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

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Background

Probe-Microphone	Initial-Fit
direct measure of the response	an approximation of the measured response
accounts for the head-related transform function	predicted from patient-specific data entered by clinician

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

- Hawkins and Cook (2003)
  - 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)

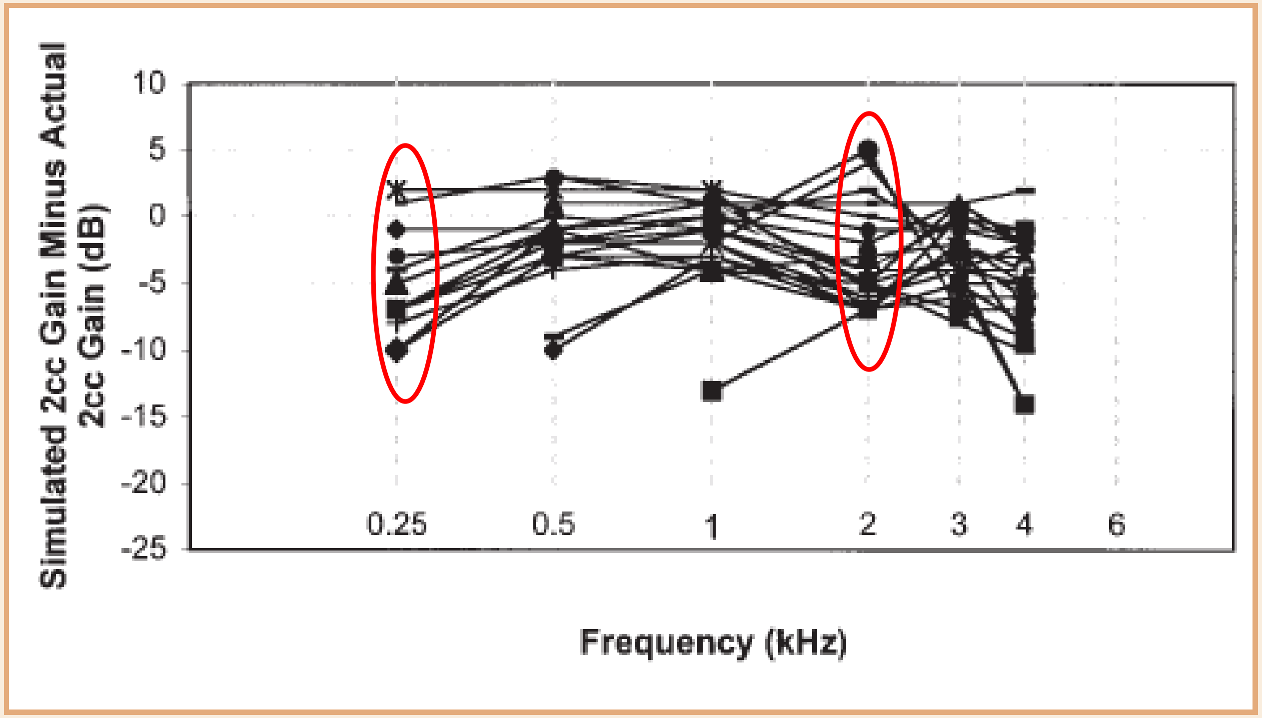


Figure 1. *Differences in measured 2-cc coupler gain and software-simulated 2-cc coupler gain for 28 hearing aids. Negative values indicate that the software-simulated 2-cc coupler gain is less than the measured 2-cc coupler gain.*

OK, but what about actual measured gain in the ear?

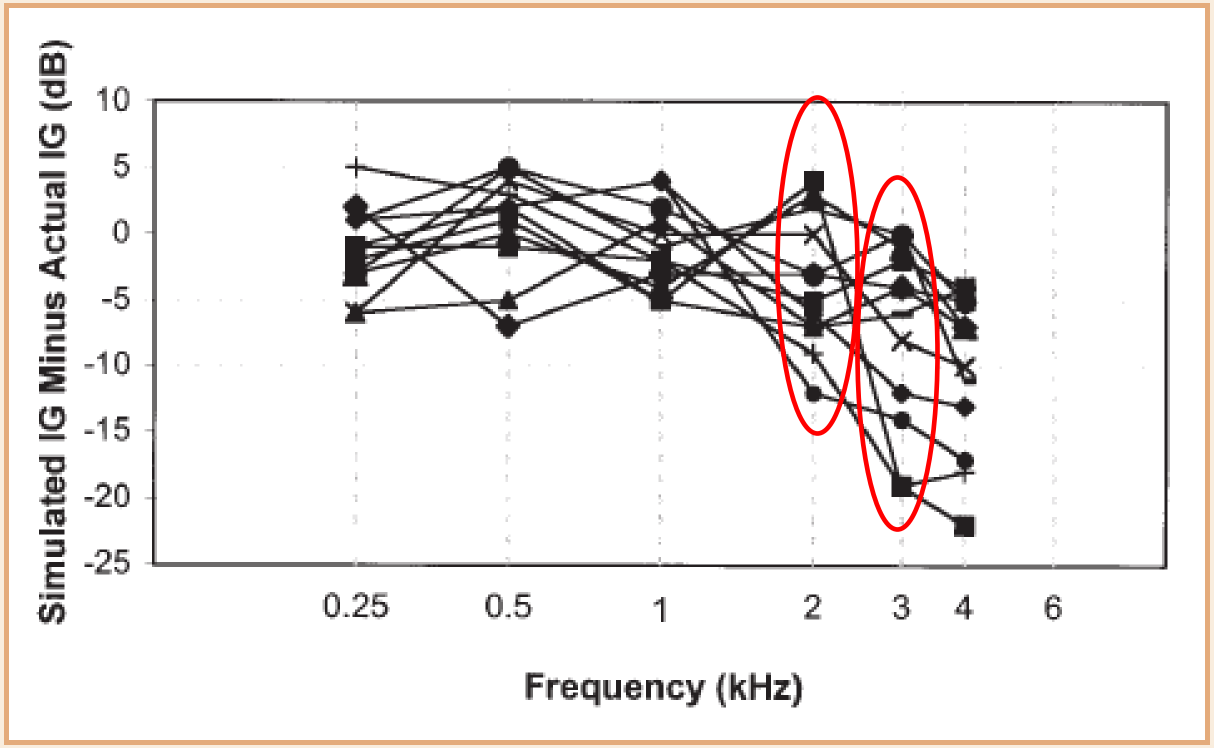


Figure 2. *Differences in measured insertion gain and software-simulated insertion gain for 12 patients. Negative values indicate that the software-simulated insertion gain is less than the measured insertion gain.*

Aarts and Caffee (2005)

Flat, mild loss

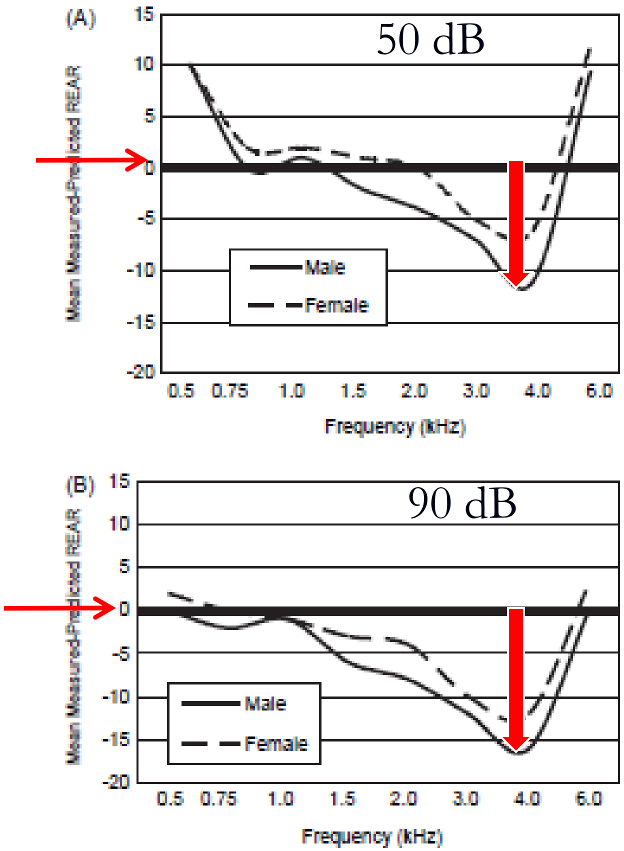


Figure 1. Mean difference between measured real-ear aided response (REAR) values and predicted REAR values for male (N = 17 subjects, N = 31 ears) and female (N = 24 subjects, N = 47 ears) subjects for a flat mild hearing loss using a 50 dB SPL FFT speech weighted input (A) and a 90 dB SPL FFT speech 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

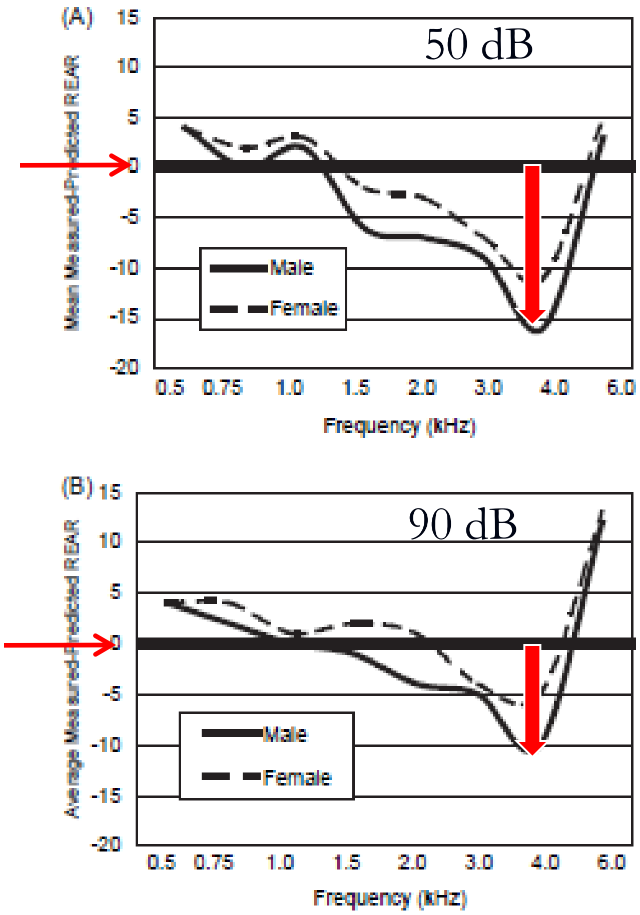
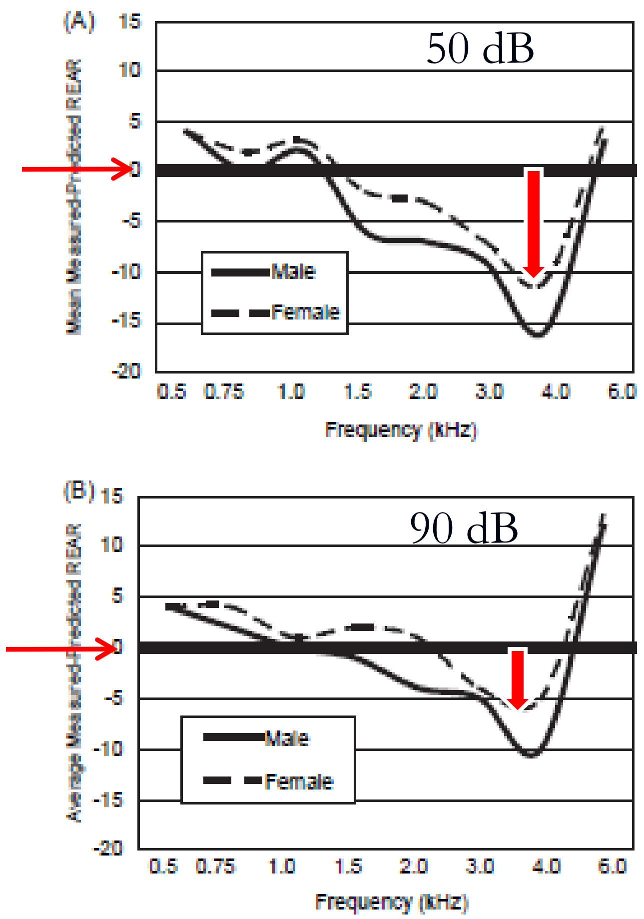


Figure 2. Mean difference between measured real-ear aided response (REAR) values and predicted REAR values for male (N = 17 subjects, N = 32 ears) and female (N = 24 subjects, N = 47 ears) subjects for a sloping mild-to-moderately-severe hearing loss using a 50 dB SPL FFT speech weighted input (A) and a 90 dB SPL FFT speech weighed 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



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Aazh and Moore (2007)

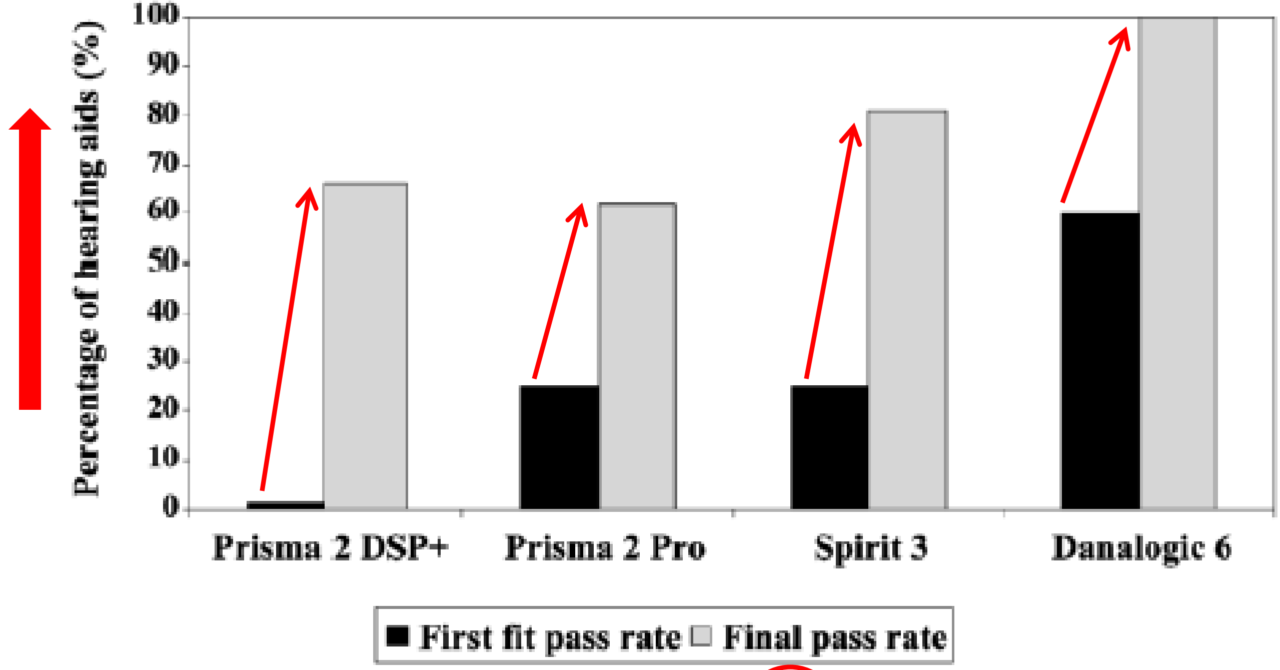


Figure 1. The percentage of fittings that came within ±10 dB of the NAL-NL1 target in the frequency range 0.25 to 4 kHz using the first fit program of the aids (black bars) and after adjustments in frequency-gain response (light gray bars), for four different types of digital hearing aids.

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

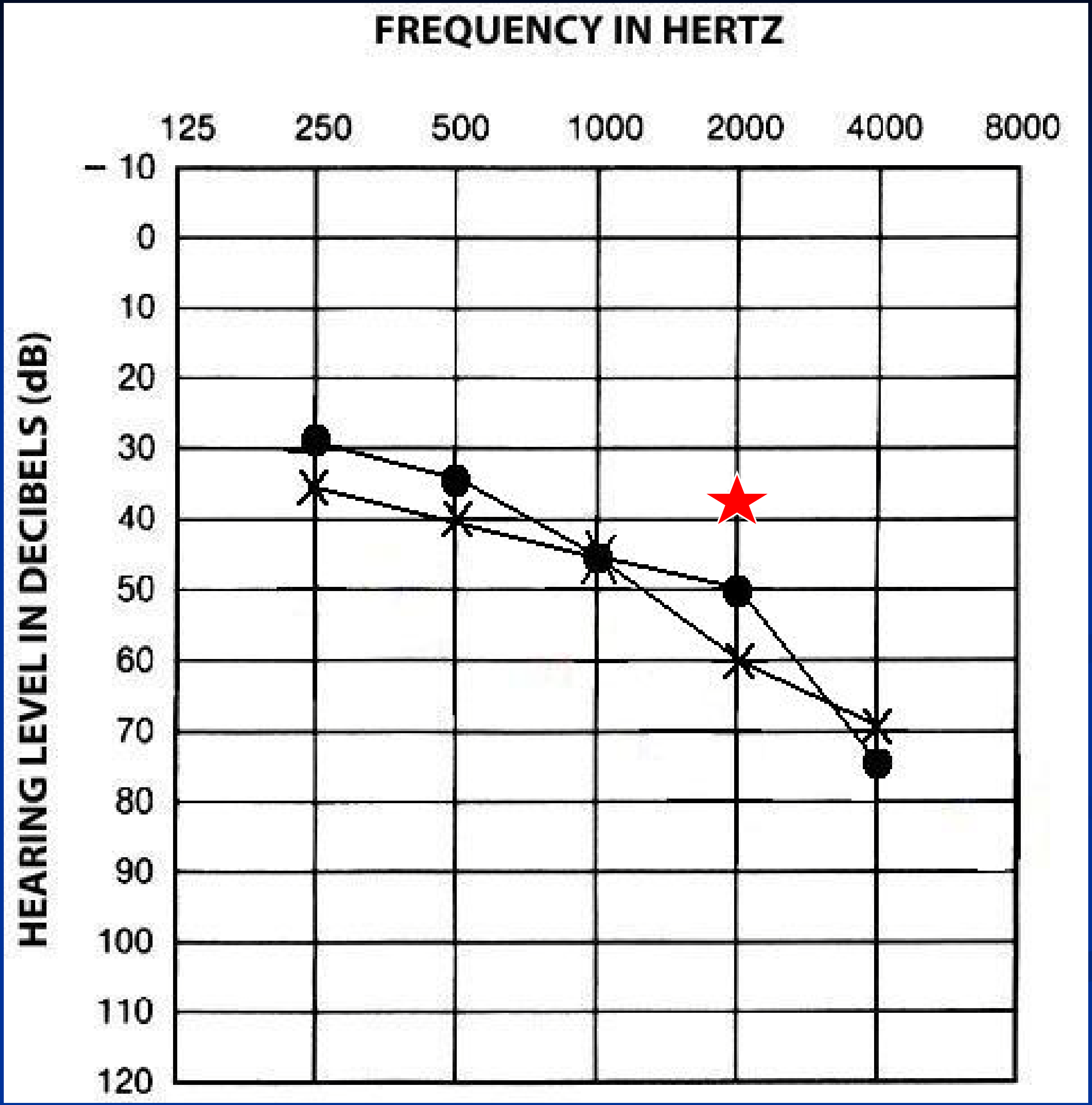
SPL dB
110
100
90
80
70
60
50
40
30
20
.25
.5
1 (kHz)
2
4
8
FONIX TYPE 7000 ANALYZER
Visible Speech
Curves
Name Symbol Num Meas Max Avg Min Ref NR SII
E1 26 101 87 71 52 4X 91
E2
E3
Targets
Name Symbol Description SII
HTL Hearing Threshold Level
LOWT LLLLLL Low Target 95
MIDT MMMMMM Middle Target 99
HIGT HHHHHH High Target 99
UCL Uncomfortable Level
LTASS
Symbol Description
111111 Low LTASS level
Mid LTASS level
hhhhhh High LTASS level
Press START to start measurement.
Test continues until STOP is pressed.
F1 Left Ear Select
F2 Env 1 Crv Select
F3 Curve On/Off
F4 Curve Actions
F5
F6
F7
F8
SETUP 1 2007-03-11 2:57:56PM

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.

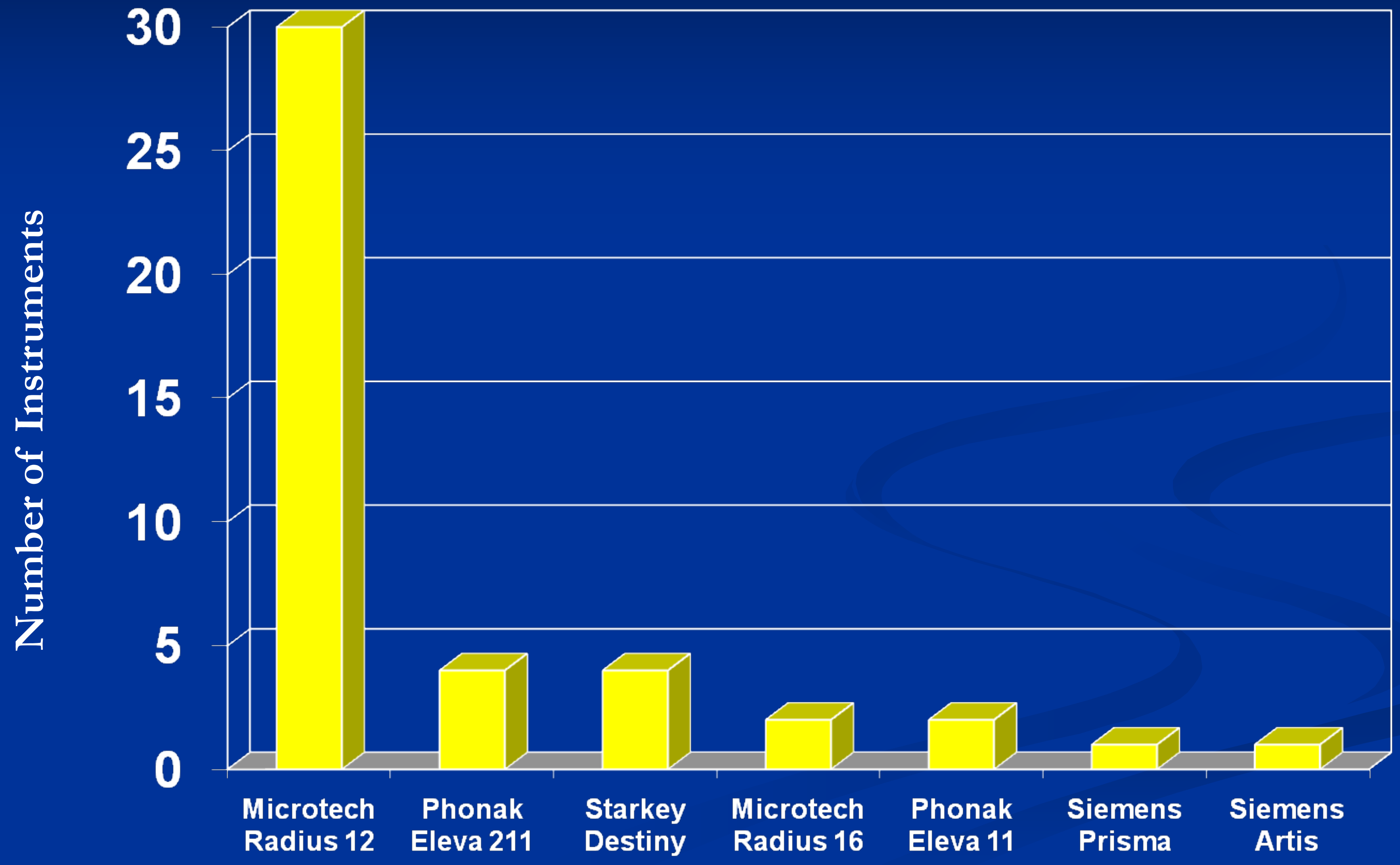
Study Participants

- 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

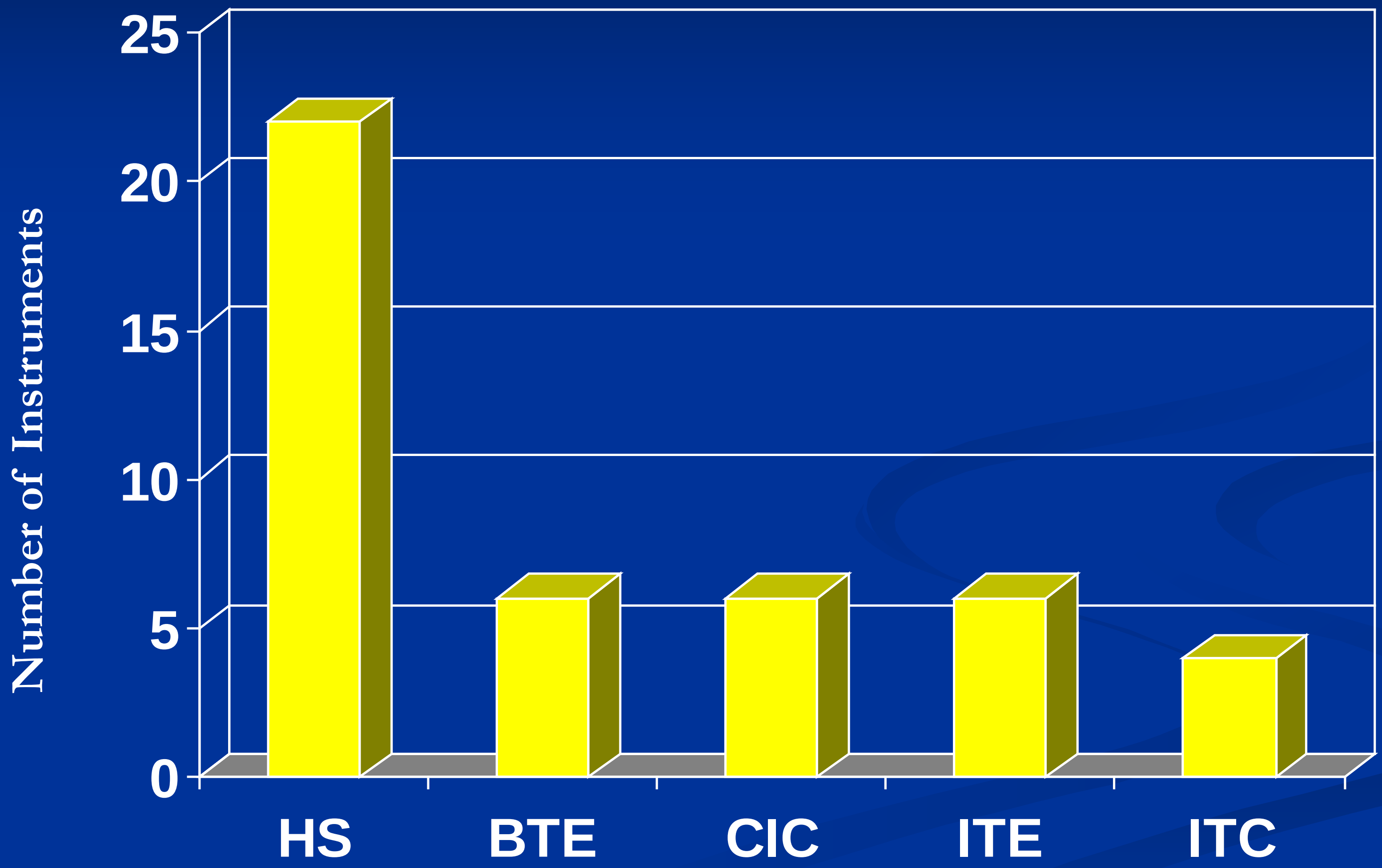


FREQUENCY IN HERTZ
125
250
500
1000
2000
4000
8000
HEARING LEVEL IN DECIBELS (dB)
– 10
0
10
20
30
40
50
60
70
80
90
100
110
120

Hearing Aids by Manufacturer



Hearing Aid Styles



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

Session 1

- **Pre-fit APHAB**
- **Instrument fitting**

- initial-fit or probe-fit
- “sham” probe-fit
- 50 dB and 80 dB SPL checks
- 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**

- 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

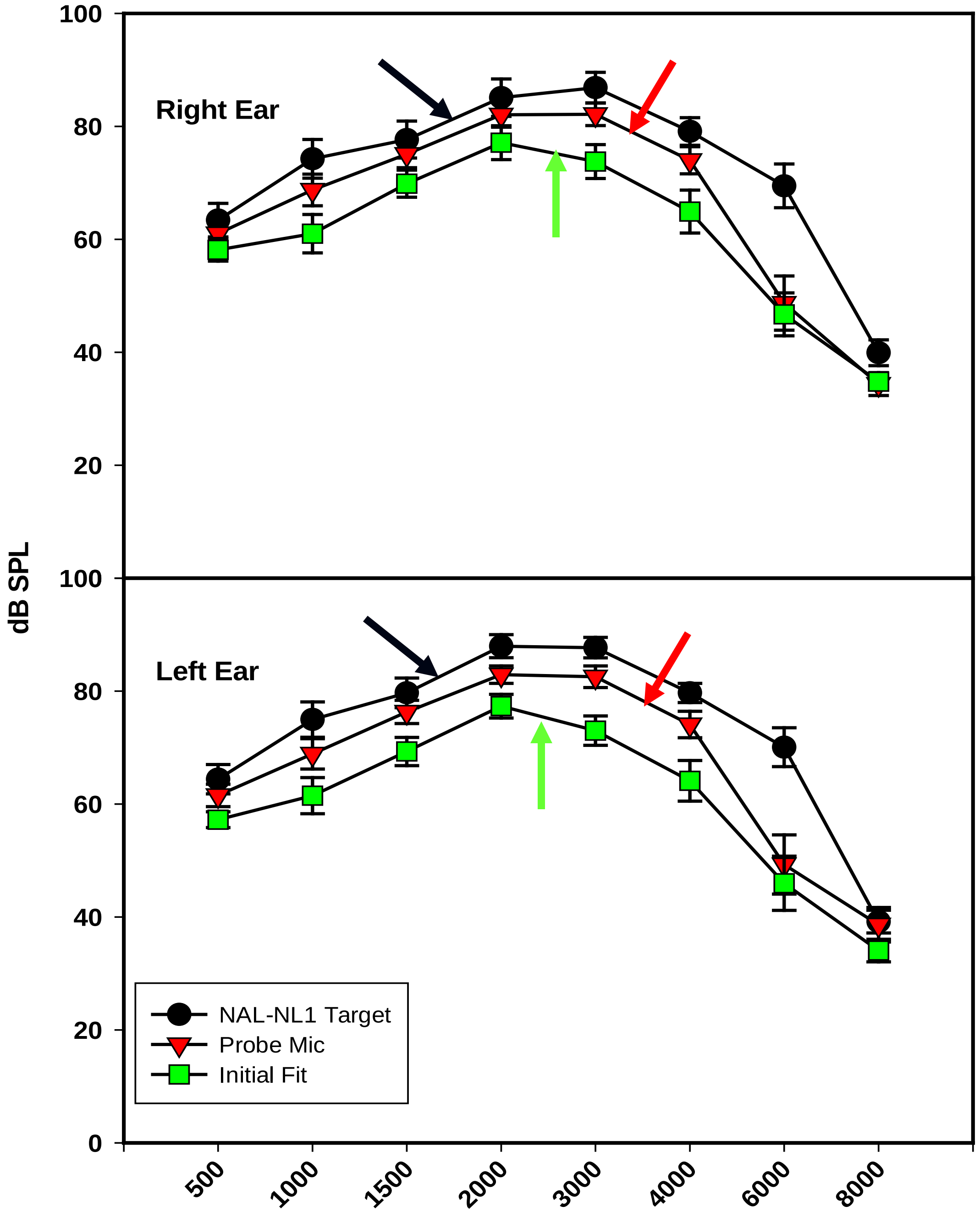
4-6 weeks

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

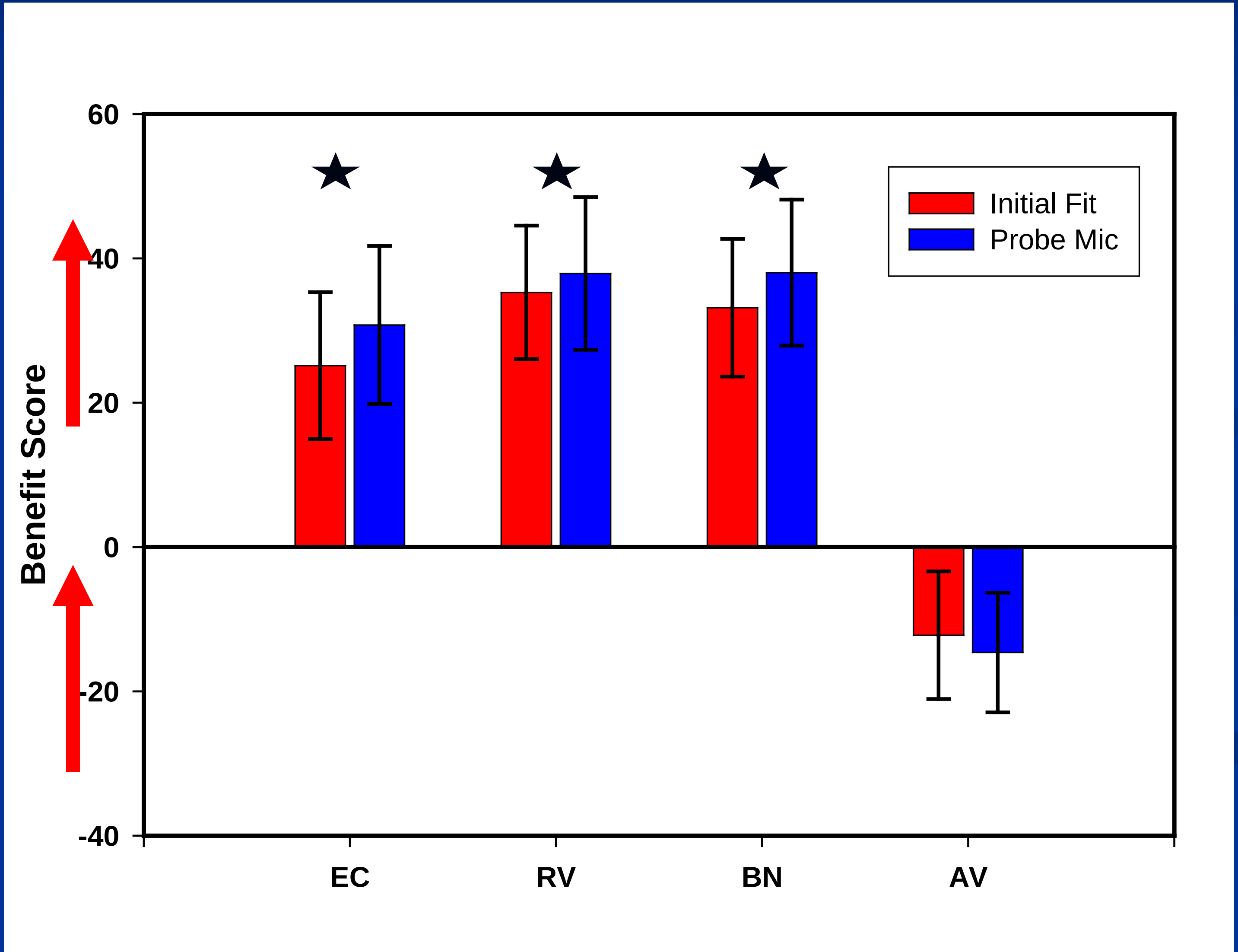
Results

- Comparison of Real Aid Aided Response for both fittings
- APHAB subscale and Global scores
- Fitting method preference

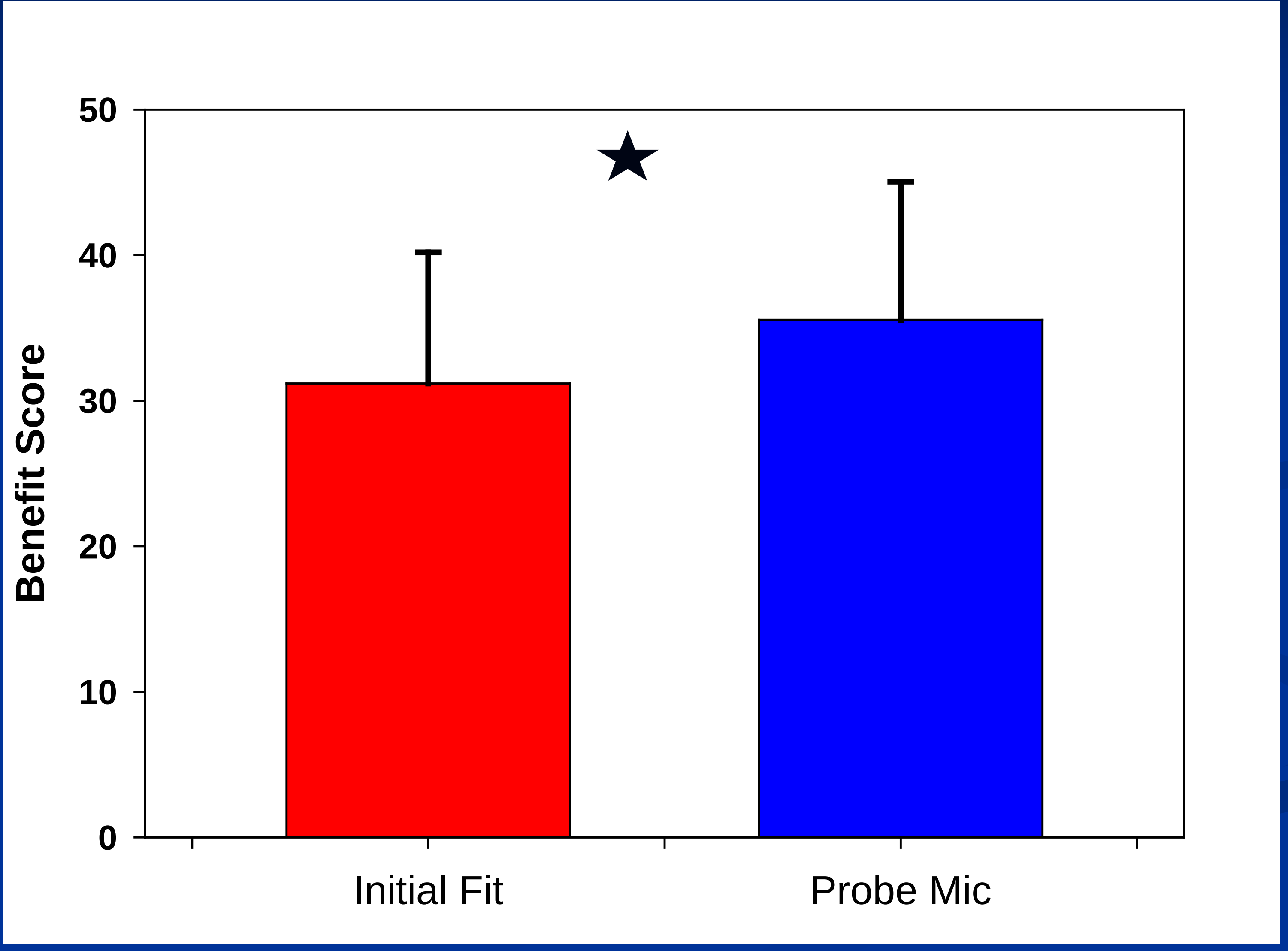
REAR as a function of fitting method



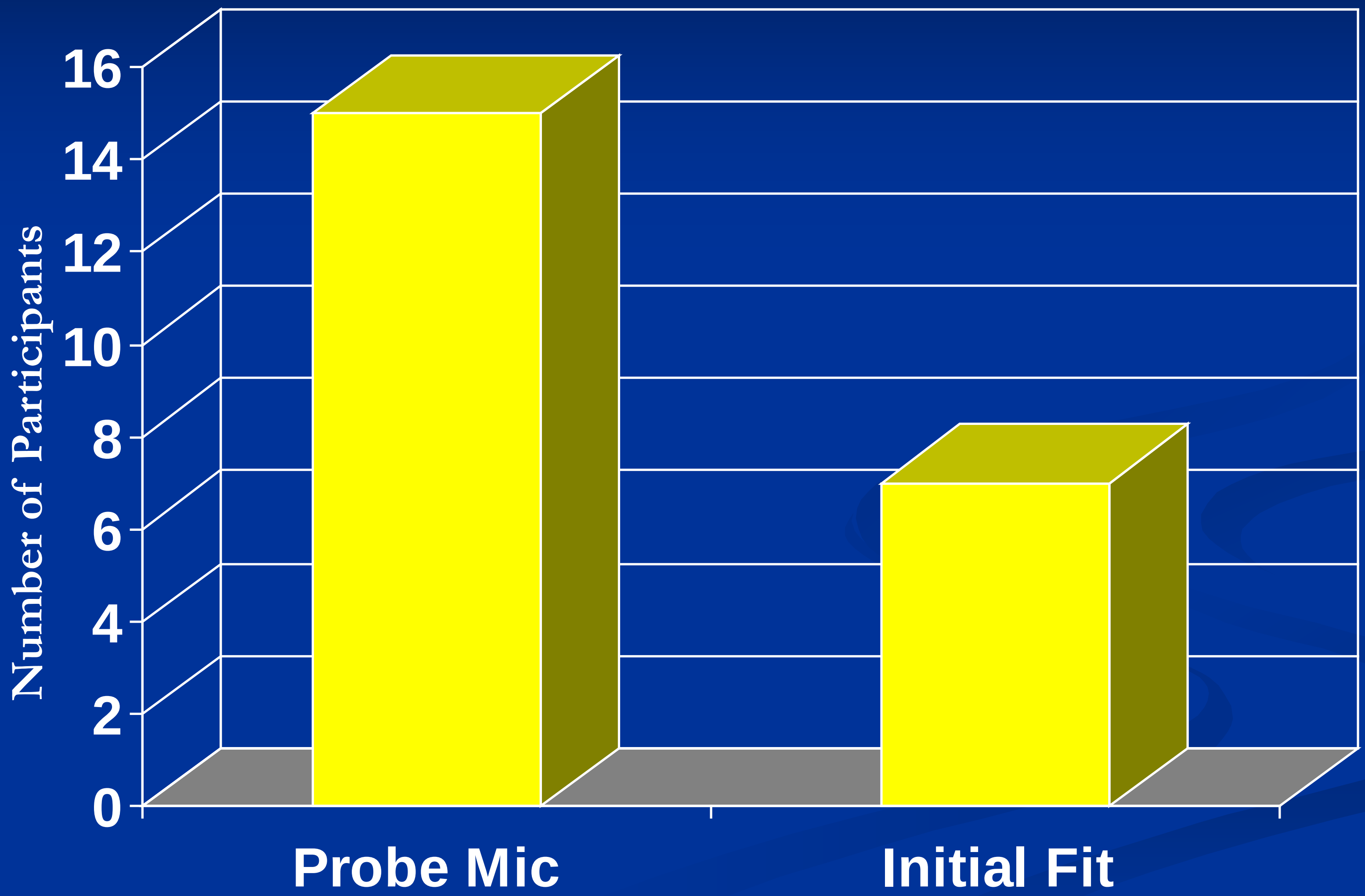
Benefit as a function of fitting method



Global Scores (EC+BN+RV) 3

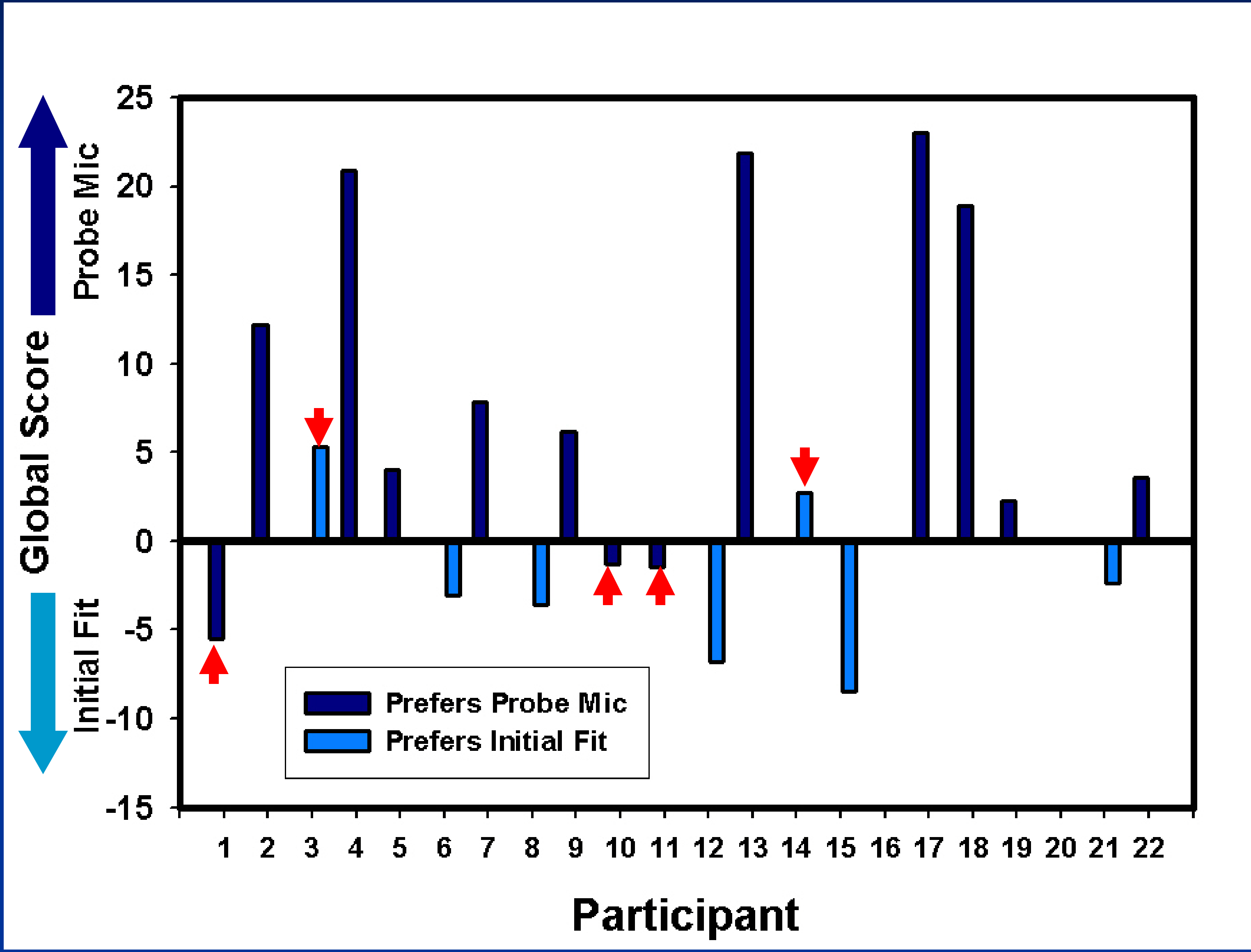


Preference



Number of Participants
16
14
12
10
8
6
4
2
0
Probe Mic
Initial Fit

Global Score Differences



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.

BETTER HEARING INSTITUTE

Version 6

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***

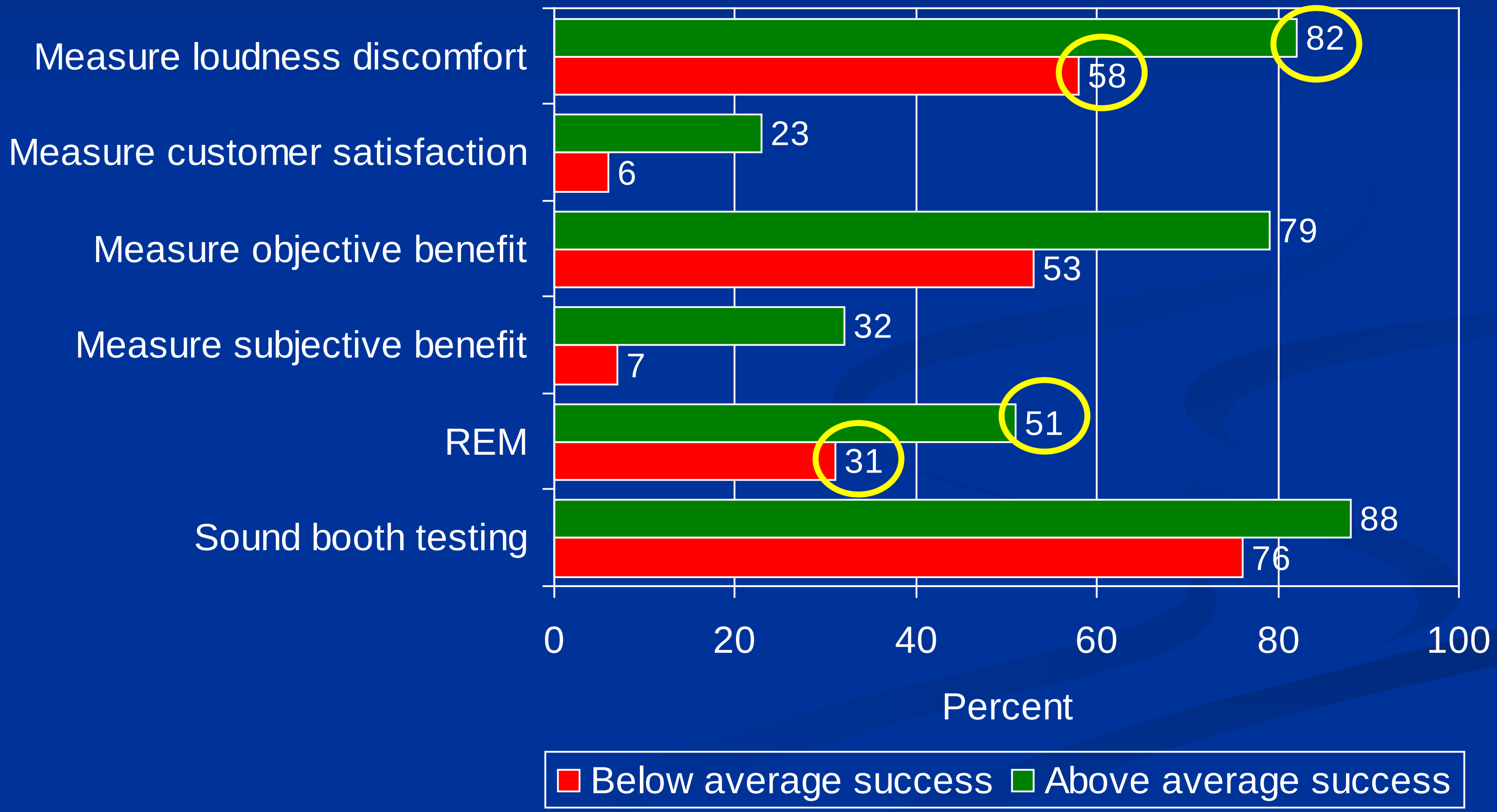
Success measures

- 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.



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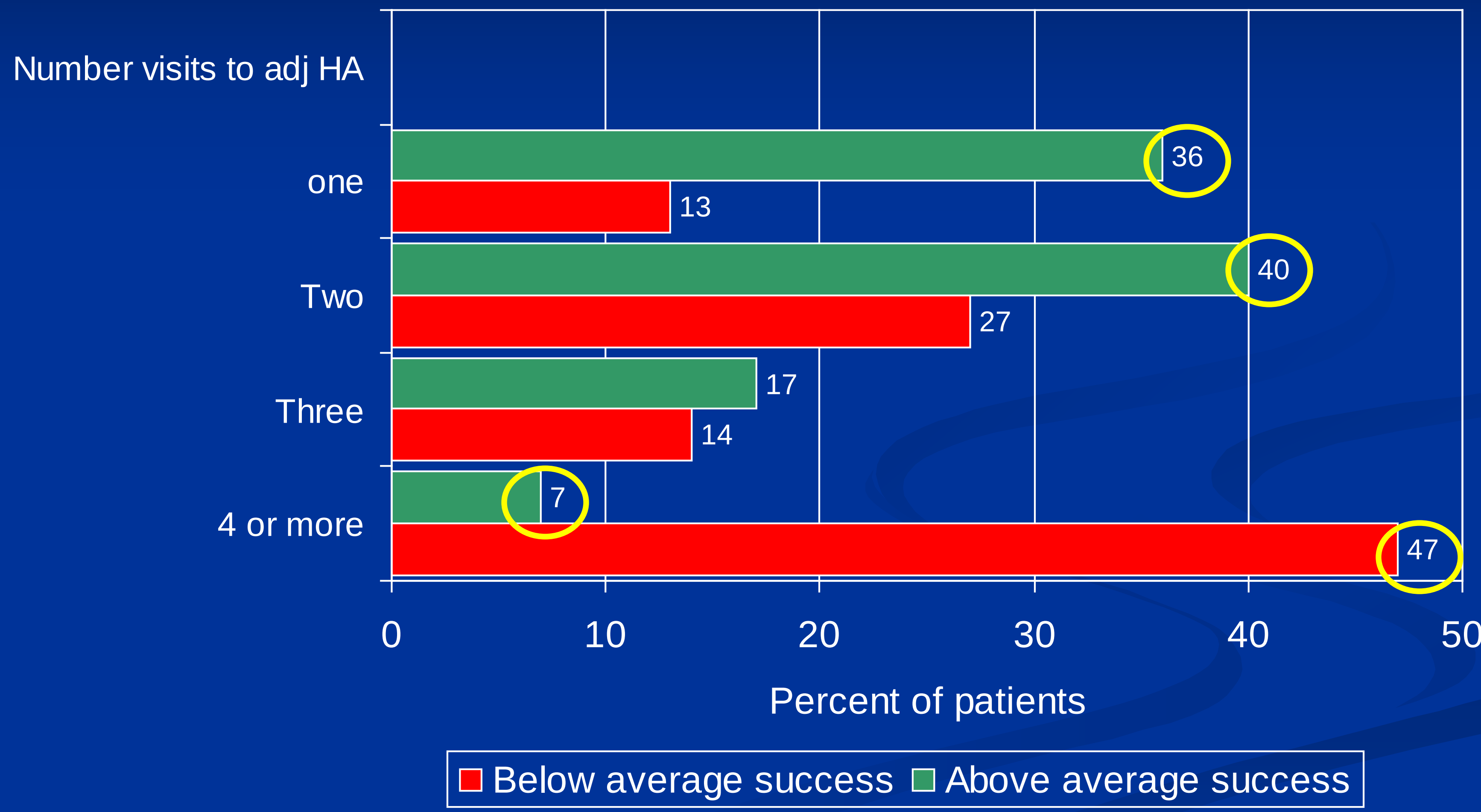
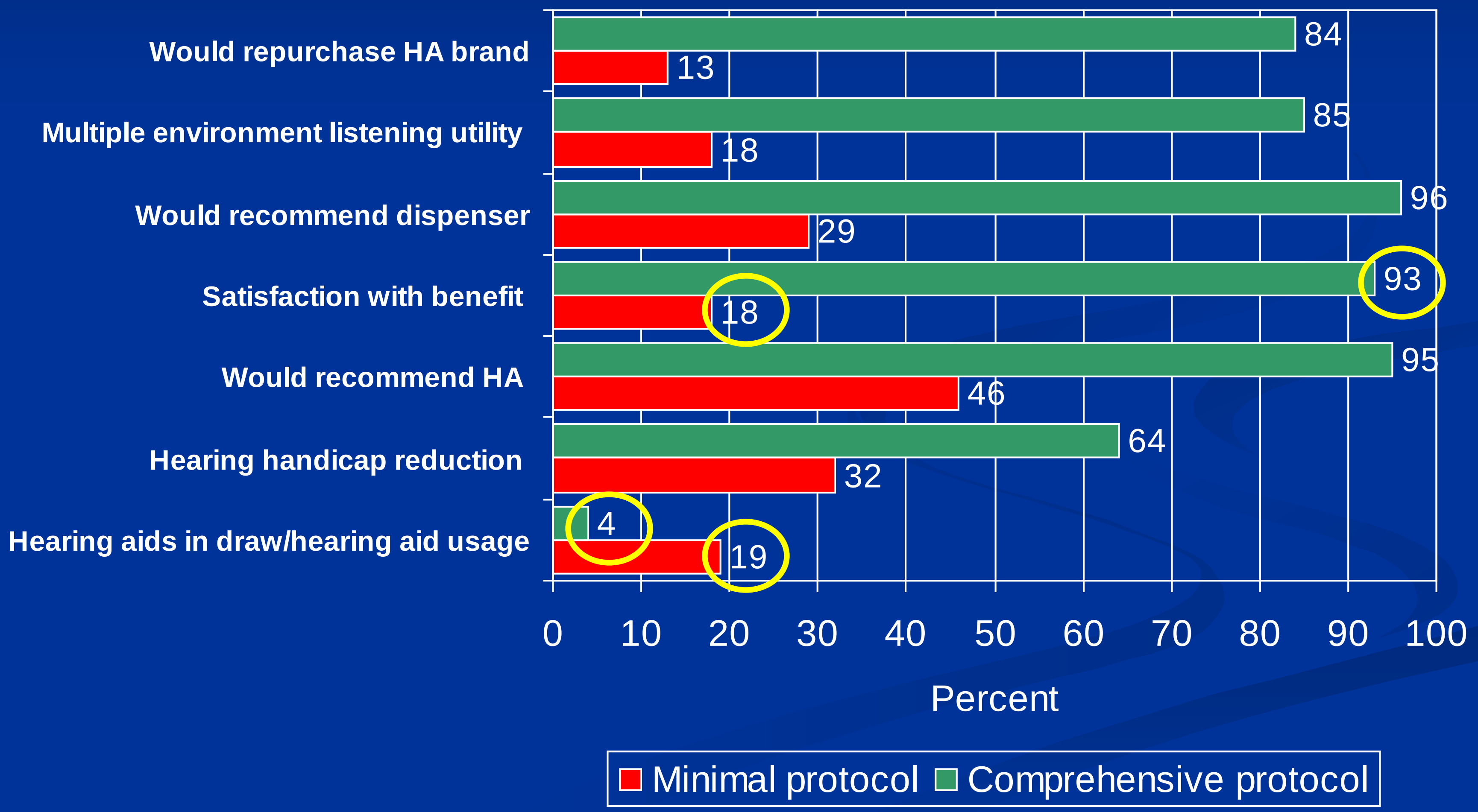


Impact of a protocol on hearing aid success comparing a minimum protocol (0-2 items) to a more comprehensive protocol (10-12 items).



Conclusion

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

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