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# **No need to choose sides: A sideways look at FM**

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# FM alone, or in conjunction with the hearing aid microphone (FM+M)?

- When using FM with children in the classroom, it is often the practice that the FM be used in the FM+M mode
  - Child has a better chance at incidental learning
  - Can interact more with classmates
  - Can still hear the teacher with good SNR



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# FM+M considerations

- Using the FM+M setting does not provide as much SNR improvement as using the FM alone
    - Hawkins, 1984
      - FM advantage of 32% seen with FM only dropped to an advantage of only 12% with FM+M
  - Using the HA alone is still better for hearing speech from the side.
  - Might hear ambient noise when using +6 dB DAI gain in a quiet environment.
  - Child will have more auditory distractions
  - Cost of equipment
  - Competency of teacher with FM device
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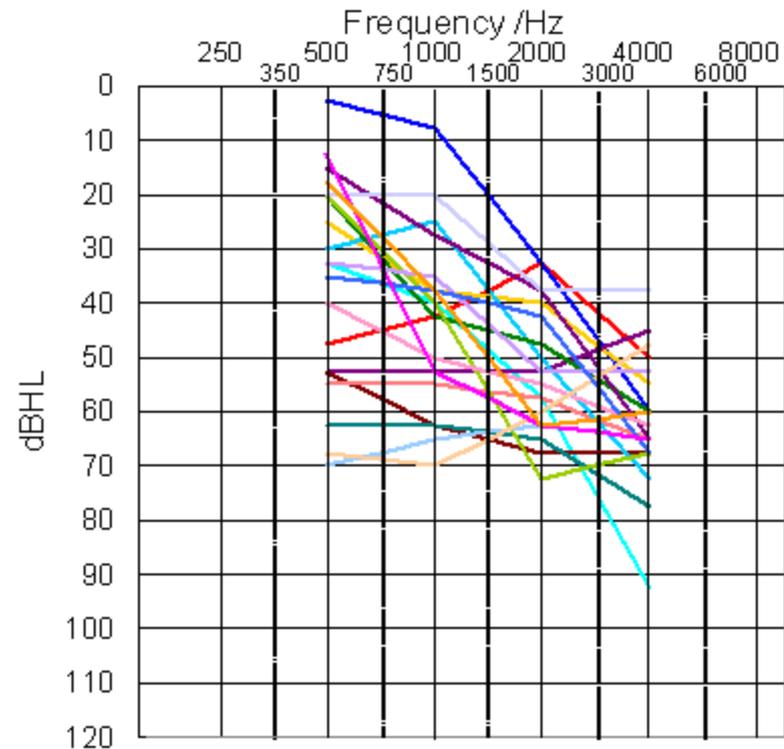
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# Purpose

- Determine the optimal FM settings for improving the intelligibility of speech in quiet using FM+M mode with an ISP hearing aid when the signal of interest originates from the side
    1. Demonstrate the decrease in speech recognition when the FM and hearing aid system are used in the FM+M mode.
    2. Examine the loss in audibility when speech originates from the side when using FM only mode.
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# Methods

- 20 Participants
  - 6 mild-to-moderate sloping hearing losses
    - 1 moderate reverse slope
  - 6 moderate flat hearing losses
  - 7 precipitous hearing losses



# Hearing aids



## Ensuring Audibility and Minimizing Noise

- Inteo 9/élan with CAMISHA shell/earset
- 15-channel enhanced dynamic range compression
  - Low compression threshold (0 dB HL)
- Multi-segment input-output curves
- Extended Input dynamic range at 107 dB SPL and AOC
- Multi-Directional active feedback cancellation in 15 channels

# SCOLA FM system

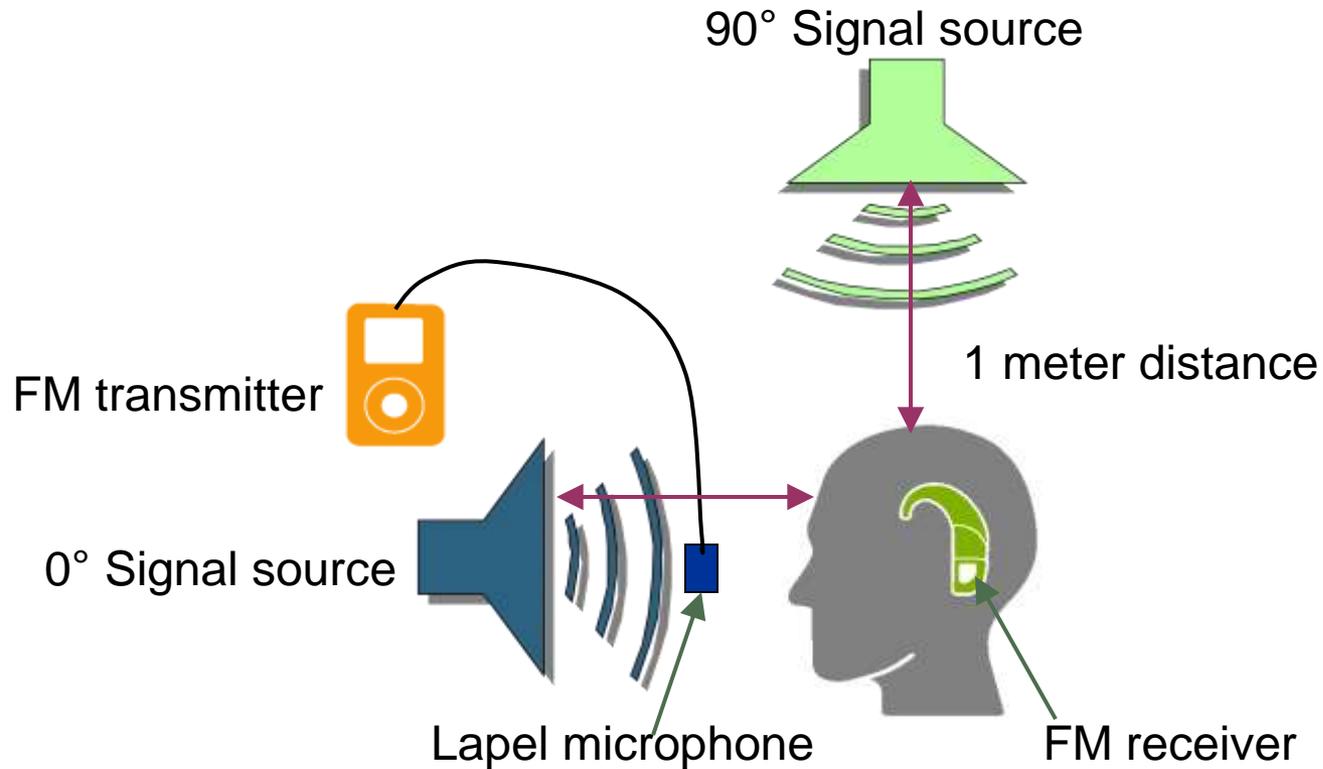
- The SCOLAteach
  - Narrow band (50 kHz channel bandwidth) radio transmitter
  - Bandwidth of 100-7000 Hz using an omnidirectional lapel microphone
- The SCOLAfex receiver
  - Bandwidth of 100-6500 Hz
  - Gain range of 30 dB (-16 dB and +14 dB), taken in 2 dB step sizes
- The FM microphone was placed a distance of 12.5 cm from the speech speaker (0°) woofer.



# Procedures

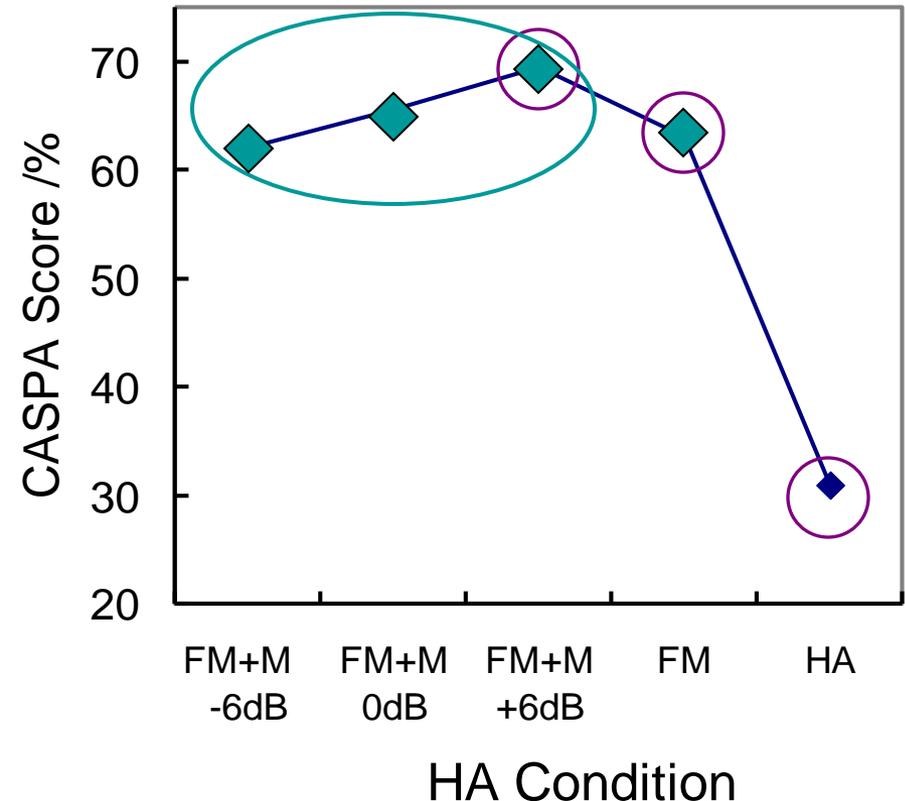
- Participants were seated 1 m from the 90° (right side) and 0° speakers in the classroom.
  - Repeated words from one CASPA list for each of 10 conditions.
    - Three-phoneme word test (Boothroyd, 1999)
  - The hearing aids were set with 1 master program and DAI gain offset for M-DAI was altered for each test condition:
    - Hearing aid alone with adaptive Locator with noise reduction
    - FM only with SE and DAI gain offset of 0 dB
    - FM+M omnidirectional with SE under three DAI gain offset conditions
      - +6 dB
      - 0 dB
      - -6 dB
    - These conditions were repeated with speech originating from 0° and 90° speakers.
  - All conditions were counterbalanced.
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# 0° and 90° speech signal sources



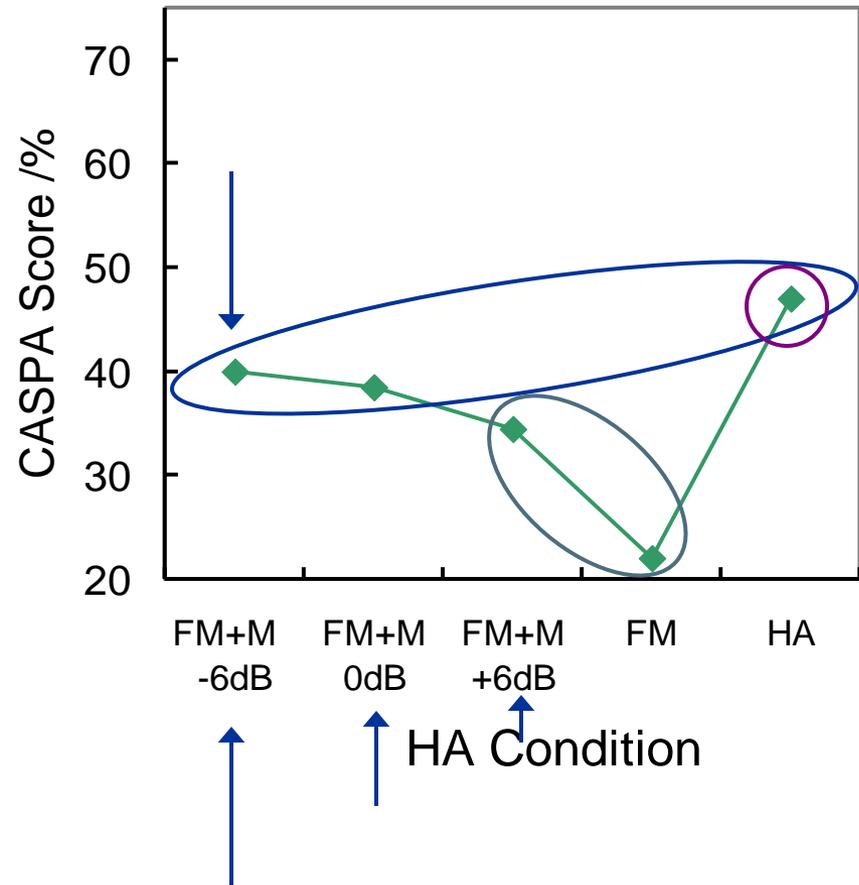
# Results - 0° signal source

- Average performance
- Results for the FM+M conditions (FM only, +6, 0, -6) were not significantly different from each other (df = 19,  $p > 0.05$ )
- All FM conditions were significantly better than the hearing aid alone condition

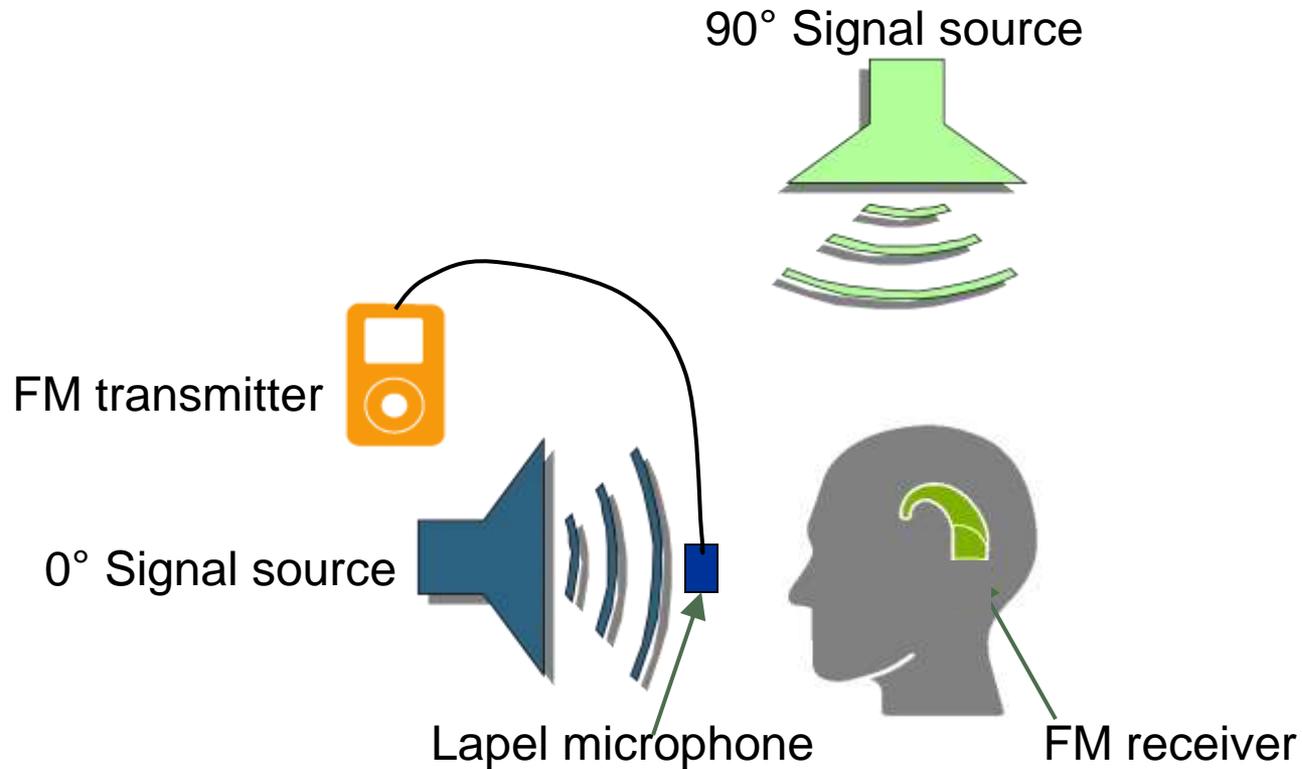


# Results - 90° signal source

- HA only condition improved CASPA word scores by 25% over the FM only condition
- Word scores were not significantly different between the hearing aid only condition, -6, and 0 conditions

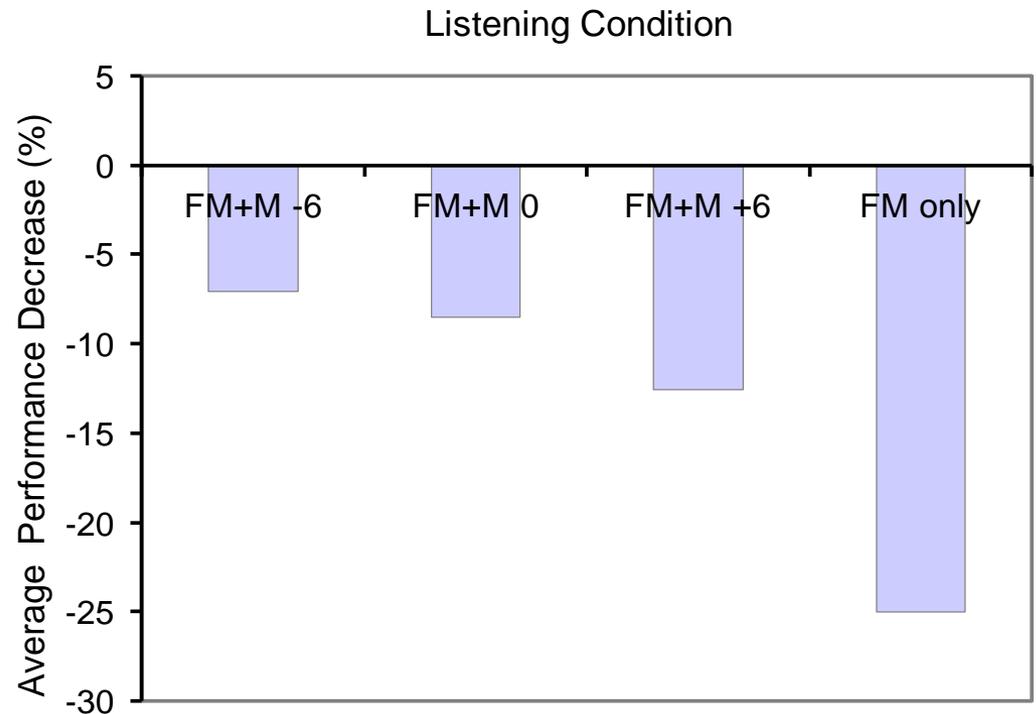


# 0° vs. 90° speech signal source



# 90° condition – Reduction in performance due to use of FM compared with HA only

- The FM only condition was 25% worse than the HA only condition when speech originated from the 90° speaker.
  - The FM+M +6 condition was 12.5% worse than HA only
  - FM+M 0 condition was 8.5% worse than HA only
  - FM+M -6 condition was 7% worse than HA only



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# Conclusions

- What is lost when the FM+M is used?
    - 25% reduction in speech recognition when speech originates from the side ( $90^\circ$ ) if the FM+M +6 mode is used instead of the hearing aid by itself
  - What is lost when the hearing aid alone is used?
    - CASPA word scores dropped by 38.5% on average when the FM+M +6 condition was replaced with the HA only condition with speech from  $0^\circ$ .
    - CASPA word scores dropped by 32% on average when the FM only condition was replaced with the HA only condition with speech from  $0^\circ$ .
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# Conclusions

- What is the best FM gain to apply when using FM+M in order to hear speech from the side?
  - -6 dB or 0 dB (not significantly different from each other)
- In order to hear the speech signal from the side with the best recognition ability it is best not to add signal-to-noise ratio gain to the FM signal.
  - Results from a noise condition indicated the FM gain should be 0 dB.
  - However, it is also important to remember that in most cases the important signal is coming from the front.
- Compromise with 0 dB gain

*The End*

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# References

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  - Fabry, D. (1994) Noise reduction with FM systems in FM/EM mode. *Ear Hear* 15 (1):82–86.
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