Can CROS aids improve speech recognition and comprehension in classrooms?

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Disclosures

Collaborators

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Funding support

- Phonak

Other support

- Amy Stahl, Haiping Huang, 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*

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*


Academic difficulties are also apparent to the teacher.

Interventions in classrooms

Minimally invasive
- Nothing
- Preferential seating

Surgical options
- Osseointegrated devices
- Cochlear implantation

Amplification options
- FM / remote microphone system
- CROS system
Previous work suggests FM systems are the best option.

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

The student...

The speaker...

The legend...

The result...

- Good
- Moderate
- Fair
- Poor
CROS benefits depend on configuration

... and the FM always “wins”

Kenworthy, Klee, & Tharpe (1990) *Ear Hear, 11, 264 - 270*
Benefits depend on stimuli

Kenworthy et al (1990)
Collapsed across listening condition, FM system provided significant benefits for most children.

Data from Kenworthy et al. (1990)
Limitations of previous findings

Signals originated from front hemisphere
Static head position
30 year old technology
Focus on speech recognition
Classrooms include diverse talker locations

- Normal hearing bilaterally
- Right unilateral loss
Modern classrooms have diverse seating arrangements.

Clusters

Normal hearing bilaterally

Clusters

Right unilateral loss
Modern classrooms have diverse seating arrangements.

- **Horseshoe/U-Shape**
- **Horseshoe/U-Shape**
- **Horseshoe/U-Shape**

**Left panel:**
- Normal hearing bilaterally

**Middle panel:**
- Normal hearing bilaterally

**Right panel:**
- Right unilateral loss
Seat assignment makes a difference

Horseshoe/U-Shape

Right unilateral loss

Horseshoe/U-Shape

Right unilateral loss

Horseshoe/U-Shape
Predictions based on seating arrangements complicated by many factors

Who is the REAL talker of interest?
- Teacher
- Classmate in group discussion
- Friend who is being social

Acoustic properties
- Low noise and/or low reverberation
- High noise and/or high reverberation

Head movement
- Facing the talker of interest
- Focused on school work at desk
- Looking out the window and daydreaming
The importance of head movement in a classroom
Do children orient themselves in classrooms?

Adaptive directional microphones might offer additional advantages.

Figure 5. Average speech recognition performance as measured using the CST across the three fixed position noise configurations (diffuse, two-source side, and two-source back) for each of the three microphone modes.

Classrooms are places of learning and comprehension
Story Comprehension
Mild / UHL disrupts comprehension

Fig. 2. Scores (% correct) for the sentence recognition task for the children with normal hearing (NH; light gray) and children with minimal/mild hearing loss (MMHL; dark gray). Boxes represent the interquartile range and whiskers represent the 5th and 95th percentiles. For each box, lines represent the median and filled circles represent the mean scores. Asterisks represent values that fell outside the 5th or 95th percentiles.

Fig. 3. Scores (total correct/18) for the comprehension task for the children with normal hearing (NH; light gray) and children with minimal/mild hearing loss (MMHL; dark gray). Boxes represent the interquartile range and whiskers represent the 5th and 95th percentiles. For each box, lines represent the median and filled circles represent the mean scores. Asterisks represent values that fell outside the 5th or 95th percentiles.
Purpose

Can CROS aids improve speech recognition and comprehension in classrooms?

Goal was to take into consideration

- Talker location
- Updated technology
- Comprehension and recognition
- Live stimuli in simulated classroom
Methods

Participants
- Children with normal hearing
- 10 – 14 years old
- Simulated unilateral hearing loss with 70 dB HL masking in one ear

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 “dead” ear
     ◦ Real Ear Sound
     ◦ Demo hook
   ◦ Receiver on good ear
     ◦ Ultrazoom
     ◦ Non-occluding, non-custom eartip

2) Roger microphone
   ◦ Microphone
     ◦ 6 cm in front of loudspeaker in center
     ◦ “Lanyard” directionality
   ◦ Receiver on good ear
     ◦ 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

Stories developed by Dawna Lewis and colleagues at Boys Town

Fairy tales translated from foreign languages

Each loudspeaker displays a talker and presents her voice

Each talker reads a few sentences of the story

Story split between 4 loudspeakers

Seven stories total divided across 6 conditions
Story Comprehension Test Environment

- Noise loudspeaker
- Roger microphone location
Sentence Recognition Test Environment
A note on looking behavior

12 year old girl

10 year old girl
We are preparing data for manuscript publication.

Preliminary analysis revealed CROS benefits for the off-center loudspeaker.
We are preparing data for manuscript publication.

Preliminary analysis revealed CROS benefits for the loudspeakers to the side and back.
We are preparing data for manuscript publication.

Preliminary analysis revealed small, but consistent benefits of the CROS hearing aids relative to the unaided condition.
Summary

Previous research suggests FM systems provide benefits in classroom listening situations for most children.

Findings limited by:
- Location of talkers
- Dated technology
- Recorded stimuli
- Focus on speech recognition

Conducted a study in a simulated, modern classroom with updated hearing aid technology and natural looking behavior.

Findings suggest benefits of CROS and FM systems depend on listening situations.
Can CROS aids improve speech recognition and comprehension in classrooms?
CROS aids CAN improve recognition and comprehension in classrooms!

Comprehension more sensitive to the effects of technology
  ◦ Consistent with the findings of Kenworthy et al (1990), who found NST more sensitive to interventions than contextually rich sentences

CROS benefits largest in the “hard” situations, which are loaded towards the patient’s bad side

Collapsed across all configurations and tasks, CROS aids provide small, but consistent, benefits
Do we need to take FM 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

Do consider CROS as a possible solution for students in classrooms, especially if
  ◦ Peer input is important
  ◦ Student is older
  ◦ Student rejects an FM system

FM systems are best for
  ◦ Situations with a single talker (structured lecture, play)
  ◦ Younger children who might not orient themselves towards the talker
Do you want to sit with me at lunch?

Let’s get started. Please turn to page 13...
Do you want to sit with me at lunch?

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Take Home Message

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

Benefits most apparent for talkers on the “bad side”

Benefits of CROS relative to an FM most notable in multi-talker situations with peers who are not using the remote microphone
Thank You!

Questions?