

# Critically Appraised Topic II

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PICO: In children with sensorineural hearing loss, does the use of directional microphone hearing aids improve speech intelligibility in noise as compared to omni-directional microphone hearing aids?

# BACKGROUND



- Poor signal to noise ratios can significantly reduce speech understanding for children
  - Those with hearing loss are particularly vulnerable
- Typical SNR in a classroom range from -6 to 6 dB
  - Making listening in this environment difficult
- Microphone technology has been shown to consistently improve SNR for listeners in noise
  - Directional hearing aids can improve SNR based on spatial location of signal of interest relative to the unwanted signal
- FM systems are preferred intervention
  - However, may not be optimal for multiple talkers
- Controversy related to benefits of directional microphones

# Search Strategy



## Database:

- Pubmed
- USF Library MetaSearch
  - PsychInfo, Medline, Academic Search Premeir

## Search Terms:

| Search Terms                         | #  |
|--------------------------------------|----|
| Directional HAs and pediatics        | 1  |
| Directional HAs in children          | 25 |
| Directional mics in children         | 5  |
| Adaptive directional HAs in children | 4  |
| HA mics in children                  | 14 |
| Adaptive vs fixed microphones        | 1  |
| Directional Amp and Pediatrics       | 2  |

# Search Strategy Cont'd



## Inclusion:

- Pediatrics
- Sensorineural Hearing loss
- Testing in noise/speech recognition
- Peer reviewed journals from 1999-present
- Objective outcome measures

## Exclusion:

- Adults
- Conductive/mixed loss
- Testing completed in quiet

# Search Results



## Three articles

Gravel, J., Fausel, N., Liskow, C., & Chobot, J. (1999). Children's speech recognition in noise using omni-directional and dual-microphone hearing aid technology. *Ear and Hearing*, 20(1), 1-11.

Kuk, F. K., Kollofski, C., Brown, S., Melum, A., & Rosenthal, A. (1999). Use of a digital hearing aid with directional microphones in school-aged children. *Journal of the American Academy of Audiology*, 10, 535-548.

Ricketts, T., Galster, J., & Tharpe, A. (2007). Directional benefit in simulated classroom environments. *American Journal of Audiology*, 16, 130-144.

# Article Results



Gravel et al (1999)

## Purpose:

- To investigate whether children with cochlear hearing loss received significant benefit for speech recognition in background noise from hearing aids incorporating dual-microphone technology versus conventional omnidirectional microphones.

## Subjects:

- 20 children (age 4-11)
- Bilateral cochlear hearing loss
  - Ranged from mild to severe
- Binaural BTE hearing aids (Phonak PiCS)

# Article Results



Gravel et al (1999)

## Procedure:

- Multi-talker background competition
- Fixed level of speech signal ( $0^\circ$ ) and noise varied in 2 dB steps ( $180^\circ$ )
- Tested in conventional omni-directional and dual-microphone conditions

## Results:

- In the dual microphone condition
  - Mean advantage of 4.7 dB
- Younger children required a more advantageous SNR to achieve an equal performance criteria as older children.
- ▶ Dual Microphone technology provided a significant advantage in background noise for children with mild to severe cochlear hearing loss.

# Article Results



Kuk et al. (1999)

## Purpose:

- To determine the percentage change in speech recognition score (and an equivalent SNR improvement) offered by the study hearing aids over the subjects' own hearing aids under typical laboratory conditions

## Subjects:

- 20 children (aged 7-13)
- Sensory hearing loss
  - 9 with mild-to-moderately –severe hearing loss (fit with moderate gain model)
  - 11 with moderately-to-severely- profound hearing loss (fit with high gain model)

# Article Results



Kuk et al. (1999)

## Procedure:

- Participants were fit with two directional models of Widex Senso digital hearing aids
  - Has speech enhancement algorithm
- Recorded W22 word lists at 72 dB SPL, 65 dB SPL, and 52 dB SPL (at 0°) and 65 dB SPL party noise (180°)
- Testing in their own omni-directional HA and the directional Widex Senso

## Results:

- Improved speech recognition in noise with the digital directional hearing aid
  - Lower speech score for group with more severe hearing loss
  - Average of 6.5 dB improvement in speech scores
- ▶ Speech recognition performance in noise improved with directional HAs

# Article Results



Ricketts et al (2007)

## Purpose:

- Examine children's subjective and objective performance in both omnidirectional and directional microphone modes across a variety of simulated classroom environments in a series of three experiments.

## Subjects:

- 26 participants (age 10-17)
- 25 subjects with ABG of 15 dB or less
  - One child with low-frequency conductive component of 30 dB
  - 3 subjects with extremely low admittance or – pressure in at least one ear
- Fit with BTE HAs with directional and omni-directional microphones



## Ricketts et al (2007)

### Procedure:

- HA fitting
  - 20 with Oticon Gaia and 6 with Phonak Supero
- Fit with omnidirectional or fixed directional microphone
- Speech recognition testing across varied listening conditions
  
- Experiment 1 5 listening conditions
  - 1- **Teacher front** noise fixed at 55 dB SPL
  - 2- **Teacher back** noise fixed at 55 dB SPL
  - 3- **Desk Work** noise fixed at 55 dB “keep your eyes on your work”
  - 4- **Discussion**-3 loudspeakers used and participants were encouraged to “look at the talker”
    - ✦ **4 noise signals was fixed at 65 dB SPL**
  - 5- **Bench Seating**- 2 talkers seated at either side
    - ✦ **Noise fixed at 65 dB SPL**

# Article Results



- **Experiment 2**: Examine the affects of directional and omni-directional modes for conditions in which the talker was either in front of or behind the listener
  - Stimuli included nonsense syllables
    - ✦ In 6 different listening conditions (directional, omni-directional and low-pass directional)
    - ✦ 2 source locations (Teacher Front and Teacher Back)
  - Stimulus material
    - ✦ hearing aid processed nonsense syllables (selected from the CUNY-NST)
    - ✦ Presented via inserts
  
- **Experiment 3**: To examine further the effect of the two microphone modes
  - Only 12 participants included
  - Some talkers were in front of listener and some were behind
  - Word recognition measured in a single test environment
    - ✦ With North Western University Auditory test No.6
  - Cafeteria noise fixed at 57 dB SPL
  - NU-6 fixed at 63 dB SPL

# Article Results



Ricketts et al (2007)

## Results:

### **Experiment 1**

- Directional benefit in (Teacher front, desk work, discussion)
- Equivalent performance with speaker behind or beside listener
  - Omni directional preferred
- Lack of benefit in Bench Seating condition
  - Believed to be a result head position
- 2.2 to 3.3 dB of directional benefit

### **Experiment 2**

- Significant directional benefit was measured in school-age participants
  - Even with limited contextual information
- Directional decrement when the talker of interest behind the listener

# Article Results



Ricketts et al (2007)

## Results:

### **Experiment 3**

- Source in front
  - No significant difference between omni-directional and directional
- Source behind
  - Performance significantly better in the omni-directional mode than in the directional mode
- ▶ Use of directional hearing aids advantageous in some noisy school environments
  - ▶ More beneficial when the talkers of interest are located in the front hemisphere
  - ▶ In general it's dependent on the particular listening environment
  - ▶ Microphone switching should be utilized

# Methods



## **Gravel et al. (1999)**

- Subjects serve as own control (Single group)
  - Tested in omni directional to directional setting
- Experienced HA users
  - 10 subjects were preschool age (4-6) and 10 were elementary school age (7-11)
- DSL fitting procedure
- Level II

## **Kuk et al. (1999)**

- Single group
  - Testing completed for patients utilizing their own HA then switching over to Widex directional HA
- Experienced with HAs
  - Participants were utilizing binaural analog moderate-to-high gain BTE hearing aids
- Fitting: Set crossover frequency, in-situ threshold, feedback test
- Level II

# Methods



## **Ricketts et al. (2007)**

- Counterbalanced, crossover design
  - Experienced each setting for 1 month before testing
- 24 with previous HA experience
  - None with experience with directional HAs
- DSL fitting procedure
- Disabled digital noise reduction and feedback suppression
- Level II

# Article Review Table



| Author, Year   | Level of Evidence | # of Participants | Comparison | Objective Measure           | Outcomes           |
|----------------|-------------------|-------------------|------------|-----------------------------|--------------------|
| Gravel, 1999   | II                | 20                | Omni       | PSI w/ babble               | Directional better |
| Kuk, 1999      | II                | 20                | Omni       | CID W22 in Party Noise      | Directional better |
| Ricketts, 2007 | II                | 26                | Omni       | Modified HINT-C, CUNY, NU-6 | Varied             |

# PICO Conclusion



In children with sensorineural hearing loss, does the use of directional microphone hearing aids improve speech intelligibility in noise as compared to omni-directional microphone hearing aids?

**Answer:**

- **Children with hearing impairments**
  - Speech intelligibility in background noise improves with directional microphone hearing aids as compared to omni-directional microphones
  - Especially when signal of interest is located in front ( $0^\circ$ )
    - ✦ Performance can be critically reduced if the student does not orient his/her head toward the talker of interest

# References



Gravel, J., Fausel, N., Liskow, C., & Chobot, J. (1999). Children's speech recognition in noise using omni-directional and dual-microphone hearing aid technology. *Ear & Hearing*, 20(1), 1-11.

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