VANDERBILT UNIVERSITY
MEDICAL CENTER

Potential Benefits of CROS Systems in Classrooms

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6TH EUROPEAN PEDIATRIC CONFERENCE

CURRENT DEVELOPMENTS AND NEW DIRECTIONS IN PEDIATRIC AUDIOLOGY

MUNICH, GERMANY

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VANDERBILT UNIVERSITY MEDICAL CENTER

Disclosures

Collaborators

- Anne Marie Tharpe (Vanderbilt University Medical Center)
- Dawna Lewis (Boys Town National Research Hospital)
- Gina Angley (Vanderbilt University Medical Center)
- Hilary Davis (Vanderbilt University Medical Center)




Funding support

- Phonak

Other support

- Amy Stahl, Haiping Huang, Emily Thompson, Javier Santos, Christine Jones, Lori Rakita

Unilateral hearing loss

Highly prevalent

- Unilateral hearing loss more prevalent than bilateral hearing loss *Niskar et al (1998) JAMA, 279, 1071-1075*
- 3% of school-aged children *Bess et al (1998) Ear Hear, 19, 339-354*

Risk of academic failure

- 35% repeat a grade *Bess & Tharpe (1986) Ear Hear, 7, 14-19*
- 10x more likely to fail a grade *Oyler et al (1988) LSHSS, 19, 201-210*

Reduced well-being (stress, self-esteem, social support) *Bess et al (1998) Ear Hear, 19, 339-354*

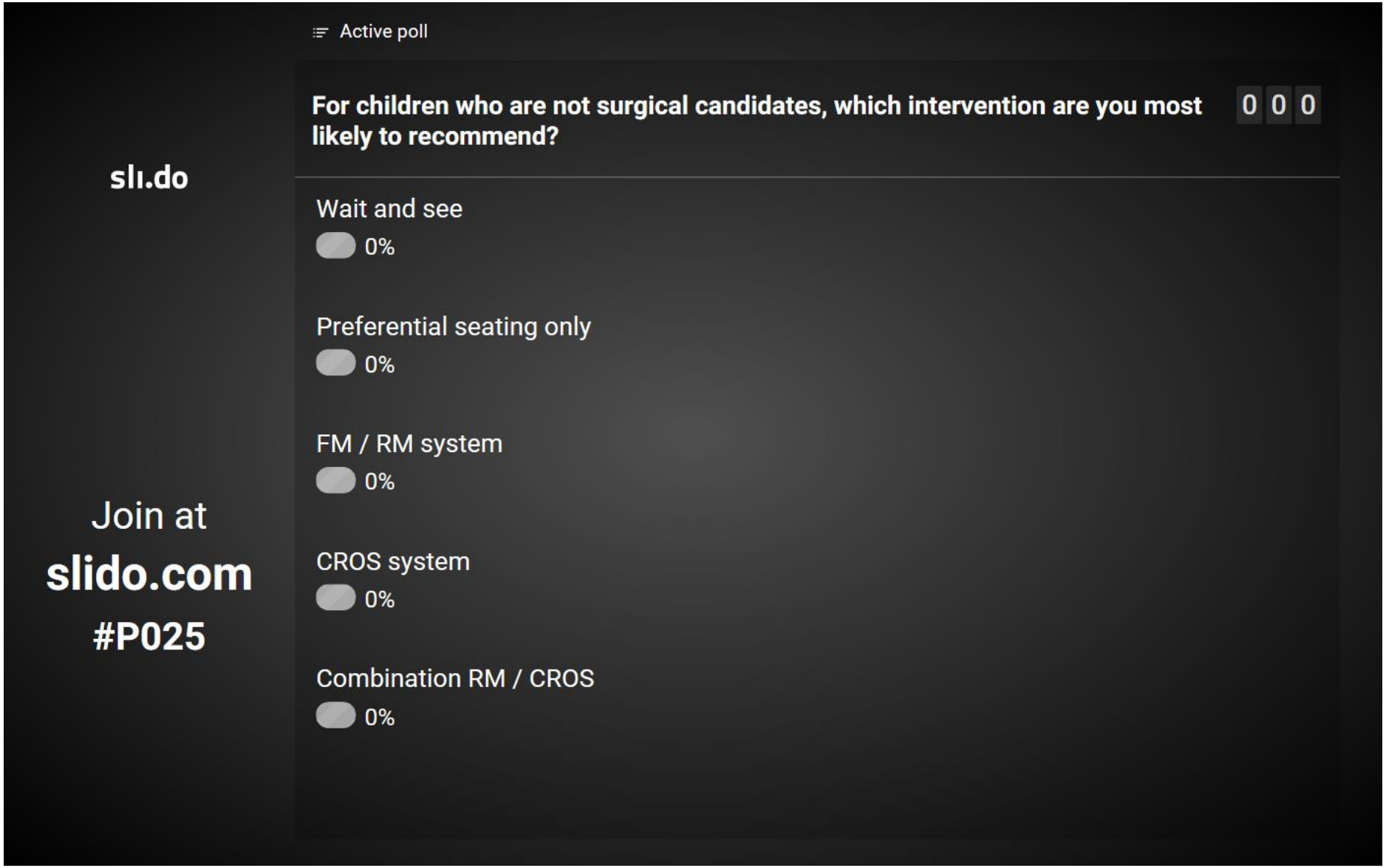
Poorer speech and language outcomes *Lieu (2004) Arch Otolaryngol Head Neck Surg, 130, 524-530.*

Interventions in classrooms

Minimally invasive
- Nothing
- Preferential seating

Surgical options
- Osseointegrated devices
- Cochlear implantation

Amplification options
- FM / remote microphone system
- CROS system


Active poll
For children who are not surgical candidates, which intervention are you most likely to recommend?
0 0 0
slı.do
Wait and see
0%
Preferential seating only
0%
FM / RM system
0%
CROS system
0%
Combination RM / CROS
0%
Join at
slido.com
#P025

Review of available literature for CROS / RM for school-aged children

SURVEY STUDIES

Miller (1967) J Speech Hear Dis

- Teachers and parents reported favorable adjustment to body worn CROS

Purcell et al (2016)

- CROS retention rates nearly 70% for children with LUHU

Shapiro (1977)

- 7 of 8 participants reported favorable CROS benefits

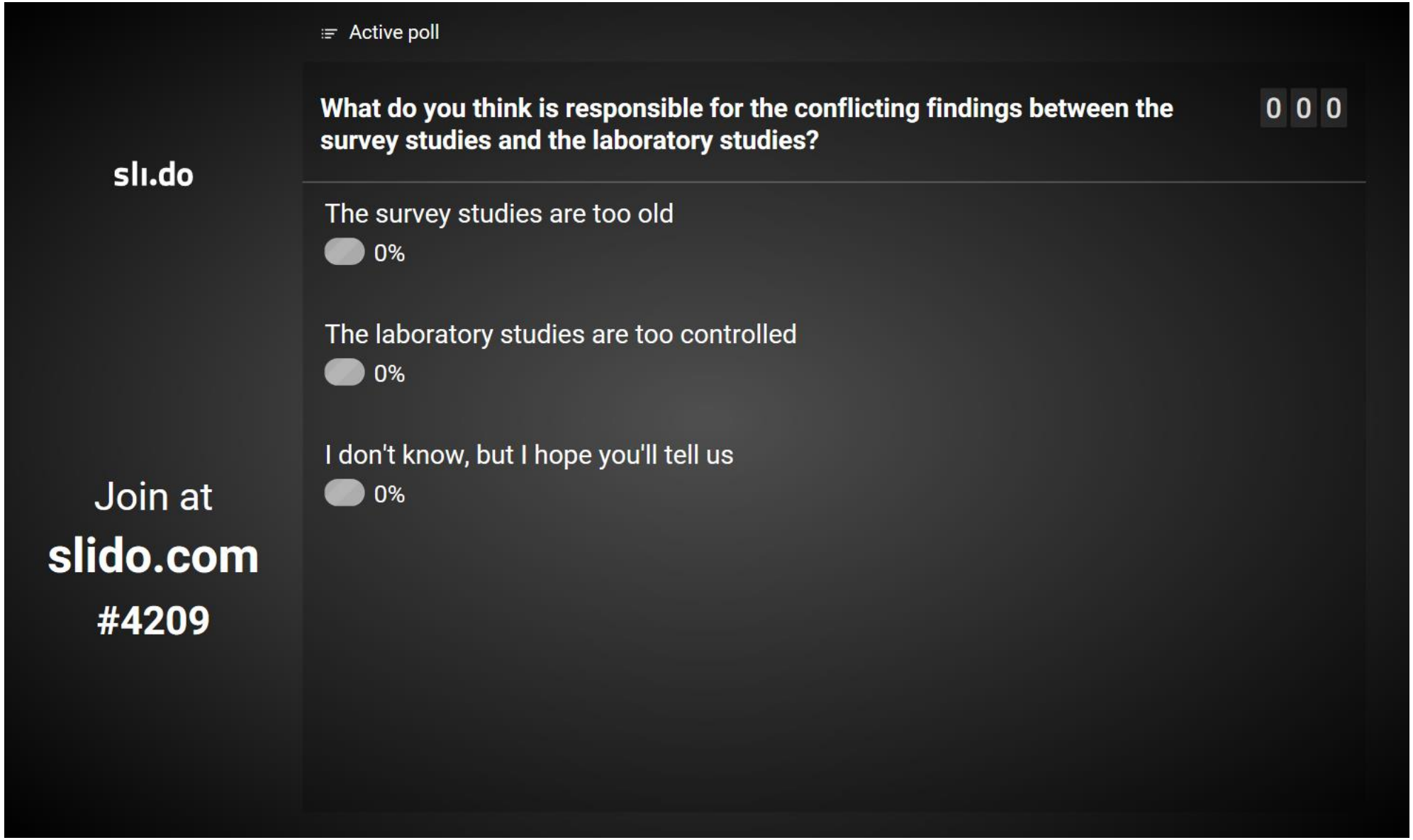
LABORATORY STUDIES

Kenworthy et al (1990)

- RM provides the most consistent benefits and CROS only provides benefits in monaural indirect conditions

Updike (1994)

- RM improved speech recognition in noise and CROS can make speech recognition worse


Active poll
What do you think is responsible for the conflicting findings between the survey studies and the laboratory studies?
0 0 0
sli.do
The survey studies are too old
0%
The laboratory studies are too controlled
0%
I don't know, but I hope you'll tell us
0%
Join at
slido.com
#4209

How to reconcile the discrepancy between survey and laboratory studies?

Survey studies are out dated?

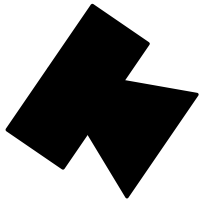
- Miller (1967) and Shapiro (1977) – little data or methodology reported
- Purcell (2016) – up to date, but observational

Laboratory studies too controlled to reflect contemporary classrooms?

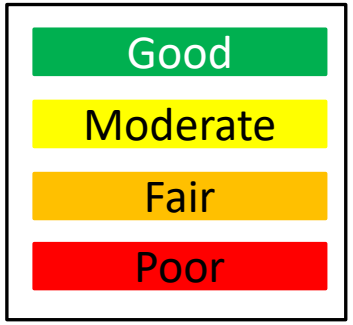
- Perhaps… let's take a look…

The student…

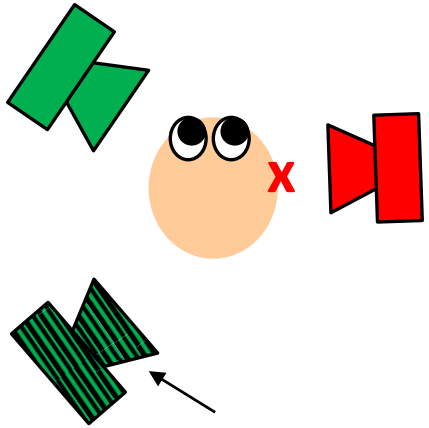
The speaker…



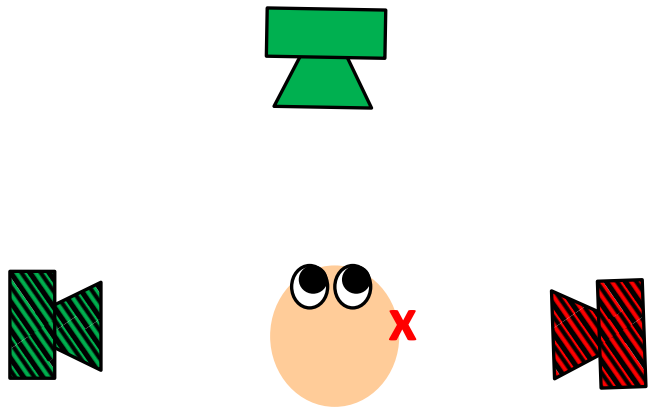
The legend…

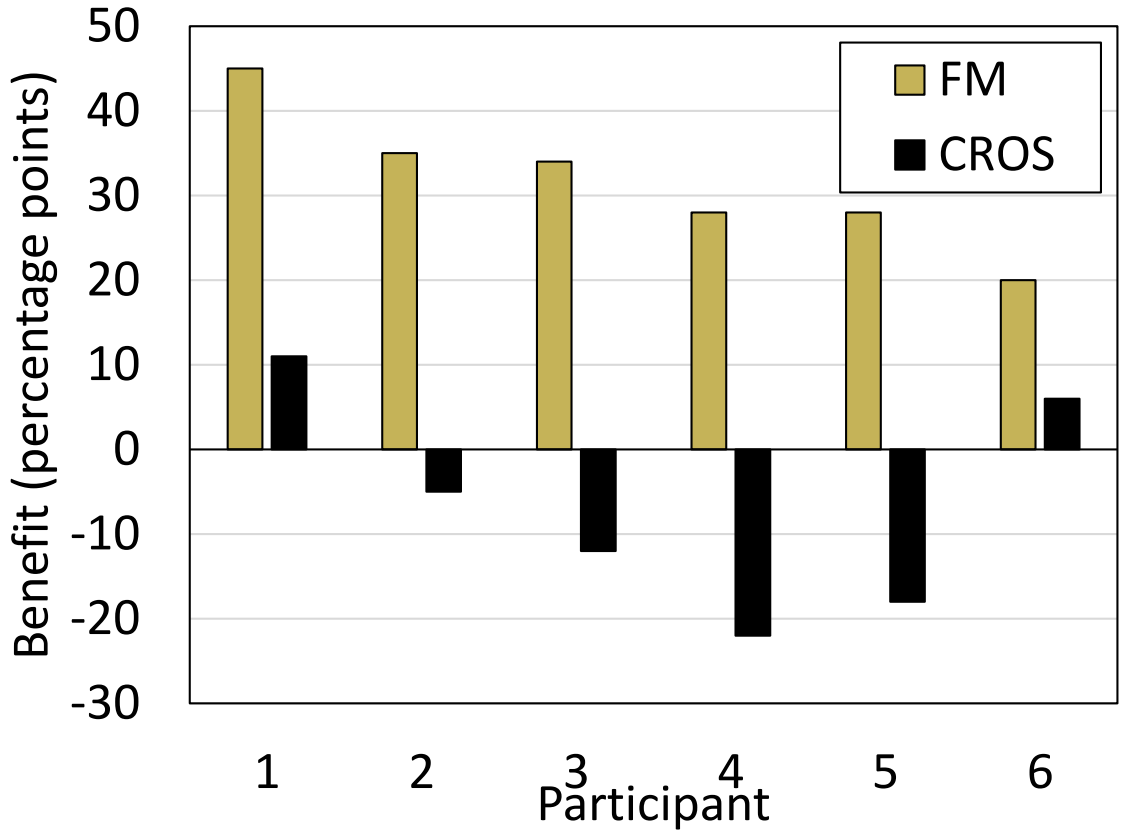


The result…



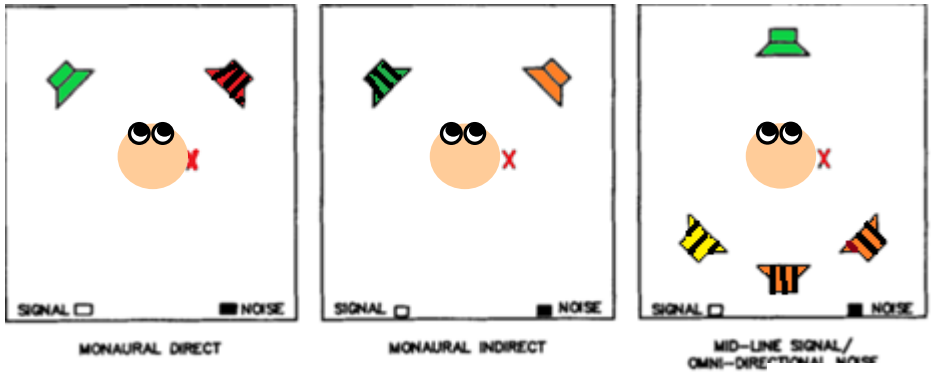
RM helps in noise and CROS hurts in noise



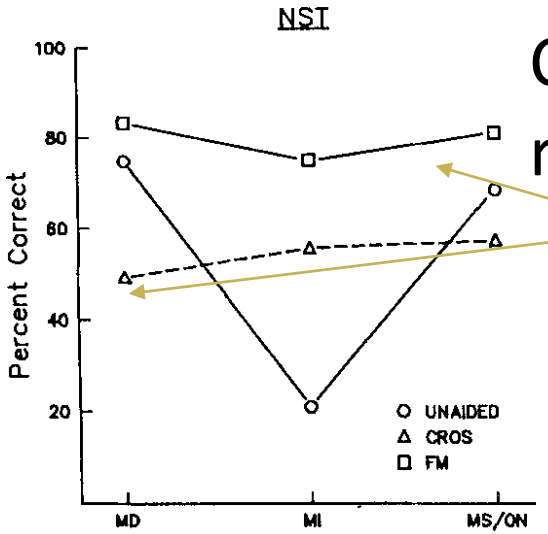


Data from Updike (1994) *J Am Acad Audiol, 5*, 204-209

CROS benefits depend on configuration

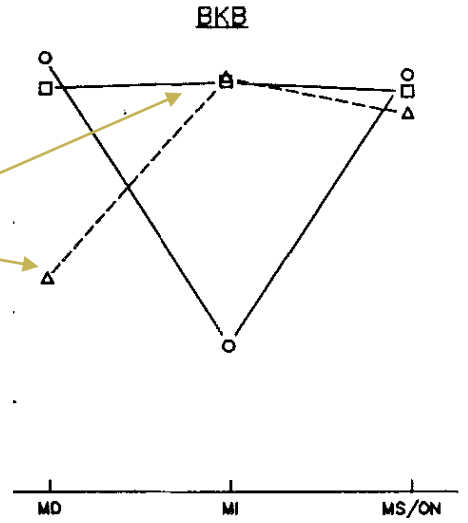


Good
Moderate
Fair
Poor



CROS makes speech recognition worse

FM always "wins"



Kenworthy, Klee, & Tharpe (1990) *Ear Hear, 11,* 264 - 270

What are classrooms like?

Complex and dynamic

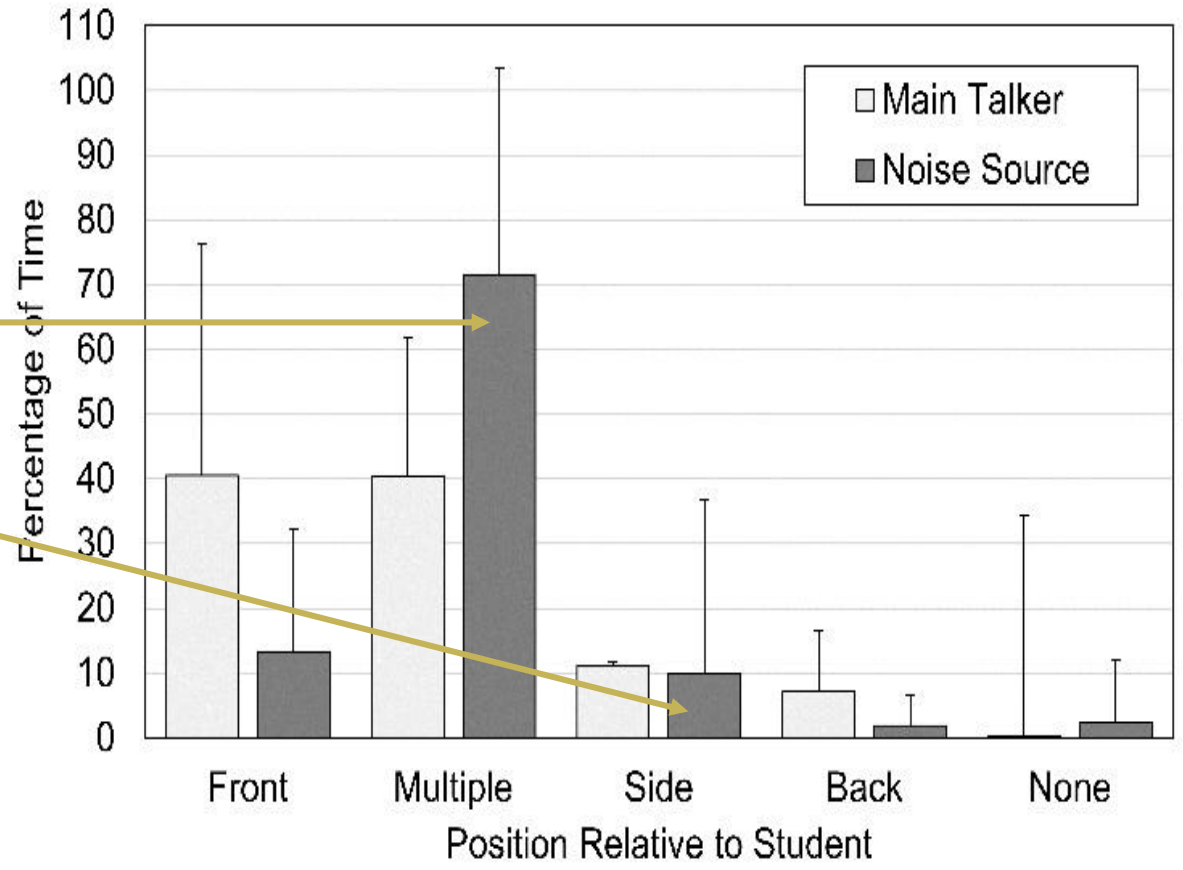
- Noise is present approximately 80% of the time

  Crukley, J., S. Scollie & V. Parsa (2011). *J Educ Audiol, 17,* 23-35

- Noise primarily surrounds a student

  Ricketts et al (2017) *JSLHR*, *60,* 263 - 275

- Noise rarely direct to the side



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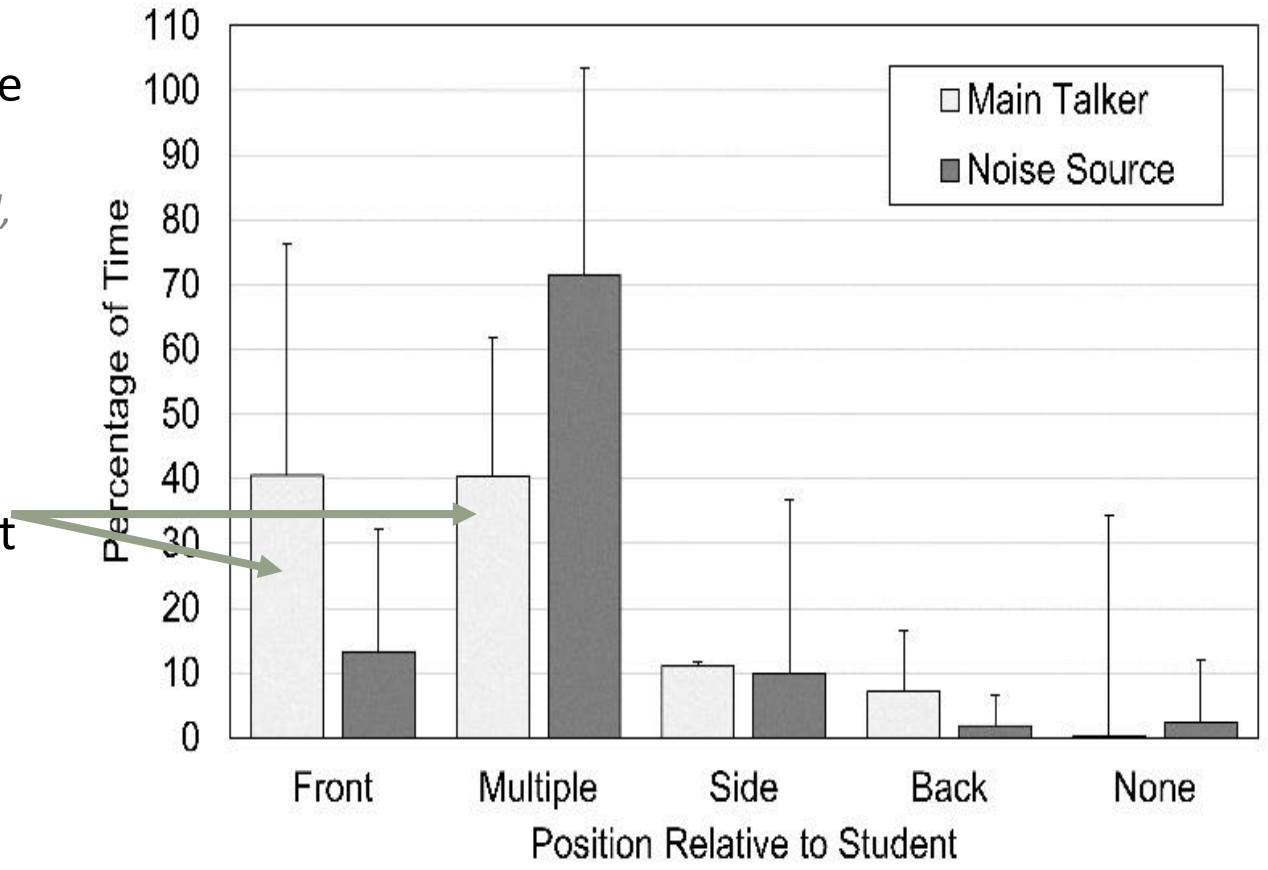
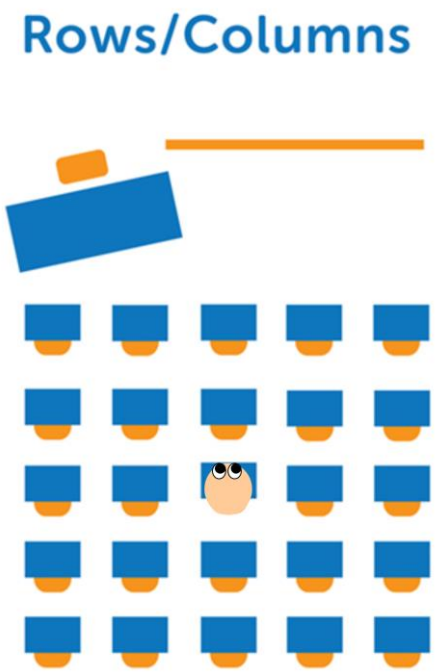
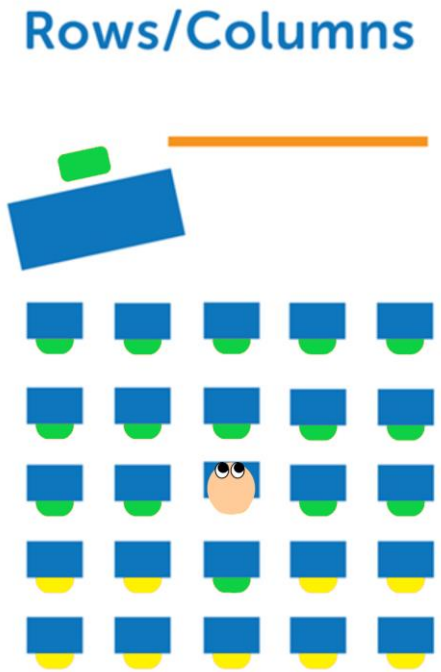
- Noise rarely direct to the side
- Talkers of interest could be anywhere, but are often from the front or in multiple locations



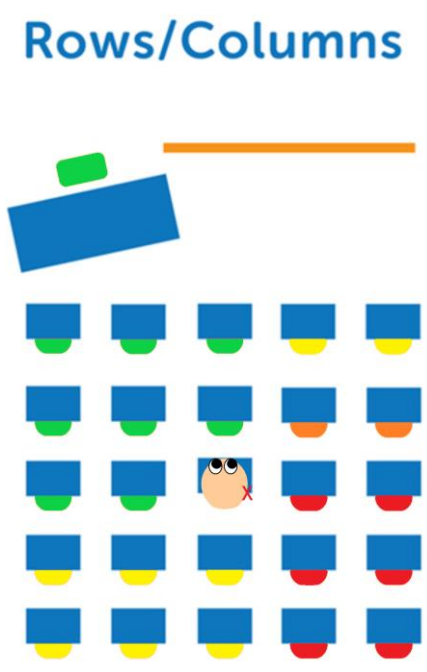
Classrooms include diverse talker locations

Good
Moderate
Fair
Poor



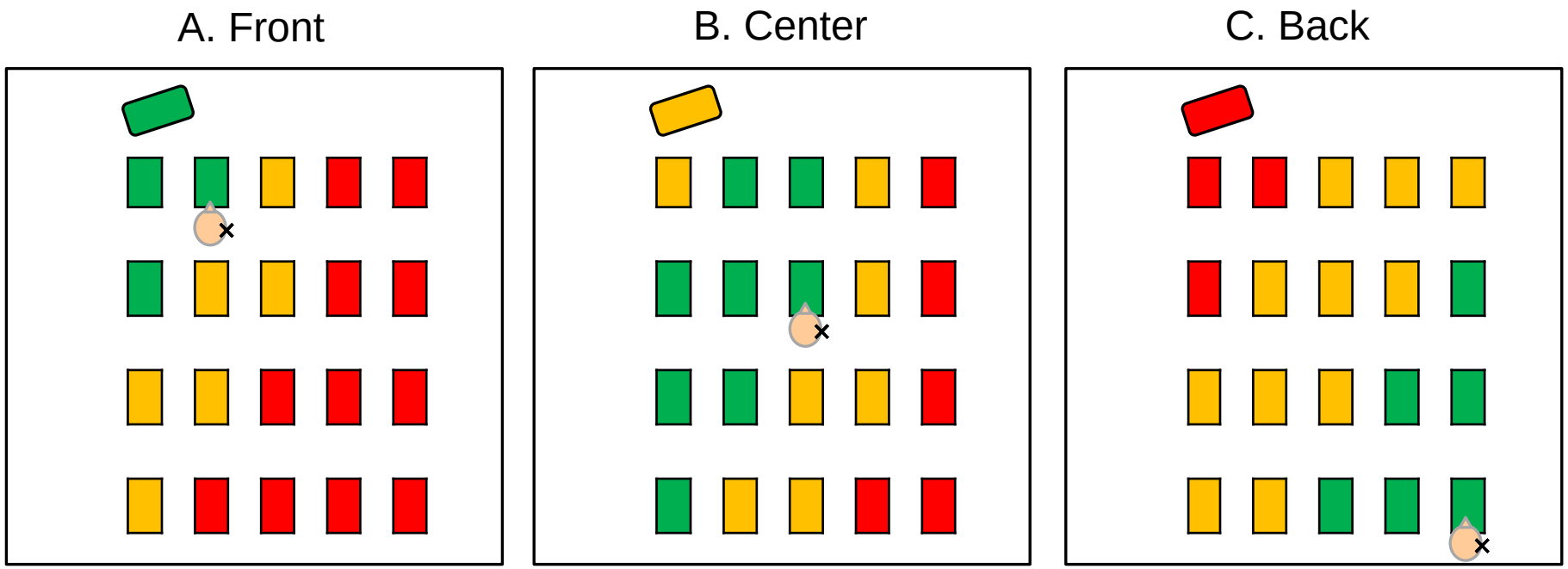


Normal hearing bilaterally



Right unilateral loss

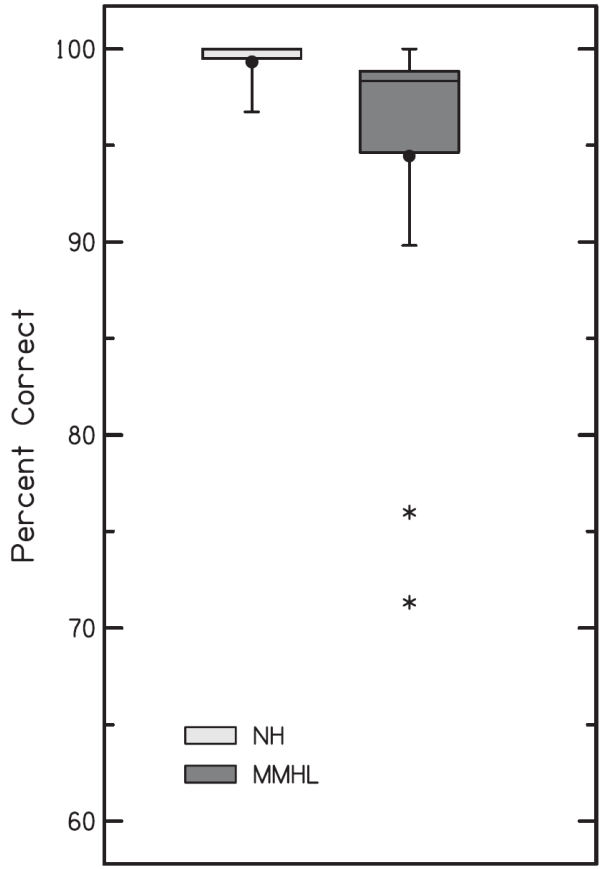
Seat assignment affects expected speech understanding in classrooms

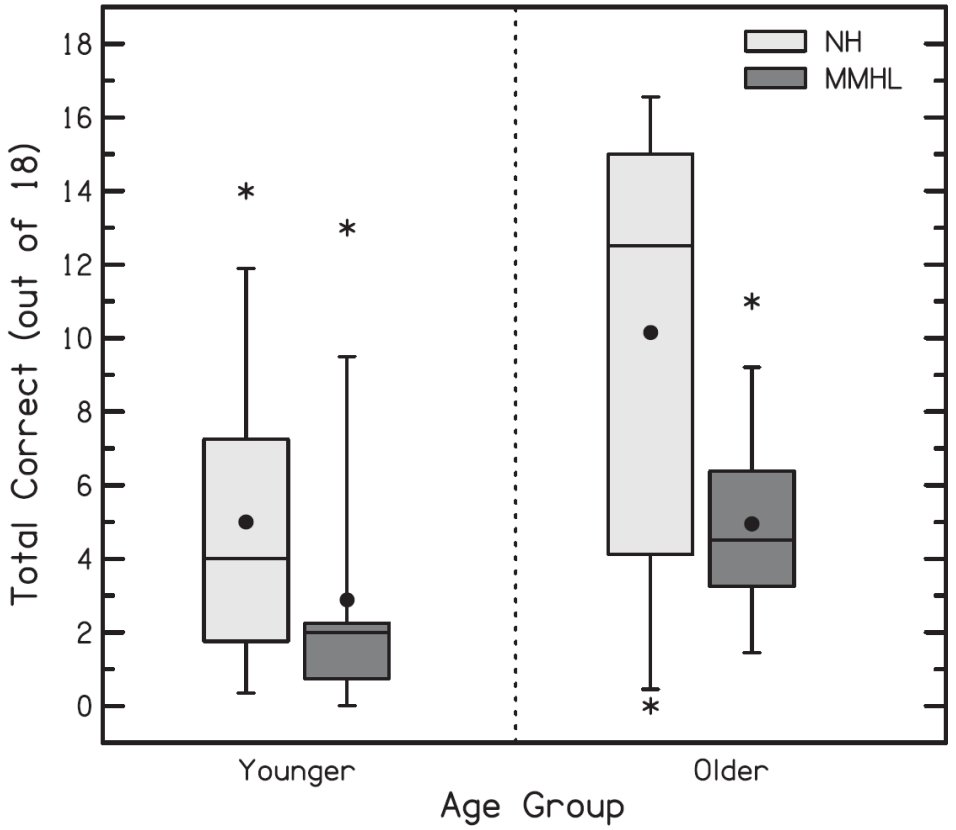


Classrooms are places of learning and comprehension

Lewis et al (2015) *Ear Hear, 36*, 136 - 144

Comprehension *more* sensitive to the effects of mild / unilateral hearing loss





Lewis et al (2015) *Ear Hear, 36*, 136 - 144

Updating evidence for CROS / RM in dynamic classroom situations

Goal was to take into consideration

- Various talker locations
- Diffuse noise
- Updated CROS / RM technology
- Comprehension and recognition
- Live stimuli in simulated classroom

- Survey and laboratory evidence

General Methodology

Participants

- First study: Children with normal hearing, 10 – 14 years old, simulated unilateral hearing loss
- Second study: Children with limited useable hearing unilaterally (LUHU; also known as SSD)

Tasks

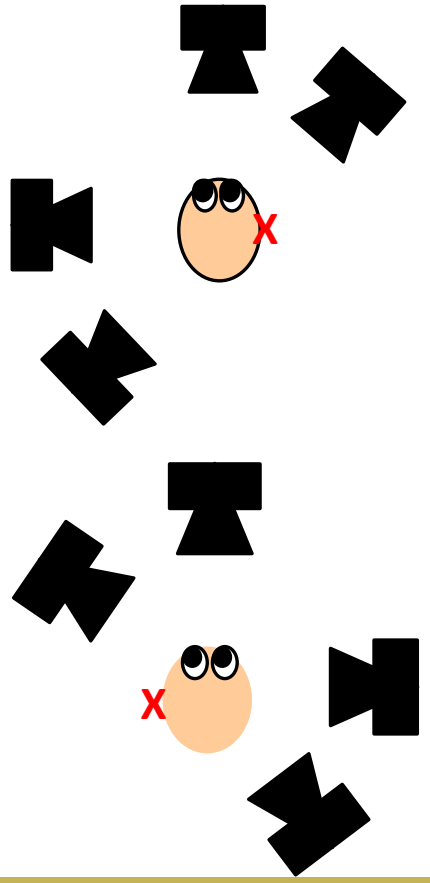
- Speech recognition
- Story comprehension

Test environment

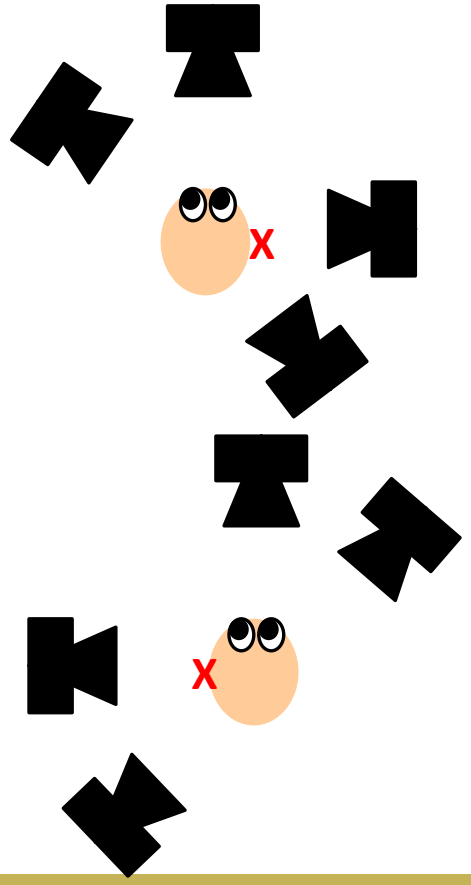
- Moderate reverberation (T30 = 475 ms)
- Signal to noise ratio: +7 (Speech 62: Noise 55)
- Multi-talker babble

Test Environment

Easy Configuration

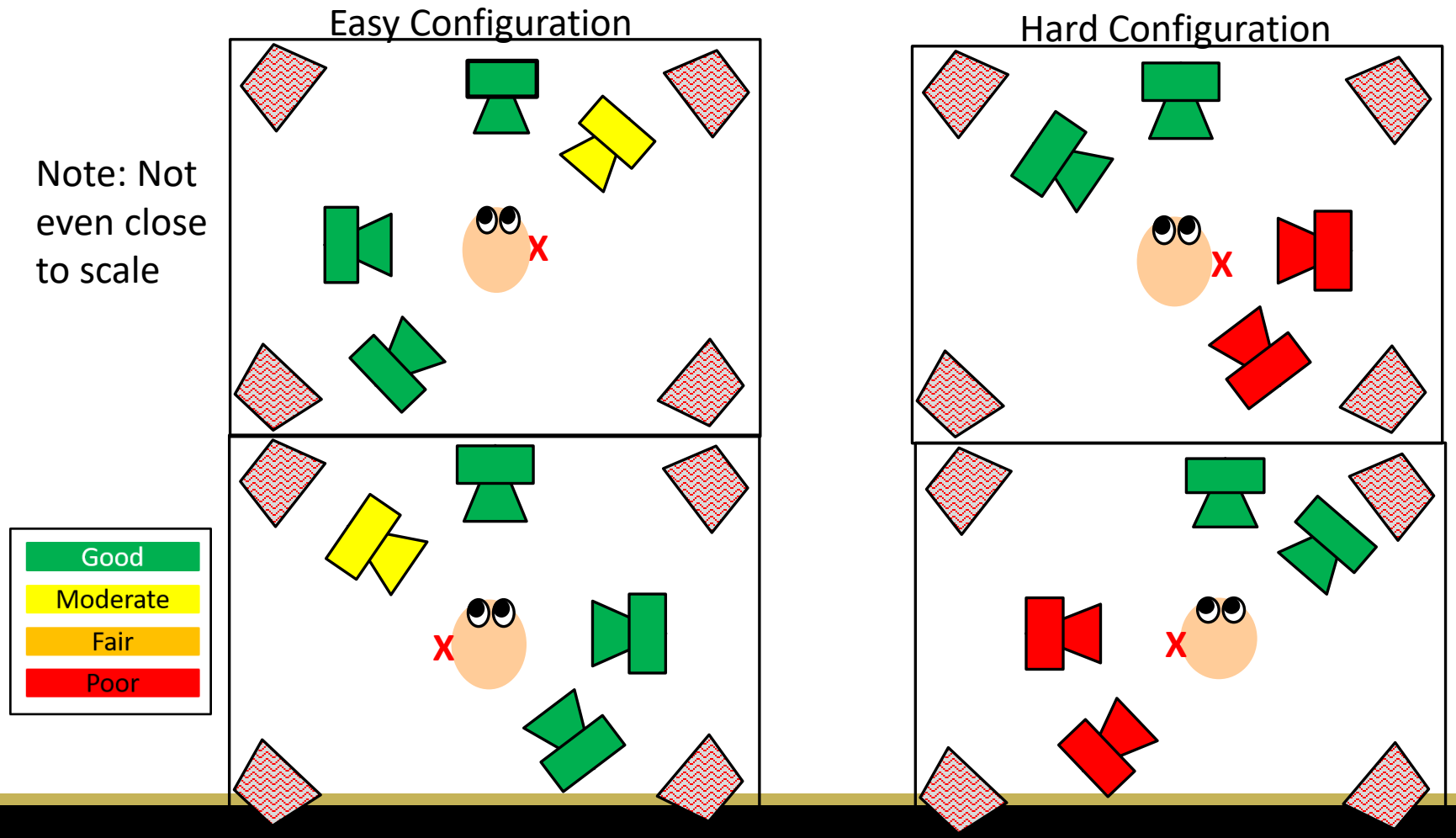


Hard Configuration



Test Environment

Note: Not even close to scale



Hearing Aids:
BTE Sky v70 M312

1) CROS
- Microphone on ear with hearing loss
  - Real Ear Sound
  - Demo hook
- Receiver on ear with normal hearing
  - Ultrazoom
  - Non-occluding, non-custom eartip

2)Roger microphone
- Microphone
  - 6 cm in front of loudspeaker in center
  - “Lanyard” directionality
- Receiver on ear with normal hearing
  - Ultrazoom
  - Non-occluding, non-custom eartip

Sentence Recognition

Hearing in Noise Test for Children (HINT-C)

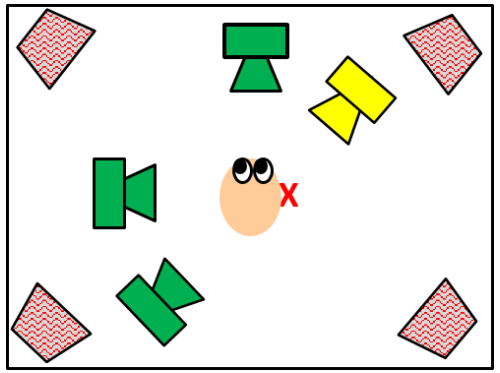
One sentence at a time

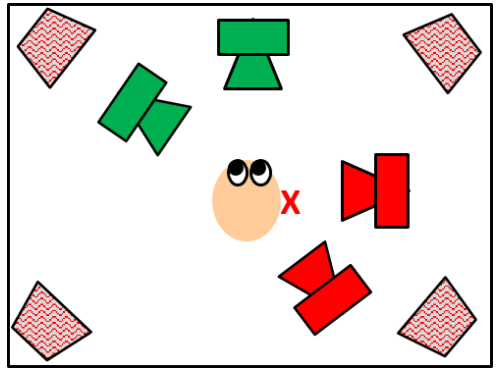
One list per loudspeaker

Interleaved in each configuration

Participant repeated one sentence at a time

Scored at word level by experimenter





Story Comprehension

Task developed by Dawna Lewis and colleagues at Boys Town

Fairy tales translated from foreign languages

Each loudspeaker/monitor combination displays a talker and presents her voice

Each talker reads a few sentences of the story

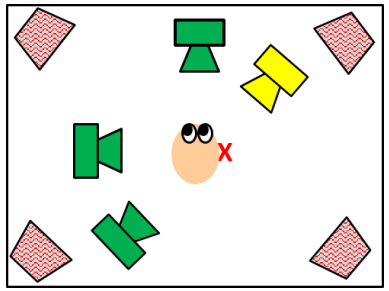
Story split between 4 loudspeakers

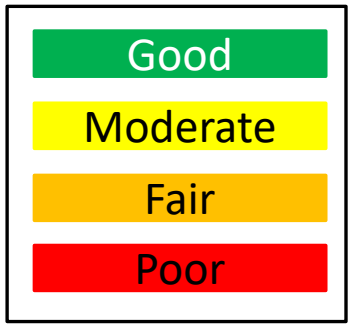
Participants heard each story only once

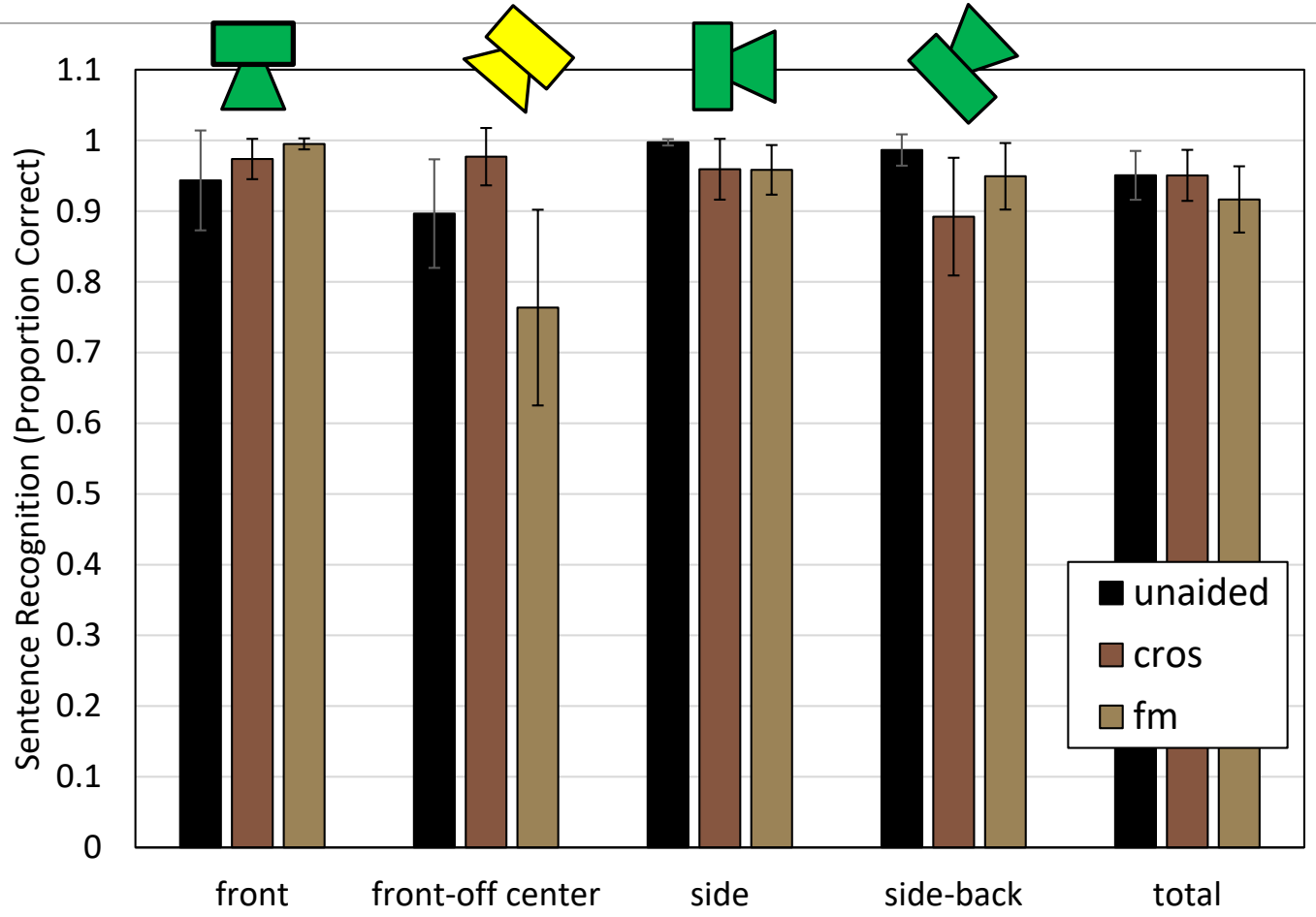
Story Comprehension Test Environment

Sentence Recognition Test Environment

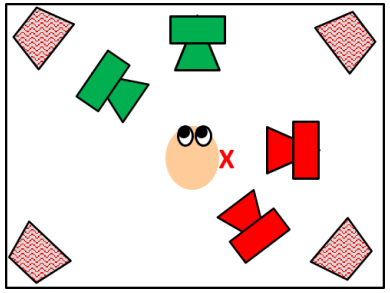
Sentence Recognition: Easy Configuration

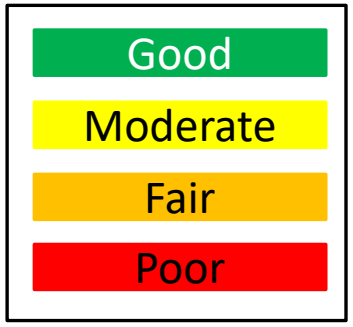


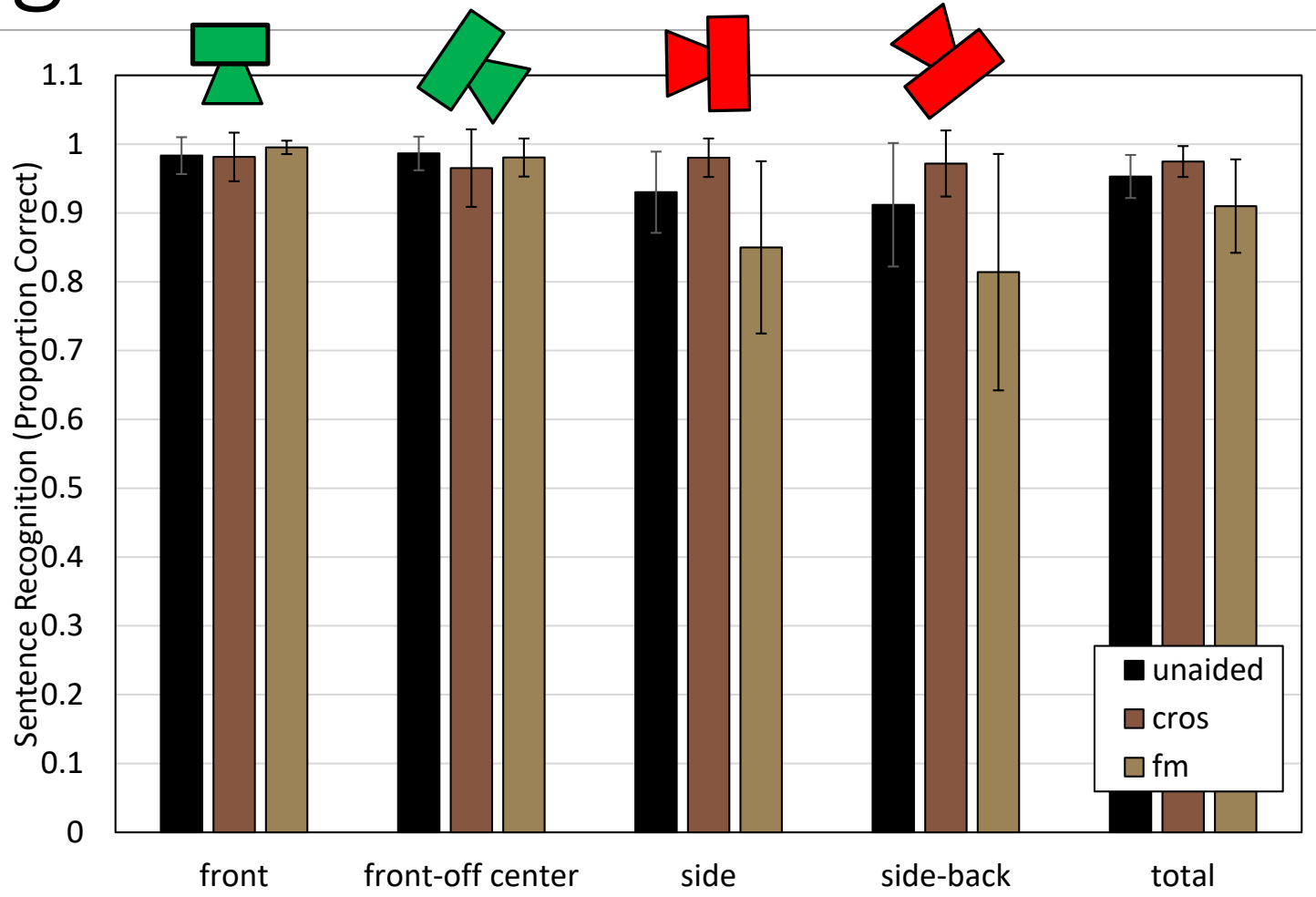




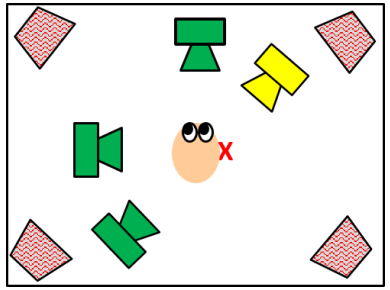
Sentence Recognition: Hard Configuration

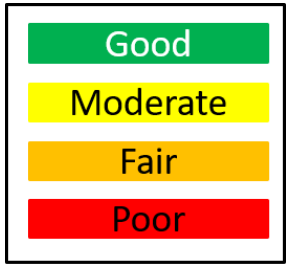


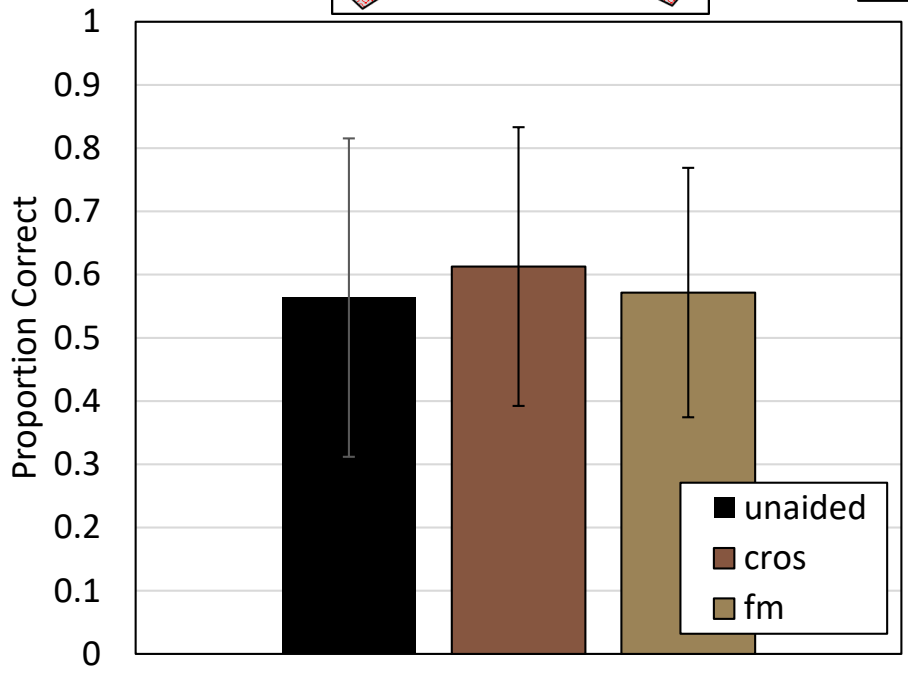




Story Comprehension: Easy & Hard Configurations







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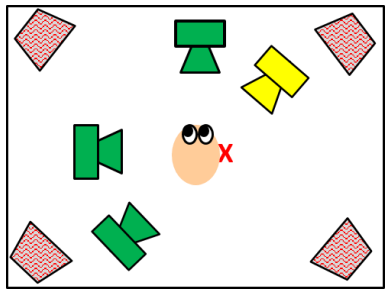
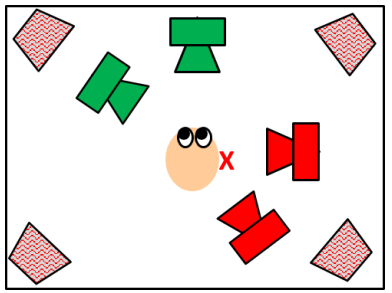
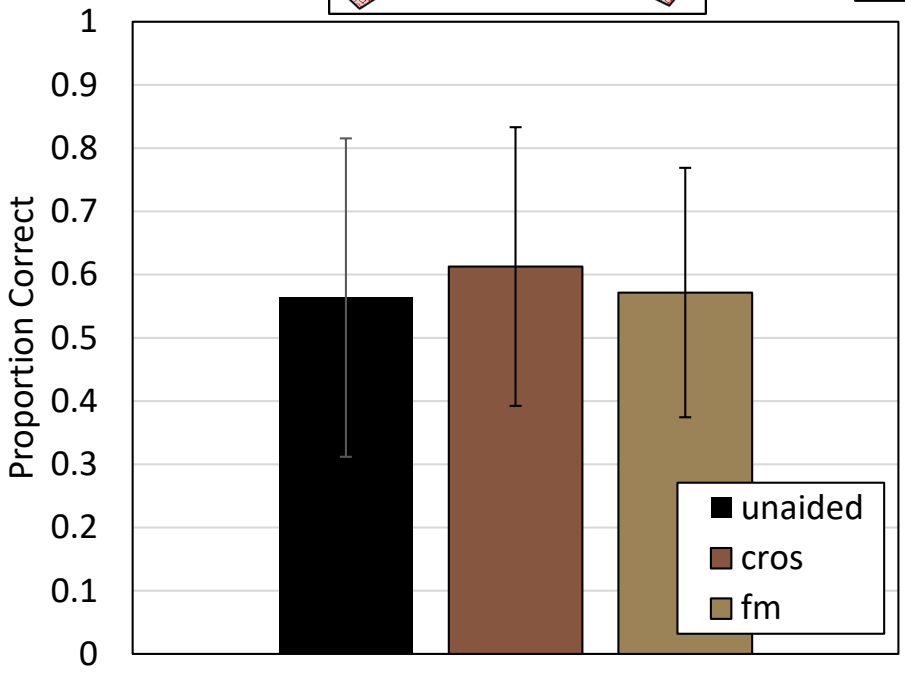
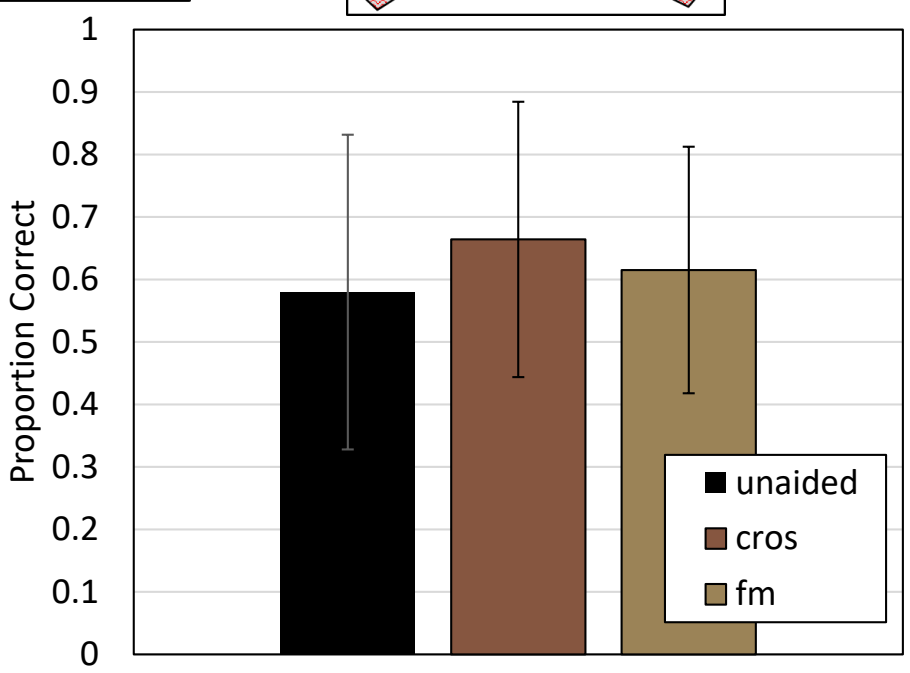


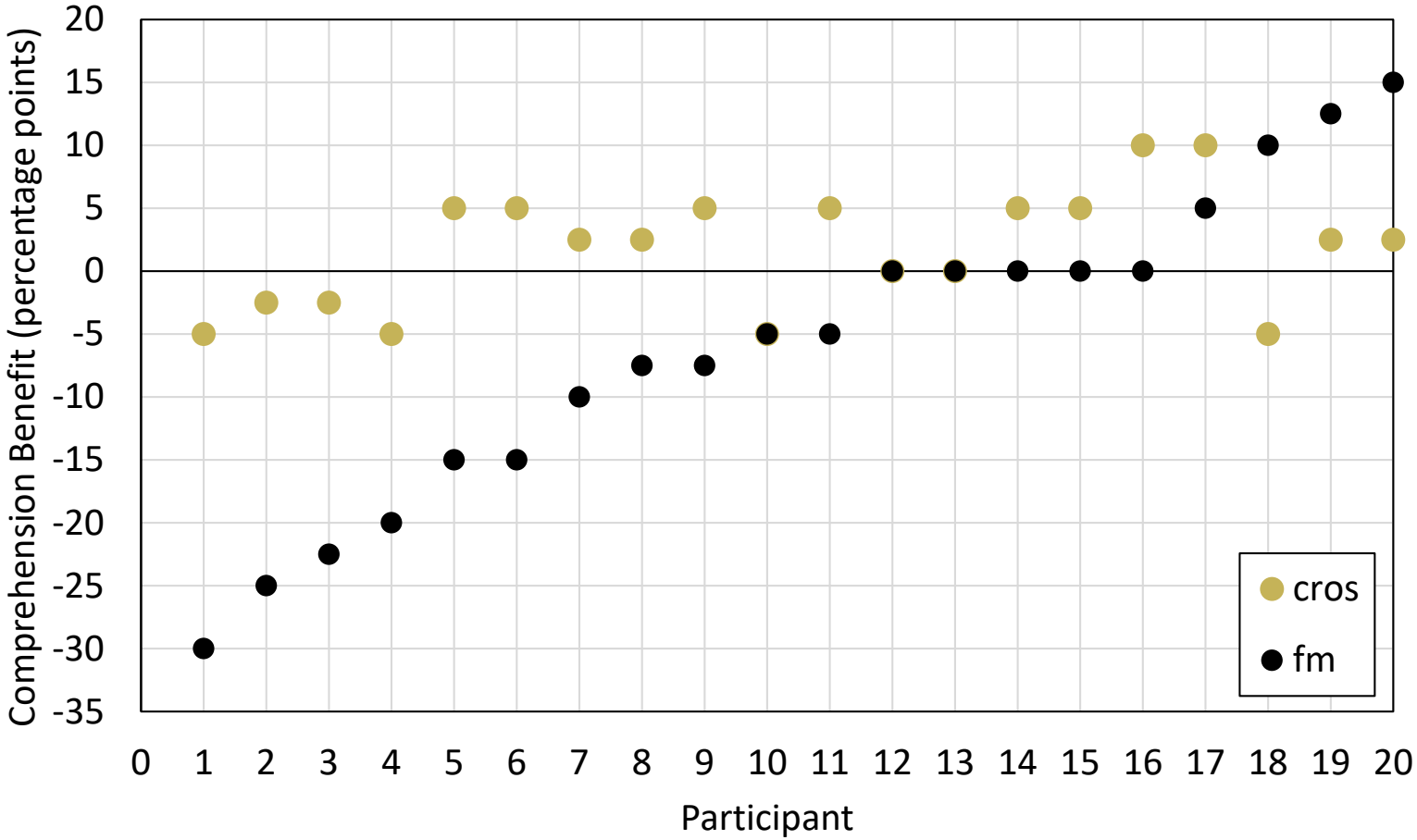
Good
Moderate
Fair
Poor



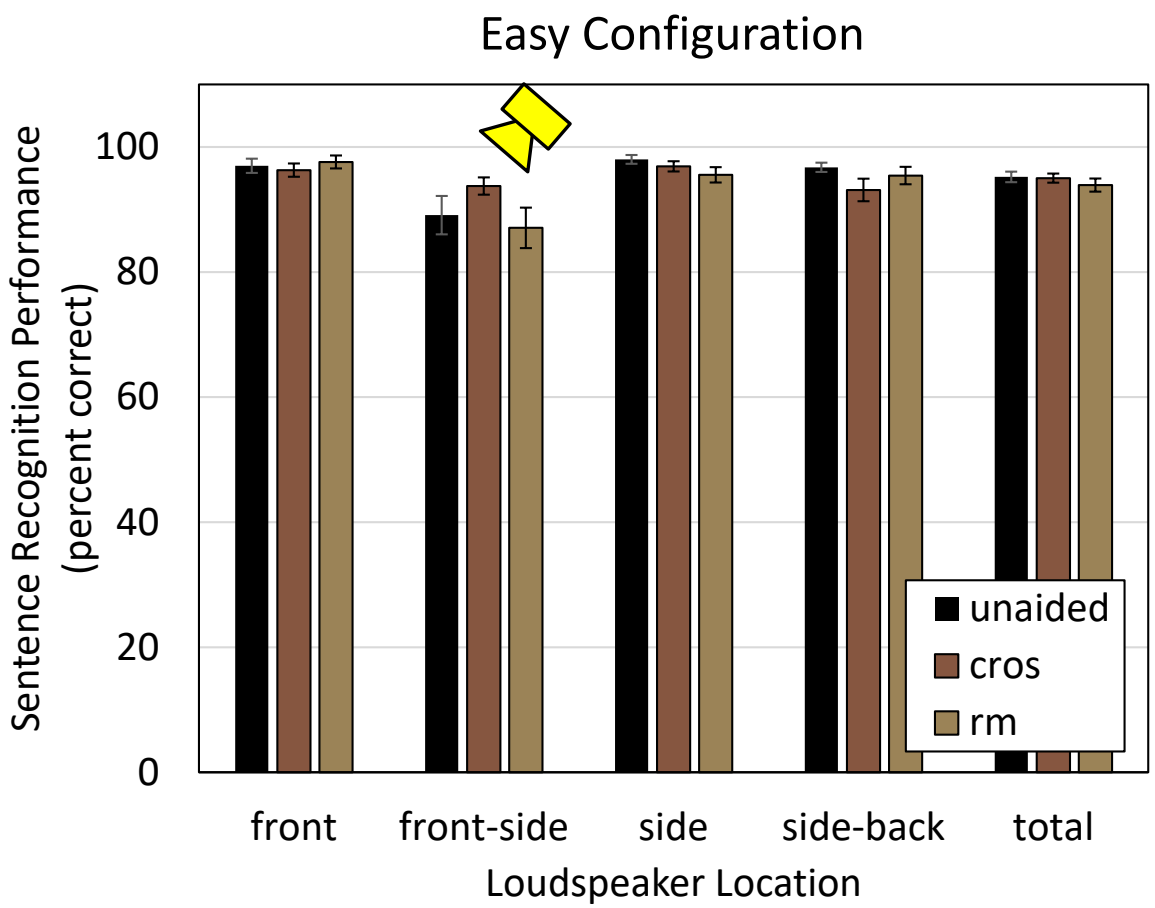


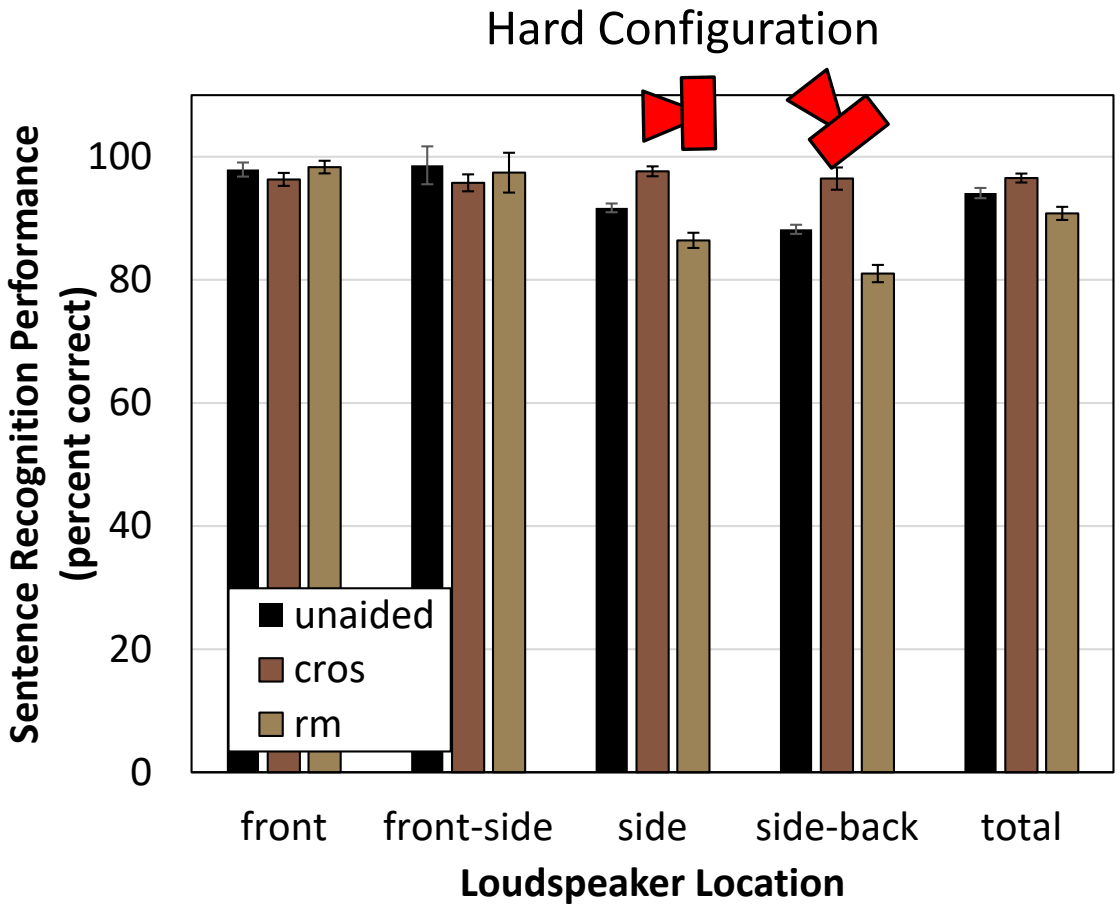


Story Comprehension Benefit

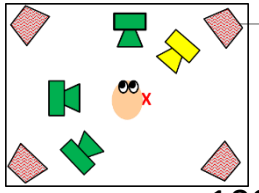


CROS also helps children with hearing loss in monaural indirect situations

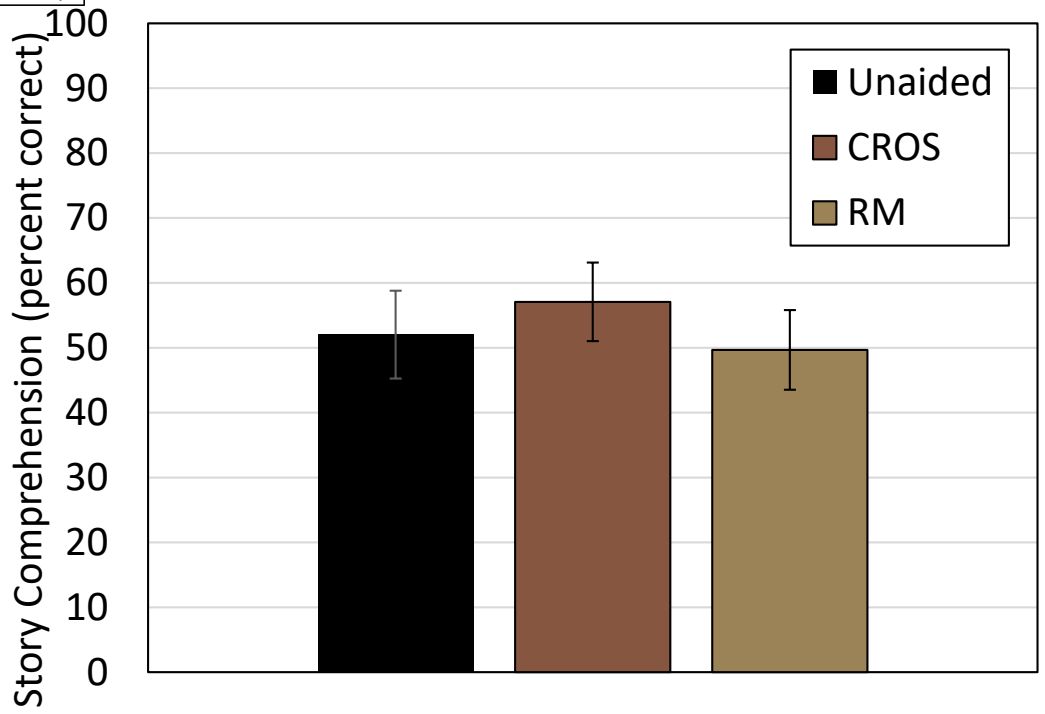


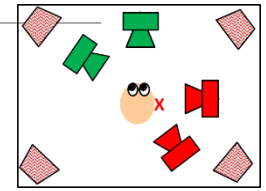


Comprehension consistently the best with the CROS system



Easy Configuration





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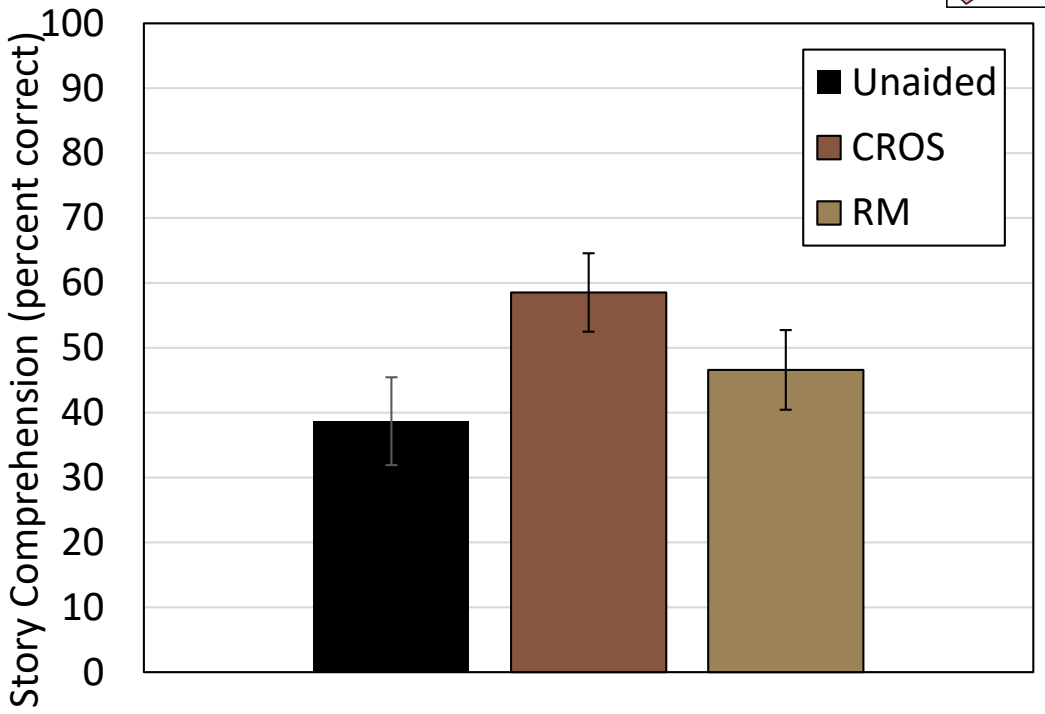


Laboratory study summary

Laboratory situation reflecting contemporary classrooms

- Reverberation
- Head movement
- Dynamic talker location
- Comprehension AND recognition

Updated hearing aid technology

- Non-occluding eartip
- Directional microphones

CROS can improve speech recognition and comprehension, especially for talkers without the remove microphone

What about CROS in "real" school listening situations?

I am in a classroom in the front. The teacher in the front is telling the class what to do.

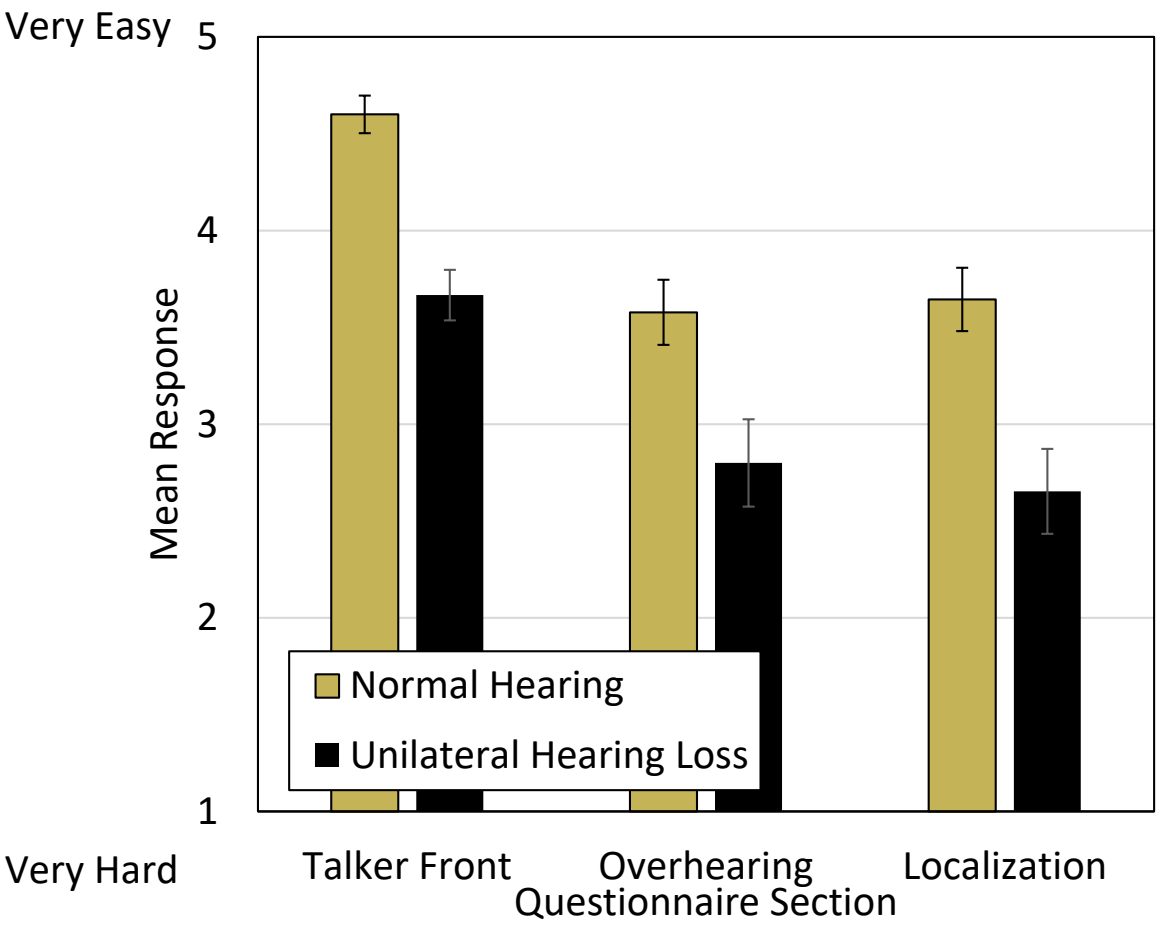
UNAIDED

Very easy
A little easy
Not easy or hard
A little hard
Very hard

AIDED

A lot better WITH hearing aid(s)
A little better WITH hearing aid(s)
Same WITH and WITHOUT hearing aid(s)
A little better WITHOUT hearing aid(s)
A lot better WITHOUT hearing aid(s)

Children with UHL have more difficulty in classrooms situations than their peers



Talker Front

- "I am in a classroom in the front. The teacher in the front is telling the class what to do."

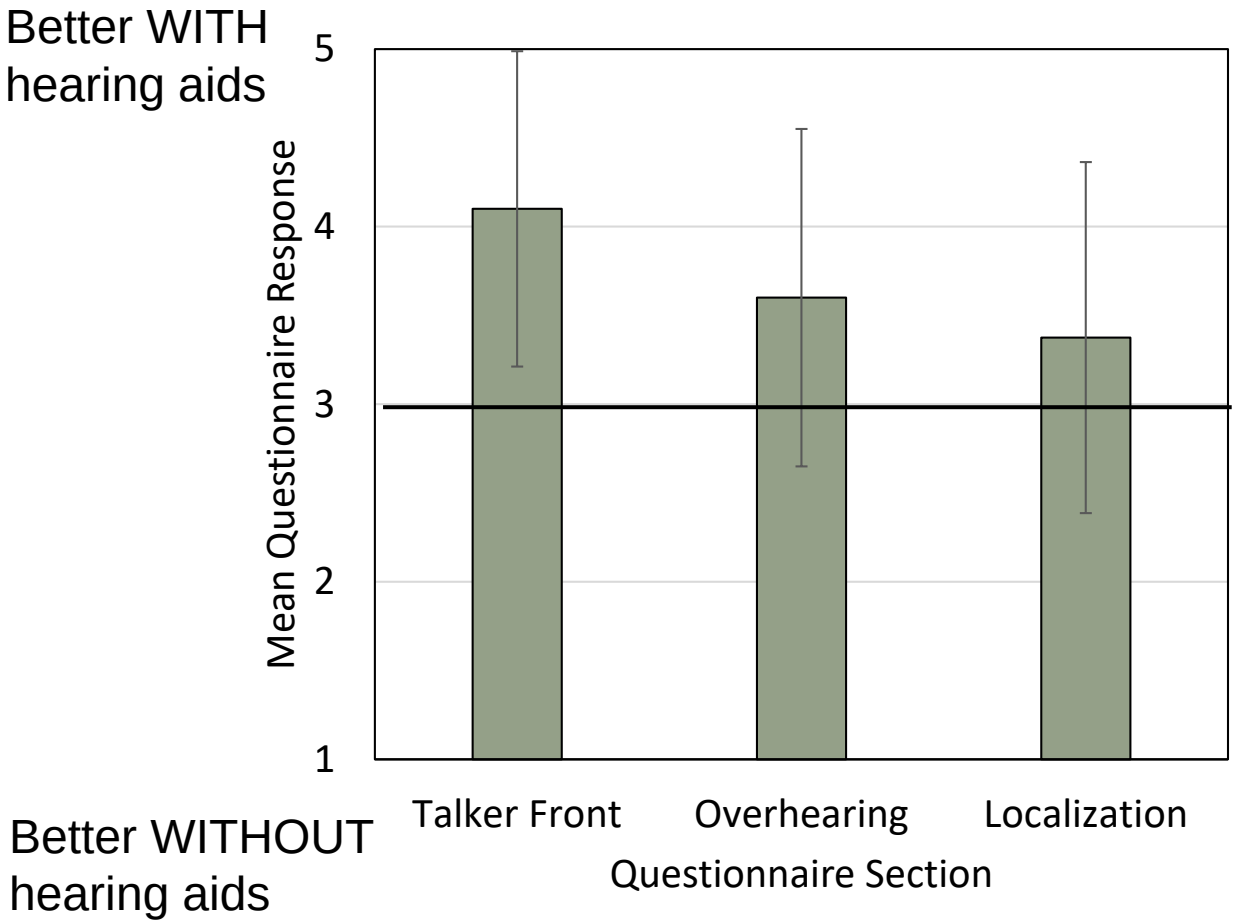
Overhearing

- "I am listening to the teacher in class and kids start talking quietly behind me and I want to know what they are saying."

Localization

- "I am at a noisy party and I hear someone say my name. I want to find where they are."

Students with CROS experience note benefits (mostly)



Responses from 10 established CROS users

Asked to consider the same situations:

- Better WITH hearing aids
- Same WITH and WITHOUT hearing aids
- Better WITHOUT hearing aids

Benefits most apparent for “talker front” situations and lowest for “localization” situations

Summary

Unilateral hearing loss significantly increases risk of academic and language difficulties in school-aged children

No consensus on optimal interventions

Previous studies on CROS/ RM revealed mixed results

- Survey studies suggest CROS beneficial with high use rates
- Laboratory studies suggest RM provide most consistent benefits

Resolution of the conflicting findings is related to:

- Age / validity of survey studies
- Controlled nature of laboratory studies

Updated evidence suggests

- CROS benefits evident in contemporary classroom laboratory environment
- CROS benefits evident in survey data regarding classroom experiences

CROS systems help children with unilateral hearing loss in “real” classrooms

Do we need to take RM systems out of the classroom?

No. These data demonstrate small, but consistent, benefits in a contrived listening situation

- Equal weight to teacher and peer
- Specific speaker configuration

FM systems are best for

- Situations with a single talker (structured lecture, play)
- Younger children who might not orient themselves towards the talker

Do consider CROS as a possible solution for students

- Peer input is important
- Student is older
- Student rejects an FM system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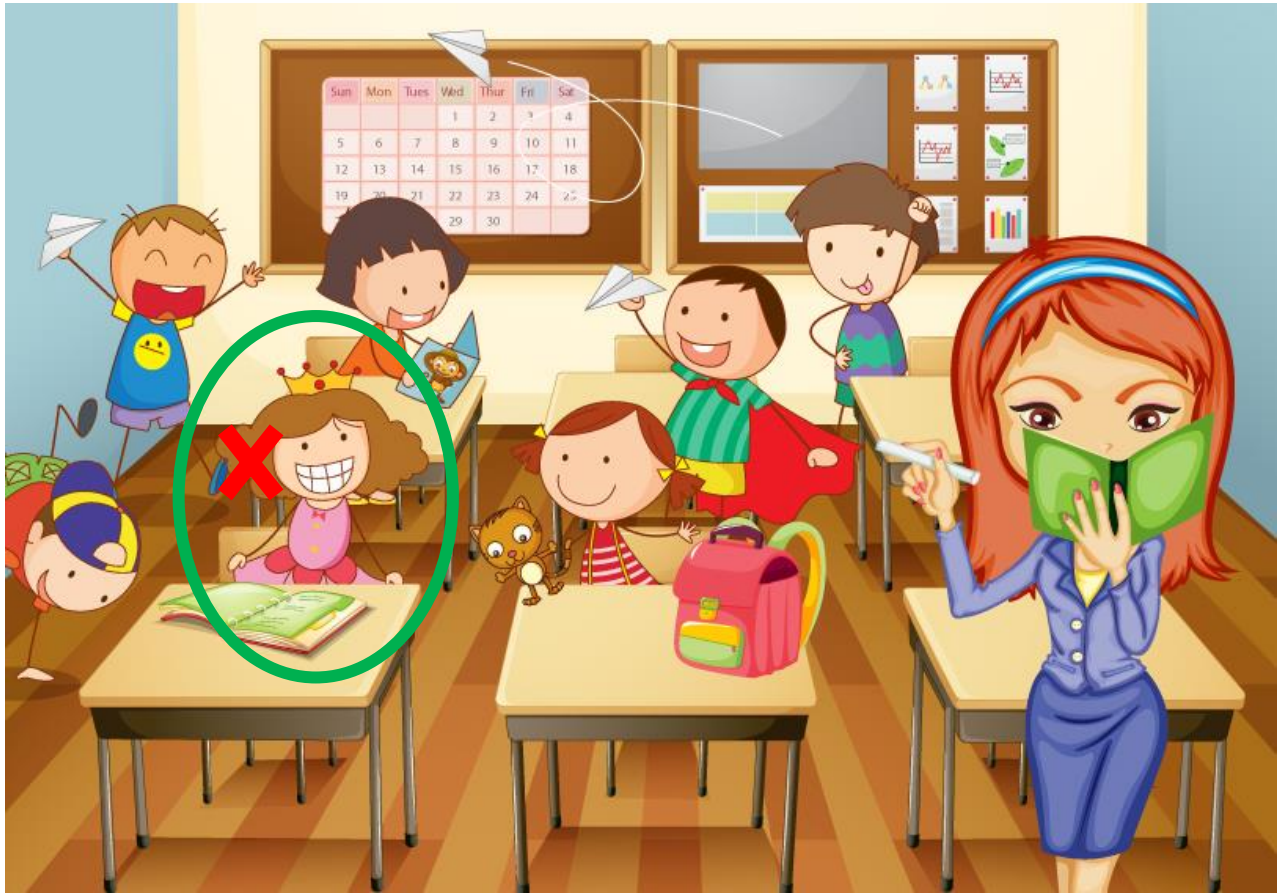
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Take home message

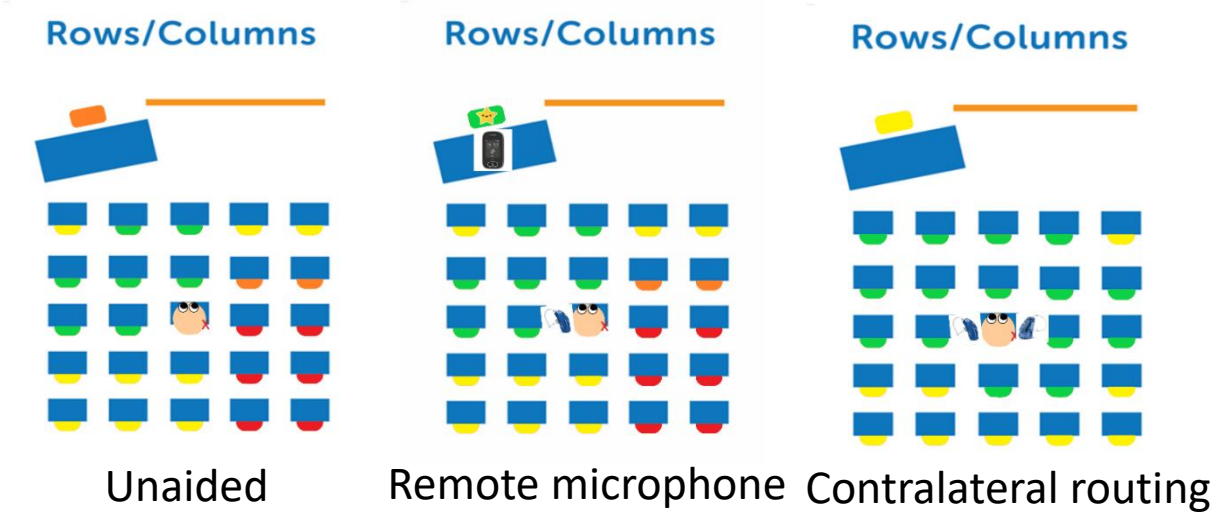
CROS has the potential to help children with unilateral hearing loss in modern classrooms

Benefits most apparent

- Talkers directed towards the ear with hearing loss
- Peers without the remote microphone

Combination RM and CROS will work for most situations

- RM + CROS simultaneously
- RM + CROS with manual / automatic switching
- Sound field RM + CROS



Thank you!

Questions?