

In adult hearing aid users with SNHL, in conjunction with binaural hearing aid use does the use of a binaural frequency modulation (FM) system as opposed to a monaural FM system lead to improved speech understanding in noise as measured by speech in noise testing?

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Search Strategy

Inclusion Criteria

- ▣ Adult population
- ▣ Articles in English
- ▣ Related to binaural hearing

Exclusion Criteria (at first)

- ▣ Pediatric population
- ▣ Related to Cochlear Implant research

Search Strategy: Databases

- USF Libraries MetaSearch Engine
 - Medicine/Nursing Category
 - Includes:
 - PubMed
 - Health reference center-academic
 - MEDLINE
 - CINAHL
 - Annual Reviews

Search Terms & Hits

- 'directional' & 'FM system' = 541 hits
 - " + 'adults' = 187
 - " – 'kids' = 178
 - " – 'children' = 98
 - " + 'hearing aid' = 7 hits
- After title review = 1 hit
- Lewis 2004

Search Terms & Hits

- 'binaural' & 'frequency modulation' = 298 hits
 - " + 'adult(s)' = 19 hits
 - After title review = 0 hits
- 'FM system' = 14309 hits
 - " + 'bilateral) = 1016 hits
 - " + 'speech' = 181 hits
 - " – 'cochlear implant' =121 hits
 - After title review= 0 new hits
- 'binaural' & 'FM system' = 87 hits
 - " + 'adults'= 43 hits
 - "- ' children' =9 hits
 - After title review = 0 hits

Search Strategy: What next?

- Along the way I saw that binaural FM testing was being conducted with pediatric CI patients. Since I wasn't able to find any more studies that related to adults I found one for the pediatric CI/FM investigation
- 'binaural FM receiver children' = 21 hits
 - After title review = 1 hit
 - Schafer, E.C, & Thibodeau, L. M. (2006). Speech recognition in noise in children with cochlear implants while listening in bilateral, bimodal, and FM-system arrangements. *American Journal of Audiology*, 15, 114-126.

Article Search Results

- ▣ Level III evidence and higher included in CAT

- ▣ Search strategies resulted in 4 articles for review:

- ▣ Lewis, M.S., Crandell, C. C. , Valente, M., Enrietto J.E. (2004). Speech perception in noise: directional microphones versus frequency modulation (FM) systems. *Journal of the American Academy of Audiology*, 15, 426-439.
- ▣ Schafer, E.C, & Thibodeau, L. M. (2006). Speech recognition in noise in children with cochlear implants while listening in bilateral, bimodal, and FM-system arrangements. *American Journal of Audiology*, 15, 114-126.

Speech Perception in Noise: Directional Microphones versus Frequency Modulation (FM) Systems

By: Lewis, Crandell, Valente, & Horn

Background

- Directional microphones and frequency modulation (FM) systems are the best technological advances found to date that aid in understanding speech in noise
- Directional microphones have been found to increase speech perception in noise by 3-8 dB over the conventional omni-directional microphones
- FM systems have been found to improve speech perception in noise by as much as 10-20 dB over the unaided listening condition

Background Cont.

- Despite the increased speech understanding in noise, users were not interested in the bulky wired FM systems of yesterday
- Today there are a few options on the market that are wireless and virtually hidden
- Still FM systems have not become a common recommendation
- When they are necessary for speech understanding what should we be recommending?
 - On receiver or two?

Methods: Subjects

Site I:

University of Florida

- 22 adults
- 24-84 years of age with median age of 73
- Mild sloping to severe SNHL

Site II:

Washington University School of Medicine

- 23 adults
- 34-81 years of age with median age of 73
- Moderate sloping to severe SNHL

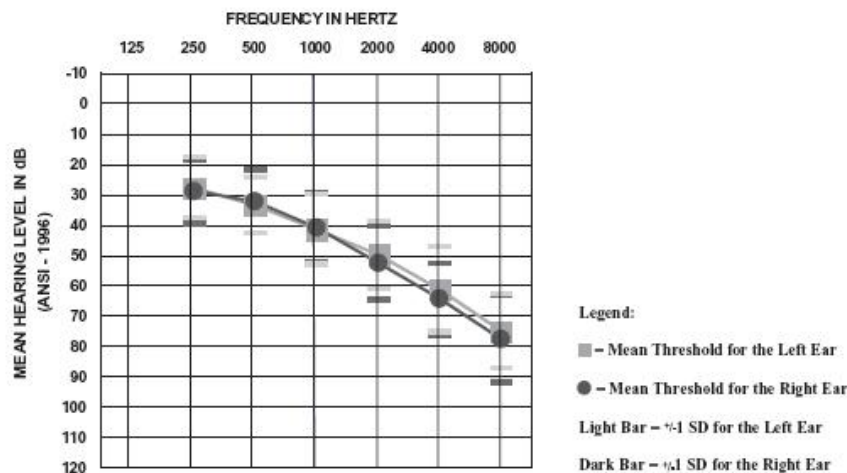


Figure 1. Mean pure-tone air-conduction thresholds for the right and left ears (± 1 SD) at Site I.

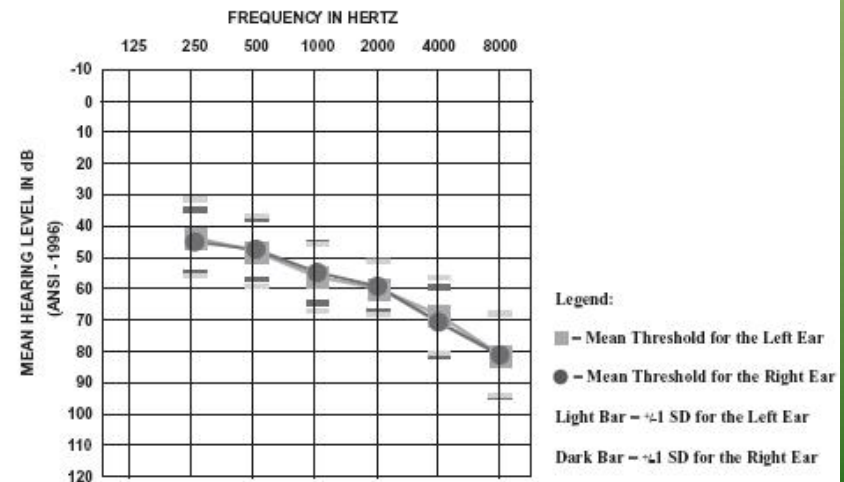


Figure 2. Mean pure-tone air-conduction thresholds for the right and left ears (± 1 SD) at Site II.

Methods

- Amplification Systems given to all subjects:
 - Claro 311 dAZ BTE bilaterally
 - Phonak Microlink ML8 FM receivers bilaterally
 - Phonak TX3 Handymic FM transmitter

Methods

- Speech Stimuli
 - Hearing in Noise Test (HINT) Sentences
- Noise Competition
 - Correlated (same noise source presented @ 45, 135, 225, and 315° azimuth) speech spectrum shaped noise
 - Supplied via the 2nd channel of the HINT CD recording

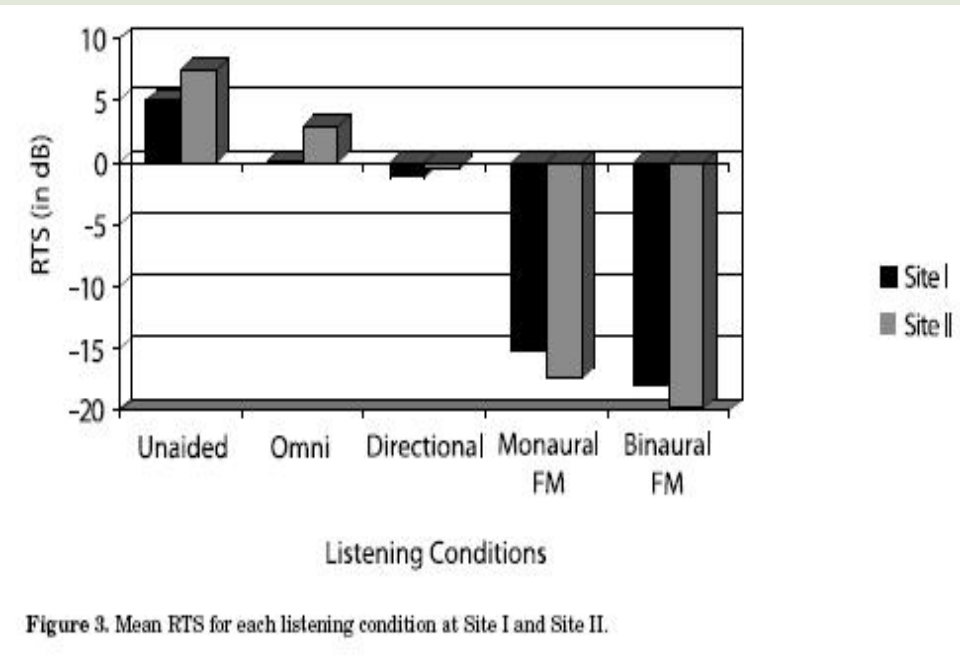
Methods: Procedures

- Reception threshold for sentences (RTS) was found
- HINT sentences presented at 0° azimuth 1 meter from the subject
- FM transmitter was placed on a microphone stand 0.5 meters off the ground and 7.5 cm away from the speaker
- RTS was found using the ‘SuperZoom’ microphone setting as recommended by Phonak for optimal speech understanding in noise

Methods: Procedures Cont.

- Noise level was held constant at 65 dBA
- Intensity of the sentences was varied to find the level where 50% correct was achieved
- RTS was found for 5 different listening conditions:
 - Unaided, binaural BTEs in omni mode, binaural BTEs in directional mode, binaural BTEs with monaural FM receiver (non-FM BTE was in omni mode and FM BTE was in FM mode only), & binaural BTEs (FM mode only) with binaural FM receivers

Results



- As you can see each condition was statistically more significant than the condition before it (resulting in better speech perception scores)
- ‘Binaural FM’ resulted in the best speech perception in noise scores with ~ -18 dB and ~ 2.5 dB better than the ‘Monaural FM’ condition

•The lower the RTS the better

Discussion

- All of the study participants benefited from the use of an FM system
- Findings of :
unaided < omni < directional < monaural FM were as expected based on what we already know from research (technology improves and brings with it better understanding in noise)

Discussion

- FM only conditions were better than both of the HA only conditions
 - ~ 3 dB of binaural advantage as found with binaural HA use
- Patients will benefit from 2 FM receivers!!!

Speech Recognition in Noise in Children with Cochlear Implants While Listening in Bilateral, Bimodal, and FM-System Arrangements

By: Schafer & Thibodeau

Background

- When concerned about a cochlear implanted child's speech recognition....what is the best route to take? 2 CI? 1 CI 1HA? FMs?
- Children with CI's often have a reduction in speech recognition in noise (20-35%) in relation to when in quiet
- Noise is a constant occurrence for children and thus speech recognition is reduced in most listening situations for CI













Methods

- Subjects
 - 22 pediatric CI users (12 sequential & 10 bimodal)
 - Age 3-12 y.o.
 - Implanted by 5 y.o. w/ ≥ 6 months of CI experience and/or ≥ 4 cons. months of HA exp.
 - Avg aided THS(500-4K Hz)= 34.9 dB HL CI1 alone, 34.2 CI 2 alone, 32.2 CI 1 & 2 together
- Procedures
 - Signal @ 0° with noise @ 135° & 225° (classroom)
 - FM transmitter was 6" from signal speaker
- Devices
 - Phonak Campus S transmitter
 - Phonak MicroLink CI-S (2)
 - Phonak MLx-S receivers (2)

Methods

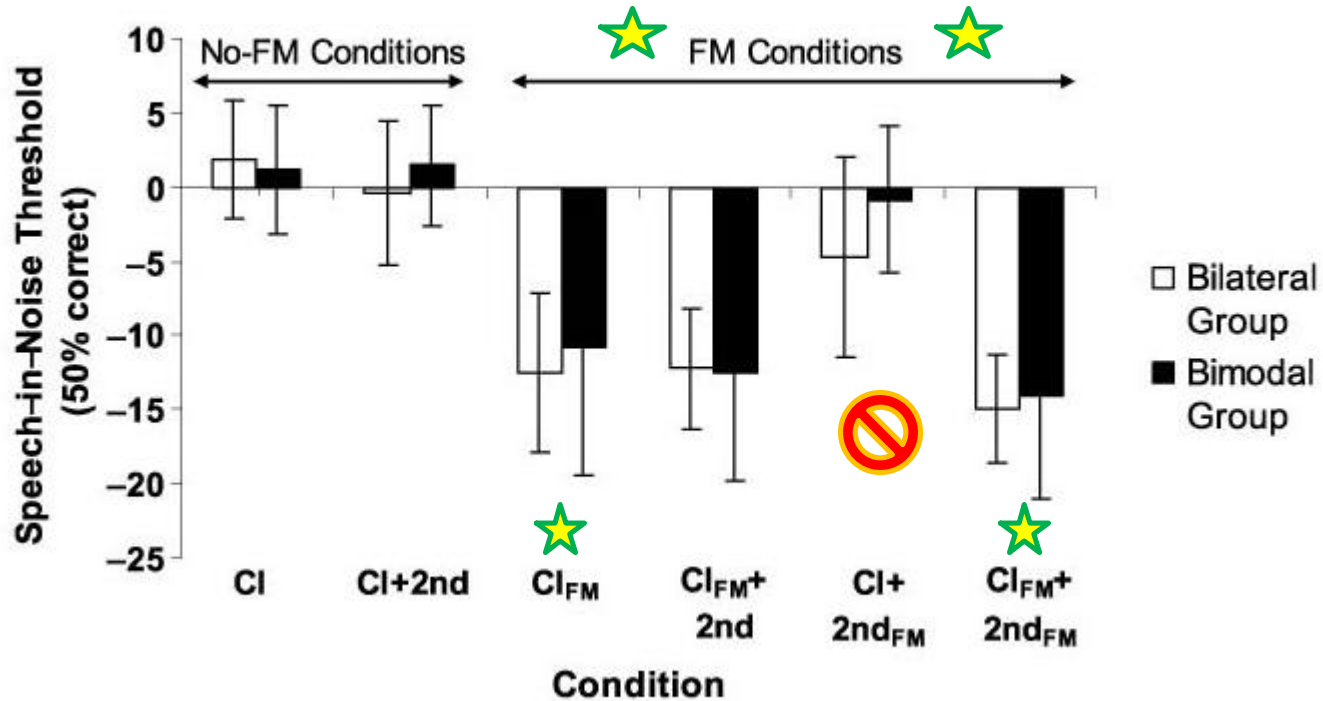
- Procedure
 - Randomized test conditions
- Noise
 - Recorded from 4 different classes in 4 different grades
 - recordings were digitally overlapped and RMS differences reduced
- Stimuli
 - Created for study and similar to BKB-SIN
 - Tested sentence recognition in presence of noise with a child's vocabulary
 - Stimuli sentences told the subject to do something w/the doll ('stomp his feet') instead of repeating due to intelligibility issues

Figure 2. Visual representations of the listening conditions. CI = cochlear implant; +2nd = input to second side; FM = frequency-modulated input to preceding device; HA = hearing aid.

Condition	Acronym	Bilateral Group	Bimodal Group
1	CI	CI 	CI 
2	CI+2nd	CI  CI	CI  HA
3	CI _{FM}	CI _{FM} 	CI _{FM} 
4	CI _{FM} +2nd	CI _{FM}  CI	CI _{FM}  HA
5	CI+2nd _{FM}	CI  CI _{FM}	CI  HA _{FM}
6	CI _{FM} +2nd _{FM}	CI _{FM}  CI _{FM}	CI _{FM}  HA _{FM}

Results

Figure 3. Average speech-in-noise thresholds for the bilateral and bimodal groups.



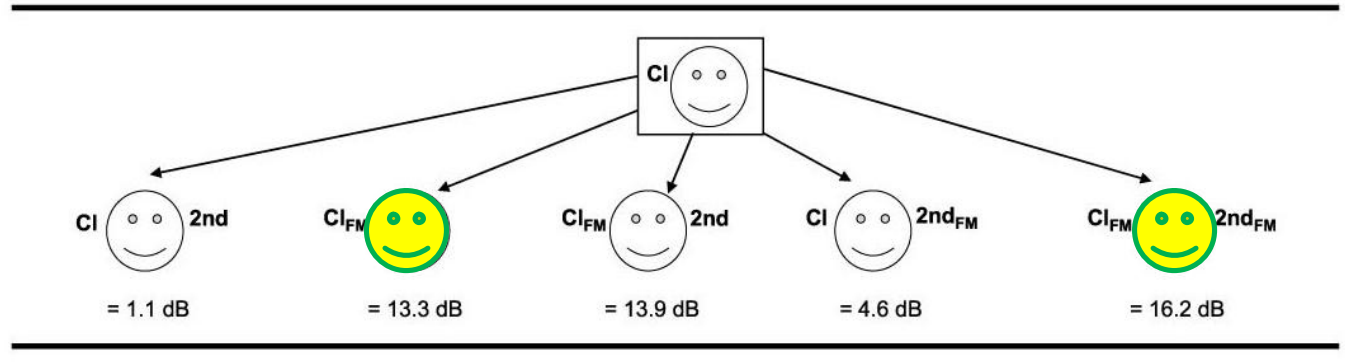
**Significant differences btwn Bilateral and Bimodal when FM included

**NO significant differences btwn Bilateral and Bimodal in the absence of FM

Discussion

- FM use increased speech in noise recognition ≤ 20 dB relative to no FM use attempt
- FM should be used on the be used on the 1st implanted side or bilaterally for best results

Figure 4. Average differences for both groups combined between speech-in-noise thresholds in the CI alone condition relative to all other conditions.



~3dB of increase with binaural FM use in the pediatric CI population

Conclusion

- Binaural FM use is better than monaural
- Binaural FM use has been found (in the cited articles) to be 2.5 dB better with binaural HA use and ~3dB better with either binaural or bimodal CI use.
- Even if you cannot find exactly what you are looking for when you have a PICO in mind, you can compile your own evidence to answer your question!

References

- ▣ Lewis, M. S., Crandell, C. C. , Valente, M., Enrietto J. E. (2004). Speech perception in noise: directional microphones versus frequency modulation (FM) systems. *Journal of the American Academy of Audiology, 15*, 426-439.
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