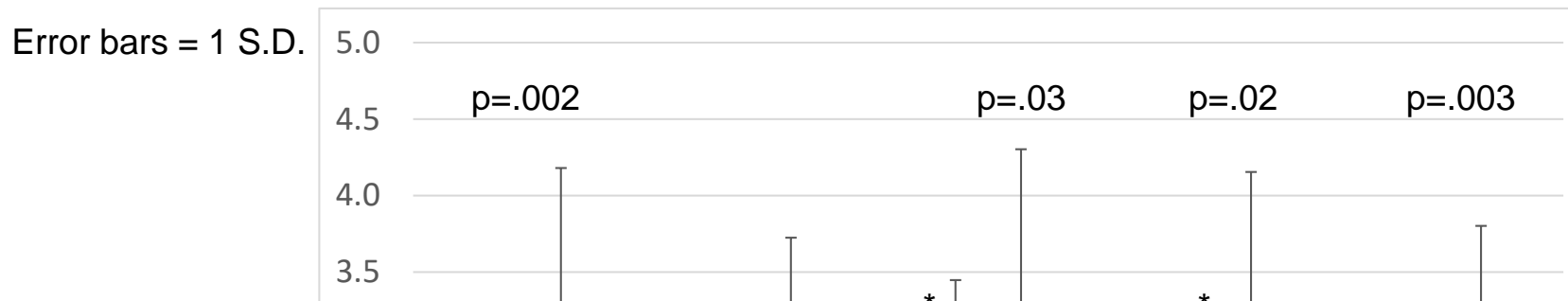
Speech: 65 dBA



Automatic Noise Management Technology for Children

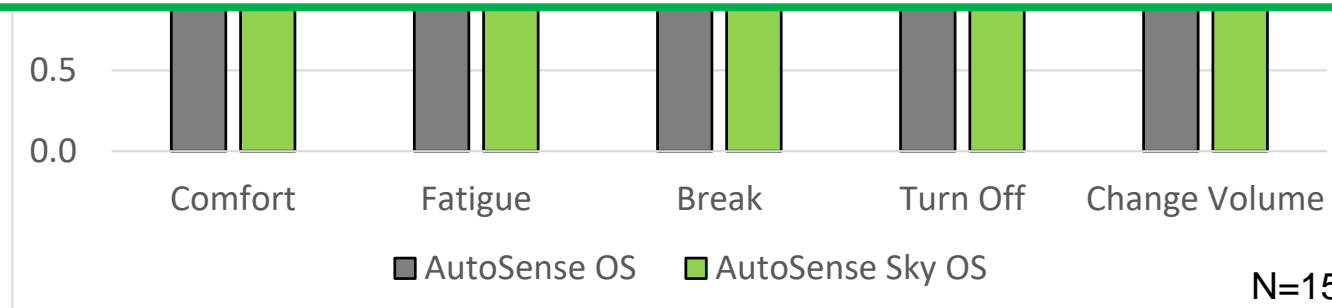


Automatic Noise Management Technology for Children



AutoSense Sky OS results in improved comfort for children using the Autosense designed for children!!!

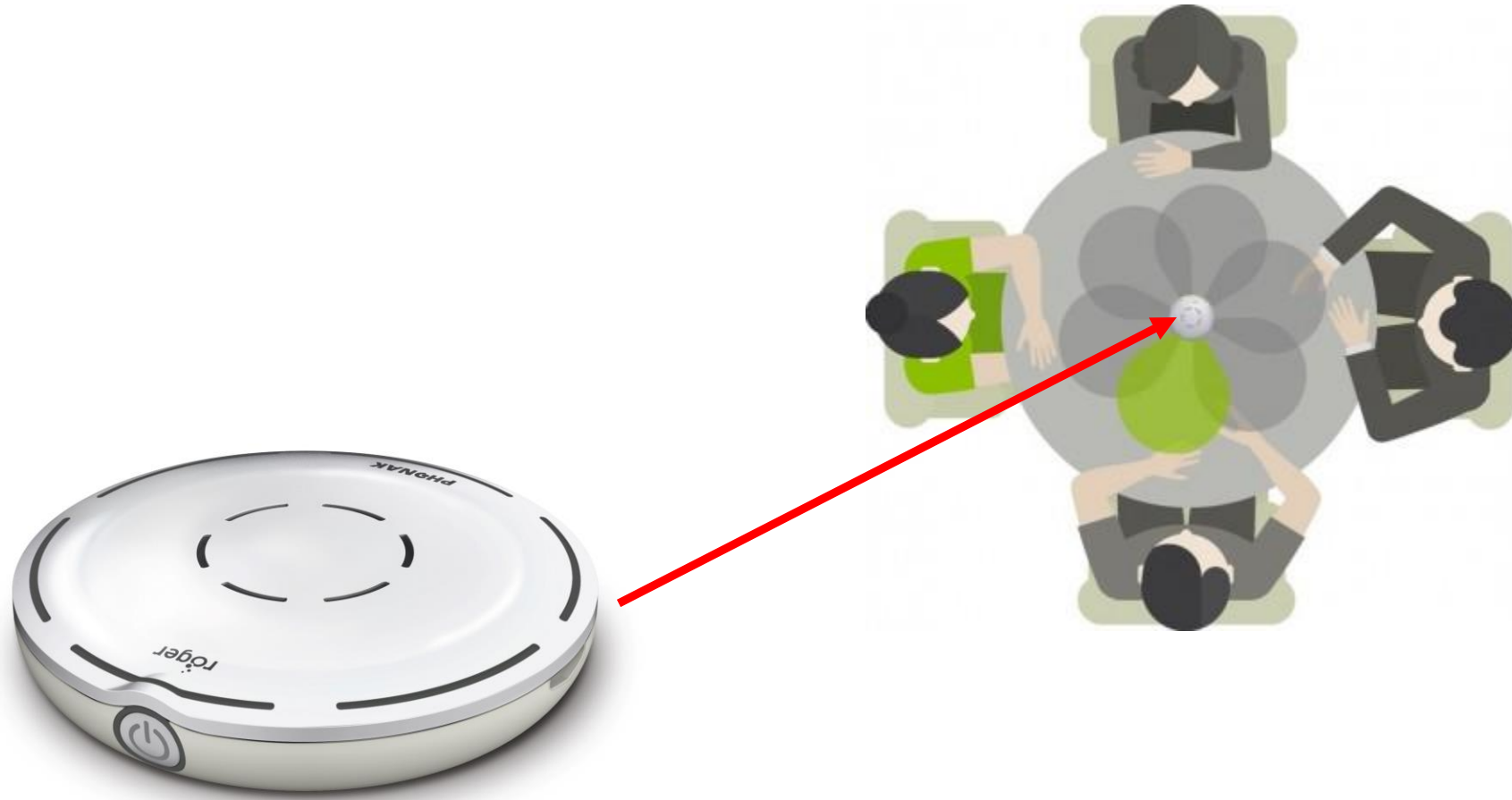
Takeaway: These added benefits result in improved hearing AND comfort!



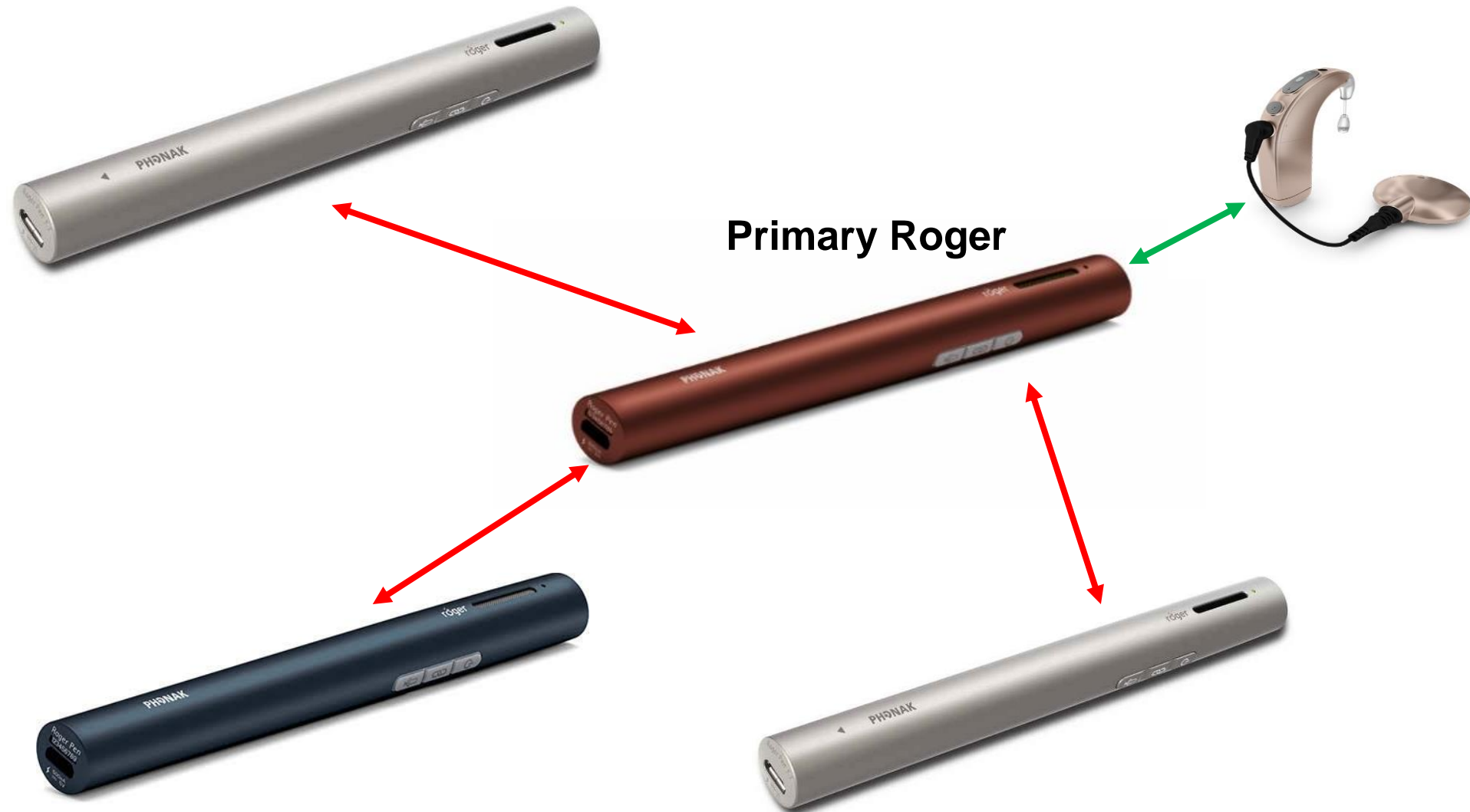
Question

How can I optimize hearing performance in small groups with more than one talker?

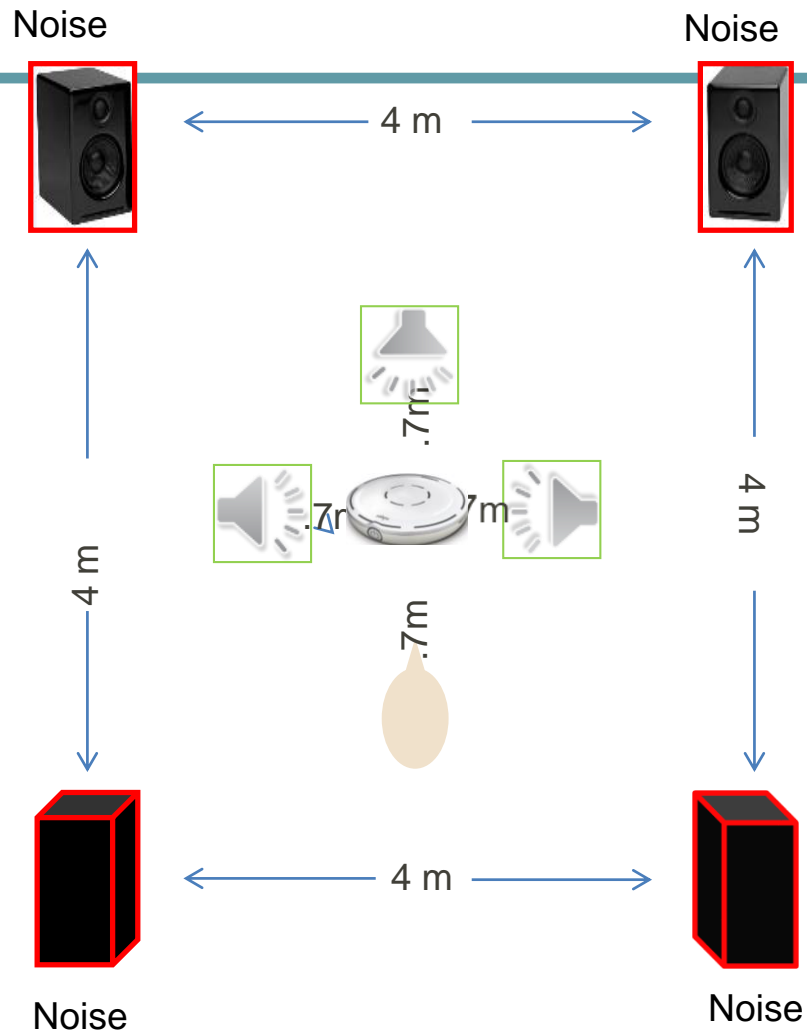
Roger Select



Roger Multitalker Network



Roger Select

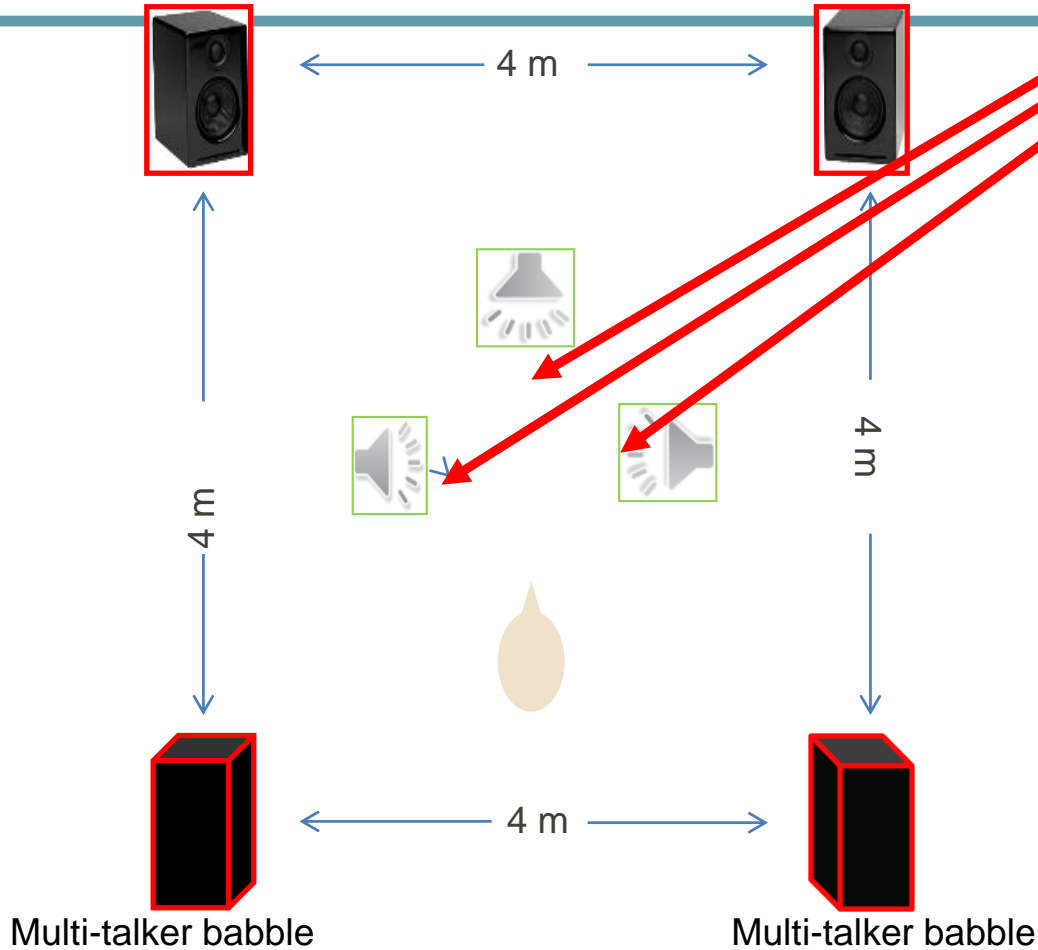


- Multi-talker babble (**noise**) from 4 corner speakers
- AzBio sentences (**targets**) were randomly presented from 0, 90, and 270 degrees simulating a group of 4 near-field individuals engaged in conversation around a table
 - Small group at school
 - Café

Roger Multitalker Network

Multi-talker babble

Multi-talker babble



- Multi-talker babble (**noise**) from 4 corner speakers
- AzBio sentences (**targets**) were randomly presented from 0, 90, and 270 degrees simulating a group of 4 near-field individuals engaged in conversation around a table
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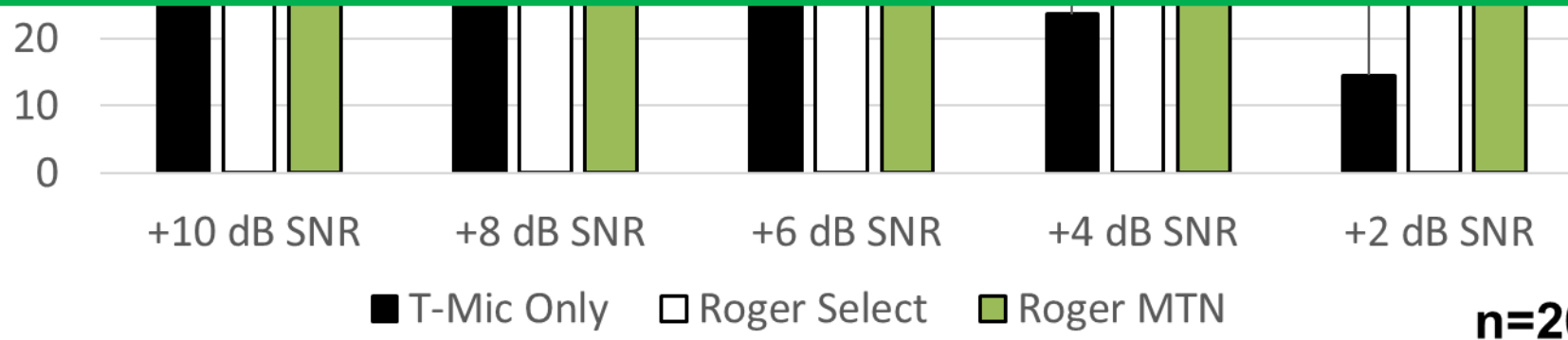
Roger Select and Multitalker Network

Roger Select improves performance with multiple talkers

Roger MTN optimizes performance with multiple talkers



All Roger solutions provide improved speech understanding in noise. Additional microphones as used in a multi-talker network will provide the best outcomes. Something to consider for an active classroom!



Take Home Points

- Our studies have found that children prefer the use of Phonak noise management technologies relative to the noise-management-technology-disabled condition and potentially understand speech better in noise with the use of these noise management technologies
 - Teaching children to orient to the speaker of interest, is another way to further support these benefits.
- Children need remote microphone technology with adaptive gain changes and beamforming to have **great** hearing performance in real world listening situations
- Adaptive noise management technology should be used in conjunction with adaptive digital remote microphone technology to **optimize** performance across a variety of real world listening situations
 - Addition of multi-talker networks will further improve speech understanding in group settings.

Protocol for Selecting Settings

- Noise reduction should be activated at fitting for all children.
- Adaptive Directionality should be considered around 18-24 months of age.
 - Counsel that a child may not hear as well from behind.
 - Teach child to orient to speaker
 - Work with parents and AVT/SLP to get feedback about how the child is doing with these additions.



Shoot for the Moon!



- THANK YOU FOR YOUR ATTENTION