

Figure 1. Remote Microphone HAT candidacy, device selection, and implementation process.



Device Selection

- Current Recommendations from AAA:
- *Group 1* - Children and youth with hearing loss who are actual or potential hearing aid users: **Bilateral ear level wireless technology**
- *Group 2* - Children and youth with cochlear implants: **Bilateral wireless technology**







American Academy of Audiology, 2008



Device Selection

- Types of FM Receivers for Hearing Aids (HA):
 - Universal receiver with audio shoe
 - Dedicated
 - Neck-loop: *not recommended because not ear level*
- Types of FM Receivers for Cochlear Implants (CI):
 - Universal receiver with adaptor, specialized earhook, or FM battery door
 - Dedicated
 - Neck-loop: *not recommended because not ear level*

Device Selection: Hearing Aids & FM

| <u>UNIVERSAL</u> | <u>DEDICATED</u> | <u>NECK-LOOP</u> |
|--|--|---|
|  <p>Phonak MLxi</p> |  <p>Phonak ML 12i</p> |  <p>Phonak MyLink+</p> |
|  <p>Oticon Amigo R2</p> |  <p>Oticon Amigo R7</p> |  <p>Oticon Arc</p> |

Device Selection: Cochlear Implants & FM

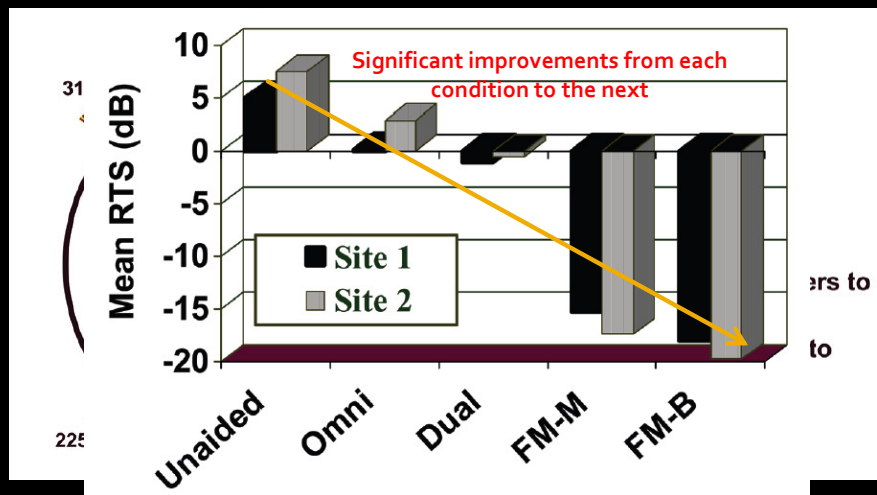
| <u>UNIVERSAL</u> | <u>DEDICATED</u> | <u>NECK-LOOP</u> |
|---|--|---|
|  <p>Cochlear ESPrIt 3G Adaptor</p> |  <p>Phonak Freedom FM</p> |  <p>Phonak MyLink+</p> |
|  <p>Advanced Bionics Auria/ Harmony FM Earhook</p> | | |
|  <p>MED-EL Opus II with FM Battery Cover</p> | |  <p>Oticon Arc</p> |

Hearing Aid-FM Research

- Limited research on HA and FM systems
 - Lewis, Crandell, Valente, & Horn (2004)
 - Speech-in-noise thresholds of 45 adults with mild-to-severe sloping SNHL
 - Tested in five conditions:
 1. Binaural unaided
 2. Bilateral Phonak Claro 311 dAZ BTEs, omnidirectional mics
 3. Bilateral Phonak Claro 311 dAZ BTEs, directional mics
 4. Bilateral Claros in omni mode & 1 MicroLink FM receiver (FM only)
 5. Bilateral Claros & 2 MicroLink FM receivers (FM only)

Lewis et al, Journal of the American Academy of Audiology, 2004

Hearing Aid-FM Research



Lewis et al, Journal of the American Academy of Audiology, 2004

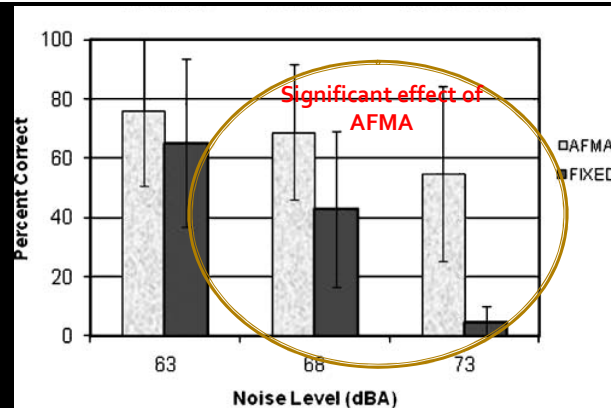
Hearing Aid-FM Research

- Thibodeau (2010)
 - Speech recognition in noise and subjective benefits from hearing aids and personal FM systems:
 - 5 adults and 5 older children with moderate-to-severe SNHL
 - Compared receivers:
 - (1) fixed FM advantage
 - (2) adaptive FM advantage (AFMA /Dynamic FM)

Automatically increases gain of receiver when noise exceeds 57 dB SPL

Thibodeau, American Journal of Audiology, 2009

Hearing Aid-FM Research



- Most participants preferred AFMA during listening activities and on a tour at an aquarium

Thibodeau, American Journal of Audiology, 2009



Cochlear Implant-FM Research

- 1. Which types of FM system is best for CIs?
- 2. How to implement FM for people using bilateral CIs or bimodal stimulation?
- 3. How to set the gain on programmable FM receivers?
- 4. Do we need to make changes to the CI programming?
- 5. Is Dynamic FM better than traditional FM?
- 6. Are neck-loop receivers helpful?



1. Which system is best?

- Meta analysis: synthesizes data from multiple studies
- Combined data from 9 studies
 - 1. Classroom soundfield – CI alone = **3.5% (\pm 5.1)**
 - 2. Desktop soundfield – CI alone = **17.1% (+ 8.8)**
 - 3. Personal FM system – CI alone = **38.0% (\pm 5.7)**

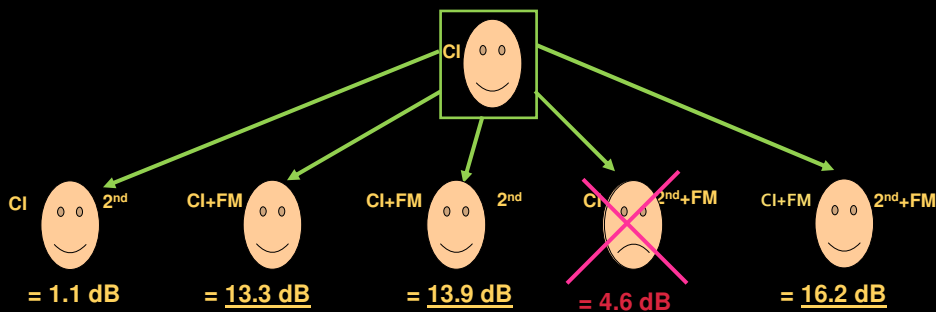
2. FM with Bilateral/Bimodal?

- Evaluated speech-in-noise thresholds:
 - 12 young children with bilateral cochlear implants
 - 10 young children bimodal stimulation (CI+HA)
- Five listening conditions with and without personal FM (Phonak Campus S & MLxS or MicroLink CI-S)

Schafer & Thibodeau, American Journal of Audiology, 2006

2. Bilateral CI or Bimodal?

- Improvements in speech recognition relative to a single CI:



FM input to first or both sides best!!

Schafer & Thibodeau, American Journal of Audiology, 2006

3. How to set the FM Gain?

- Programmable receivers: control of FM advantage: strength of FM relative to CI signal
- Sentence recognition thresholds in noise in 17 adults in 5 conditions:

- 1. No FM system
- 2. FM: gain +6
- 3. FM: gain +10
- 4. FM: gain +14
- 5. FM : gain +20



Aria:
MLxS



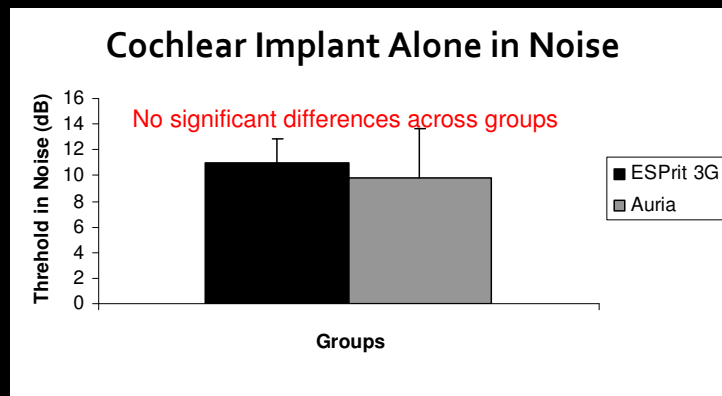
Campus S



ESPririt
3G:
MLxS

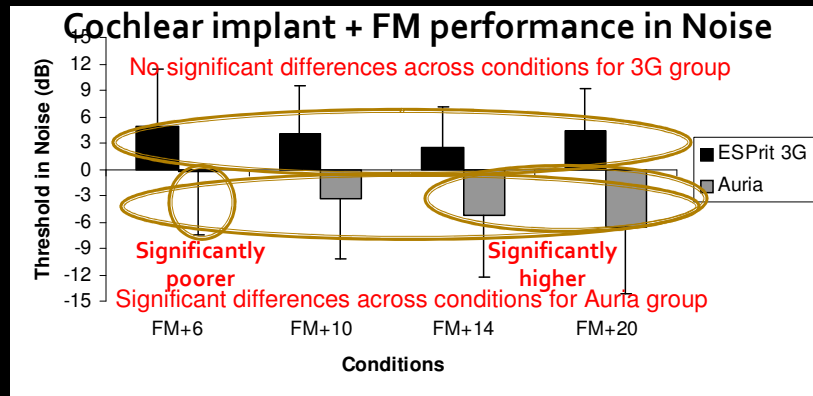
Schafer et al, International Journal of Audiology, 2009

3. How to set the FM Gain?



Schafer et al, International Journal of Audiology, 2009

3. How to set the FM Gain?



Based on data and subjective reports, we recommend **+14 to +16 FM gain settings on programmable receivers**

Schafer et al, International Journal of Audiology, 2009

4. Do we need to make changes to the CI programming??

- Audio-mixing ratios: control sound between CI microphone and auxiliary source
- Evaluated sentence recognition quiet and in noise (+5 SNR) in 12 adults after:
 - 2-week FM trial with 50/50: equal emphasis
 - 2-week FM trial with 30/70: processor microphone attenuated by 10 dB



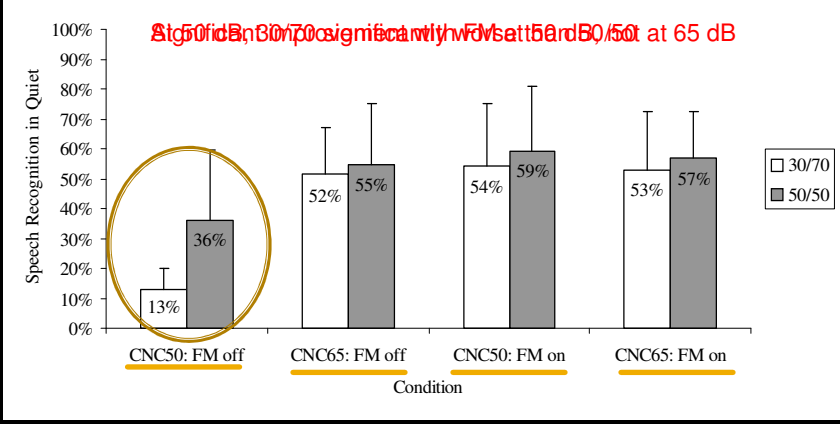
Auria: MLxS



SmartLink

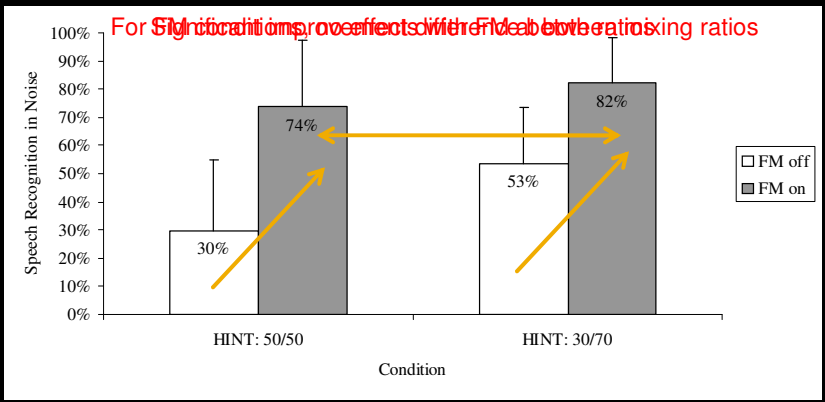
Wolfe & Schafer, Journal of the American Academy of Audiology, 2008

4. Do we need to make changes to the CI programming???



Wolfe & Schafer, Journal of the American Academy of Audiology, 2008

4. Do we need to make changes to the CI programming???



Based on data, we recommend 50/50 ratios for Advanced Bionics devices or 1:1 on Cochlear devices

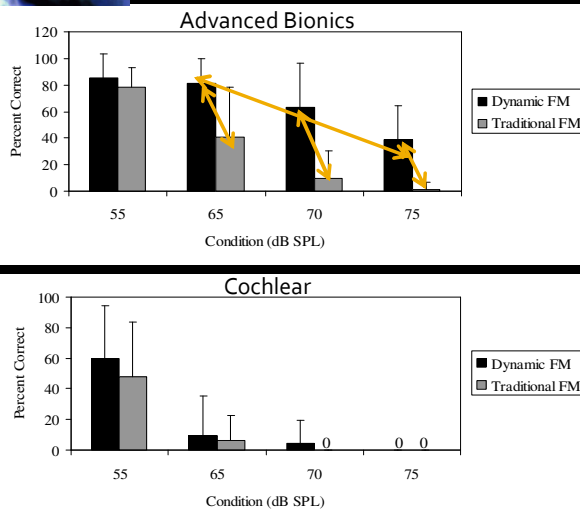
Wolfe & Schafer, Journal of the American Academy of Audiology, 2008

5. Is Dynamic FM better than traditional FM?

- Dynamic FM: Adjusts the gain of the FM receiver when the ambient noise level exceeds 57 dB SPL
- Two phases of study:
 - I. Compared traditional & dynamic FM for 13 Advanced Bionics and 11 Cochlear users
 - II. Optimizing Dynamic FM for 10 Cochlear users with Autosensitivity (ASC)

Wolfe & Schafer, Journal of the American Academy of Audiology, 2008

5. Is Dynamic FM better than traditional FM: Phase 1

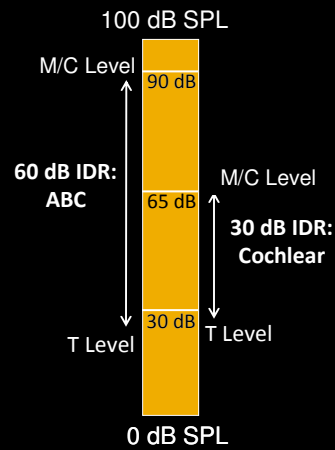


- Significant difference between groups
- Dynamic FM significantly better for ABC
- Performance worsens with increased noise

Wolfe et al, Journal of the American Academy of Audiology, 2009

Input Dynamic Range

- IDR: range or window of input levels coded in the speech processor within a person's electrical dynamic range
- IDR is fixed in the processor

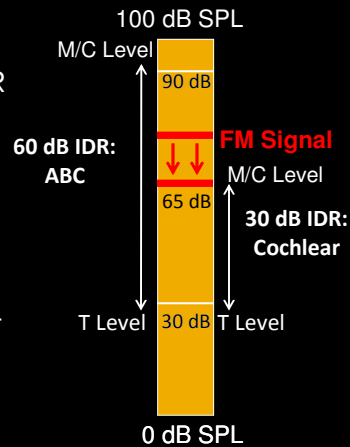


Wolfe et al, Journal of the American Academy of Audiology, 2009

Input Dynamic Range

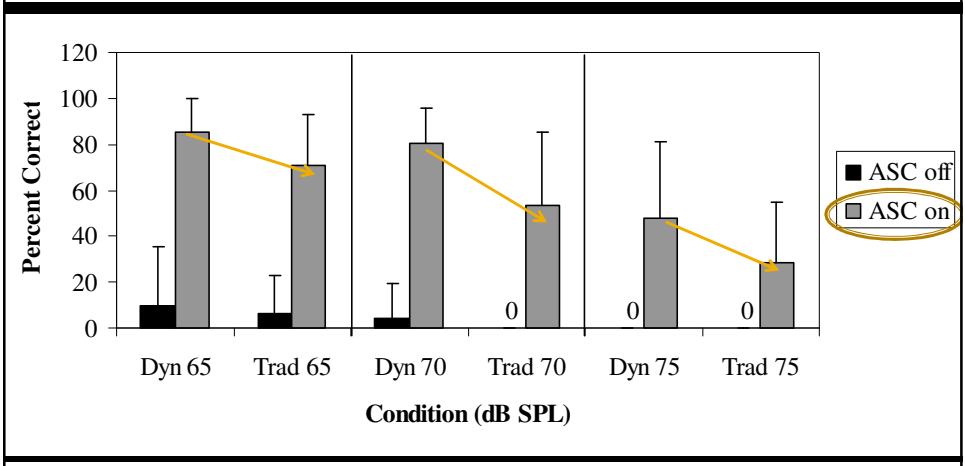
- Why would IDR affect FM benefit?

- FM signal compressed when IDR significantly limits the input signal at 65 dB
- Cochlear users: speech recognition scores unchanged with increased FM gain
- ABC users: higher IDR allows for coding of the gain changes or louder inputs from the FM



Wolfe et al, Journal of the American Academy of Audiology, 2009

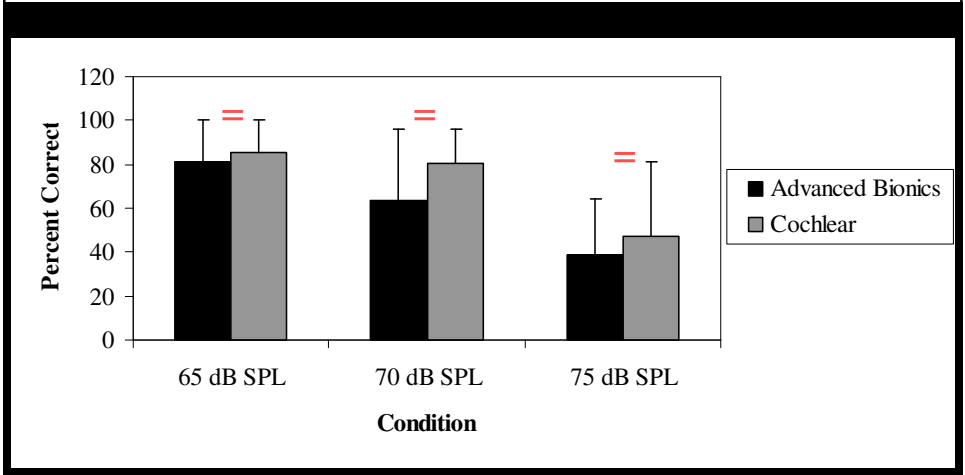
5. Is Dynamic FM better than traditional FM: Phase 2



Dynamic FM better than traditional FM, especially when using ASC

Wolfe et al, Journal of the American Academy of Audiology, 2009

5. Is Dynamic FM better than traditional FM: Phase 2

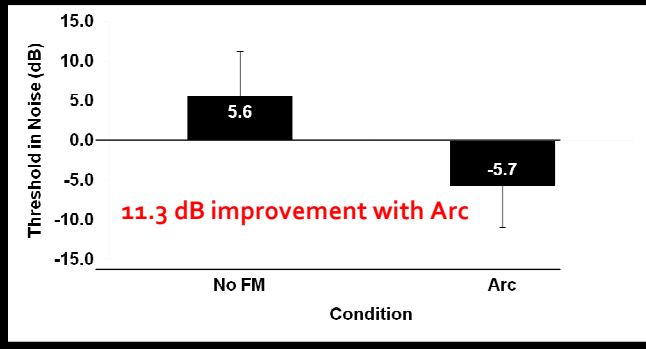


Also found that ASC allows for better performance in noise without FM

Wolfe et al, Journal of the American Academy of Audiology, 2009

6. Are neck-loop receivers helpful to those with CIs?

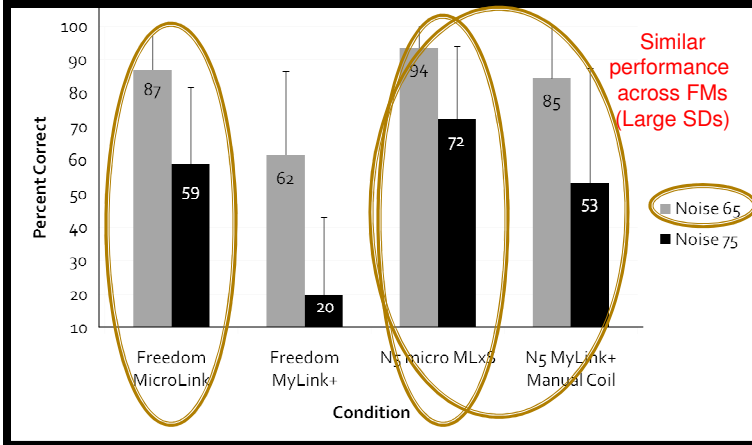
- Data collection in progress or manuscripts in preparation for two studies:
 - 8 Cochlear Freedom Users with Oticon Arc



Schafer lab

6. Are neck-loop receivers helpful to those with CIs?

- 14 Freedom users upgrading to Nucleus 5



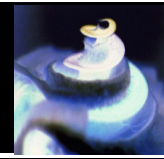
Significantly Better:

- At 65 dB SPL
- With direct connection
- Nucleus 5

Multi-center/Wolfe



Summary for Hearing Aids



- New guidelines for selection, fitting, & verification
- Research evidence that Dynamic FM better than traditional FM when listening in noise
- More research needed!!
 - Newer neck-loop FM receivers with hearing aids



Summary for Cochlear Implants



- New guidelines for selection, fitting, & verification
- Research:
 - Use personal FM, not soundfield
 - If bilateral/bimodal, use FM on both sides
 - If programmable FM, set to +14 or +16
 - Set CI programming to 50/50 or 1:1 audio-mixing ratio to ensure audibility of other people
 - Dynamic FM shows higher performance than traditional FM
 - Neck-loop receivers are helpful, but directly connected may be better??

??Questions/Preguntas??

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