Initial-Fit Algorithm vs. Probe-Microphone Verification: Comparing Self-Perceived Benefit

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Acknowledgments

- Portions of this presentation were delivered at the American Auditory Society Meeting, March 7, 2009
- This material is the result of work supported with resources and the use of facilities at the Bay Pines VA Healthcare System
- The contents do not represent the views of the Department of Veterans Affairs or the United States Government
## Background

<table>
<thead>
<tr>
<th>Probe-Microphone</th>
<th>Initial-Fit</th>
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<tbody>
<tr>
<td>- direct measure of the response</td>
<td>- an approximation of the measured response</td>
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<td>- accounts for the head-related transform function</td>
<td>- predicted from patient-specific data entered by clinician</td>
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</table>
Background

- Less than a third of audiologists surveyed reported routinely performing Probe-Microphone measurements (Kirkwood, 2006)
- Why?
Reasons I don’t use REM

- high cost of equipment
- space demands
- time needed to perform the testing
- cumbersome nature of the REM equipment
- uncertain correlation with hearing aid satisfaction
more reasons...

- belief that REM cannot/need not be used with digital hearing aids
- belief that fitting software graphics are a good substitute for REM
- failure of training programs to emphasize the need for real-ear verification
- lack of best practices in clinics where graduates are placed
and even more reasons...

- lack of dedication to best practices by some practitioners
- belief that procedures such as fitting the hearing aid in a sound field or speech mapping without probe microphones are superior to REM
- belief that “first-fit” algorithms result in equal outcomes as probe-microphone verification
Previous studies examining predicted vs. measured response

  - Initial-Fit vs. measured 2cm$^3$ coupler gain
- Bentler (2004)
  - 2cm$^3$ coupler gain among six different hearing aids
- Aarts and Caffee (2005)
  - Initial-Fit vs. measured REAR
- Bretz (2006)
  - Pediatric initial-fit vs. NAL-NL1 and DSL [i/o]) prescription targets
- Aazh and Moore (2007)
  - Initial-Fit vs. REIG with digital hearing instruments
Hawkins and Cook (2003)

Figure 1. Differences in measured 2-cc coupler gain and software-simulated 2-cc coupler gain for 28 hearing aids. Negative values indicate that the software-simulated 2-cc coupler gain is less than the measured 2-cc coupler gain.
OK, but what about actual measured gain in the ear?

*Figure 2. Differences in measured insertion gain and software-simulated insertion gain for 12 patients. Negative values indicate that the software-simulated insertion gain is less than the measured insertion gain.*
Aarts and Caffee (2005)

Flat, mild loss

Figure 1. Mean difference between measured real-ear aided response (REAR) values and predicted REAR values for male (N = 17 subjects, N = 31 ears) and female (N = 24 subjects, N = 47 ears) subjects for a flat mild hearing loss using a 50 dB SPL FFT speech weighted input (A) and a 90 dB SPL FFT speech weighted input (B). Positive values indicate that the measured value exceeded the predicted value while negative values indicate that the predicted value exceeded the measured. Values of 0 indicate no difference between measured and predicted REAR.
Sloping mild to moderately severe loss

Figure 2. Mean difference between measured real-ear aided response (REAR) values and predicted REAR values for male (N = 17 subjects, N = 32 ears) and female (N = 24 subjects, N = 47 ears) subjects for a sloping mild-to-moderately-severe hearing loss using a 50 dB SPL FFT speech weighted input (A) and a 90 dB SPL FFT speech weighted input (B). Positive values indicate that the measured value exceeded the predicted value while negative values indicate that the predicted value exceeded the measured. Values of 0 indicate no difference between measured and predicted REAR.
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**Figure 2.** Mean difference between measured real-ear aided response (REAR) values and predicted REAR values for male (N = 17 subjects, N = 32 ears) and female (N = 24 subjects, N = 47 ears) subjects for a sloping mild-to-moderately-severe hearing loss using a 50 dB SPL FFT speech weighted input (A) and a 90 dB SPL FFT speech weighted input (B). Positive values indicate that the measured value exceeded the predicted value while negative values indicate that the predicted value exceeded the measured. Values of 0 indicate no difference between measured and predicted REAR.
Figure 1. The percentage of fittings that came within ±10 dB of the NAL-NL1 target in the frequency range 0.25 to 4 kHz using the first fit program of the aids (black bars) and after adjustments in frequency-gain response (light gray bars), for four different types of digital hearing aids.
Rationale for this study

- Initial-Fit algorithm consistently fails to approximate the prescribed response as verified with a Probe-Microphone
- Does it matter in terms of subjective outcome?
Rationale

- Byrne (1992)
  - subjects judged intelligibility and pleasantness of sound as processed through hearing aids in which the frequency response was systematically varied
  - rms differences of as little as 3-4 dB were judged to be significantly different more often than not
Our Research Question

- Given that the Initial-Fit algorithm often results in differences from the prescribed target...
- can we empirically demonstrate that self-perceived benefit differs as a function of the hearing aid fitting procedure utilized?
Methods
Design

- counter-balanced, cross-over, single-blinded design
  - 22 participants randomized in order that half were fit either with the manufacturer’s Initial-Fit algorithm first or with Probe-Microphone verification first
  - After 4-6 weeks, the participants crossed-over to the other method.
Study Participants

- Experienced hearing aid users,
  - 60 to 89 years (mean = 77.95 years)
  - non-paid
  - all males
  - various degrees of bilateral, sensorineural hearing loss ranging from mild to severe
Hearing Aids by Manufacturer

Number of Instruments

- Microtech Radius 12
- Phonak Eleva 211
- Starkey Destiny
- Microtech Radius 16
- Phonak Eleva 11
- Siemens Prisma
- Siemens Artis
Hearing Aid Styles

Number of Instruments

<table>
<thead>
<tr>
<th>HS</th>
<th>BTE</th>
<th>CIC</th>
<th>ITE</th>
<th>ITC</th>
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<tbody>
<tr>
<td>22</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>4</td>
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The chart shows the number of instruments for different hearing aid styles: HS, BTE, CIC, ITE, and ITC. HS has the highest number of instruments, followed by BTE, CIC, ITE, and ITC.
Instrumentation

Measurement settings -

- unaided response: custom
- REUR auto adjust: off
- reference mic: on
- noise reduction: 4X
- fitting rule: NAL-NL1
- client age: adult

- number of channels: 3
- aid limit: multichannel
- fit type: bilateral
- sound field: 45 degrees
- reference mic position: head surface
Instrumentation

■ Stimulus settings -
  ■ static tone: off
  ■ average frequencies: HFA 2500
  ■ bias tone: off
  ■ tone filter: flat
  ■ DigSpeech: ANSI weighted
Outcome Measure

- Abbreviated Profile of Hearing Aid Benefit (APHAB; Cox & Alexander, 1995)
  - 24 items with four subscales:
    - Ease of Communication (EC)
    - Reverberation (RV)
    - Background Noise (BN)
    - Aversiveness of Sounds (AV)
  - Global score
Procedures

- initial-fit or probe-fit
- “sham” probe-fit
- 50 dB and 80 dB SPL checks
- adjustment if required
- 4-6 week wear time

Session 1
- Pre-fit APHAB
- Instrument fitting
Procedures

Session 1
• Pre-fit APHAB
• Instrument fitting

4-6 weeks

Session 2
• Post-fit APHAB
• Crossover fitting

- crossover
- adjustment if required
- 4-6 week wear time
Procedures

Session 1
• Pre-fit APHAB
• Instrument fitting

4-6 weeks

Session 2
• Post-fit APHAB
• Crossover fitting

4-6 weeks

Session 3
• Post-fit APHAB
• Preference selection
• Final adjustments
Results

- Comparison of Real Aid Aided Response for both fittings
- APHAB subscale and Global scores
- Fitting method preference
REAR as a function of fitting method
Benefit as a function of fitting method

![Graph showing benefit scores for different fitting methods. The x-axis represents different fitting methods: EC, RV, BN, AV. The y-axis represents the benefit score, ranging from -40 to 40. The graph compares the initial fit and probe mic results, with error bars indicating variability. Stars denote significant differences between methods.]
Global Scores (EC+BN+RV)

Bar chart showing benefit scores for Initial Fit and Probe Mic.

- Initial Fit: Benefit Score
- Probe Mic: Benefit Score with a star indicating a significant difference.
Preference

Preference for Probe Mic is significantly higher than for Initial Fit.
Summary

- Hearing instruments fit with Probe-Microphone verification techniques achieved significantly closer match to NAL-NL1 than the same instrument fit using the manufacturer’s Initial-Fit algorithm.
- APHAB subscale and global benefit scores were significantly higher in the Probe-Microphone condition than in the Initial-Fit condition.
Summary

- APHAB global benefit score was predictive of patient preference for fitting method.
- The Probe-Microphone fitting approach was preferred by a significantly greater number of participants than the Initial-Fit approach.
The Impact of the Hearing Health Professional on Hearing Aid User Success

Sergei Kochkin, Ph.D.
MarkeTrack VIII

- In November and December 2008 a short screening survey was mailed to 80,000 members of the National Family Opinion (NFO) panel as a means of identifying people with hearing loss and hearing aid owners.

- In January 2009 an extensive 7 page legal size survey was sent to the total universe of hearing aid owners in the panel database (3,789); 3,174 completed surveys were returned representing an 84% response rate.
Analysis

- Measured 17 items of the hearing aid fitting protocol.
- Measured 7 real-world success measures.
- Related use of protocol items to real-world success.
Protocol items measured

- Hearing tested in sound booth
- Subjective benefit measurement
- Objective benefit measurement
- Patient satisfaction measurement
- Loudness discomfort measurement
- Auditory retraining software therapy
- Aural rehabilitation group
- Received self-help book
- Received self-help video
- Referred to self-help group
- *Real ear measurement verification*
Success measures

- Hearing aids in the drawer and hearing aid usage in hours

- Benefit
  - Satisfaction with benefit (7 point Likert scale)
  - Perception of % hearing handicap reduction in 10 listening situations.
  - Multiple Environmental Listening Utility (MELU)
    - The percent of 19 listening situations in which the patient was satisfied or very satisfied
  - Quantified Client Oriented Scale of Improvement (COSI) measure
Success measures

- **Patient recommendations**
  - Would recommend the hearing healthcare professional
  - Would recommend hearing aids to friends
  - Would repurchase current hearing aid brand

- **Overall success**
  - A composite measure of success derived from factor analyzing the above variables
  -Converted to factor scores and standardized to a mean of 5 and standard deviation of 2 (stanine scores)
A comparison of above average and below average hearing aid success as measured by subjective real-world outcomes showing protocol received based on consumer perceptions.
A comparison of above average and below average hearing aid success as measured by subjective real-world outcomes showing protocol received based on patient perceptions.

Number visits to adj HA

- One: 13 below, 36 above
- Two: 14 below, 27 above
- Three: 7 below, 17 above
- 4 or more: 7 below, 47 above

Percent of patients

- Red: Below average success
- Green: Above average success
Impact of a protocol on hearing aid success comparing a minimum protocol (0-2 items) to a more comprehensive protocol (10-12 items).

- Would repurchase HA brand
- Multiple environment listening utility
- Would recommend dispenser
- Satisfaction with benefit
- Would recommend HA
- Hearing handicap reduction
- Hearing aids in draw/hearing aid usage

Percent

Minimal protocol
Comprehensive protocol
Conclusion

- The use of Probe-Microphone verification methods *do* make a difference.
References

References