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Hearing Aid Verification: What You Can't Buy Over the Counter

H. Gustav Mueller, PhD

Moderated by:
Carolyn Smaka, AuD, Editor in Chief, AudiologyOnline

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Hearing Aid Verification: What you can't buy over the counter!

H. Gustav Mueller
Professor, Vanderbilt University, Nashville, TN.
Consultant, Sivantos Group
Contributing Editor, *AudiologyOnline*

Greetings from North Dakota's largest island!

This talk is geared for those of you who are "sitting on the fence" regarding the value of hearing aid verification.

For those of you who have jumped off the fence (to the correct side):

If you are just getting started doing probe-mic measures, and need an overview of all the techniques and procedures:
AudiologyOnline Course #27179: Back to Basics: Probe-Mic and Speech Mapping Measures (2 hours)

If you are conducting probe-mic measures routinely, but would like an explanation of why some of your findings are puzzling:
AudiologyOnline Course #29398: Hearing Aid Speech Mapping Verification - Some Explanations for Puzzling Outcomes (1 hour)

HEARING AIDS

What will the future bring?

To get us started: Verification vs. Validation?.

Verification: Are we building the system right?

Validation: Are we building the right system?

Let's think this through—if you are going to "verify something" you have to start with gain/output fitting goals . . .

Something I made up.

Something a hearing aid manufacturer made up.

Something that has been validated with 30-40 years of research.

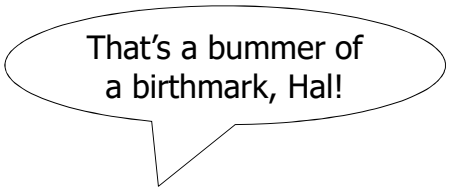
Next—how can you ensure that your fitting goals are being met?

Click on the manufacturer's "Magic Button"

Ask the Patient.

Conduct probe-mic verification.

IS THERE "PROOF" THAT PLAN A WORKS?



While targets aren't so good for Hal, what about hearing aid fittings?

So, for the professionals fitting hearing aids who *do not* believe in target verification . . . What is their Plan B?

By far, the majority use the proprietary default fitting of their favorite manufacturer.

So let's have some friendly competition . . .

Verified Prescriptive Fitting
vs.
Proprietary Default Fitting

Let's first look at the real-ear output that we can expect to obtain if we use the manufacturers' proprietary fitting.

RESEARCH

Manufacturers' NAL-NL2 Fittings Fail Real-ear Verification

Published on February 16, 2015

Research | March 2015 *Hearing Review*

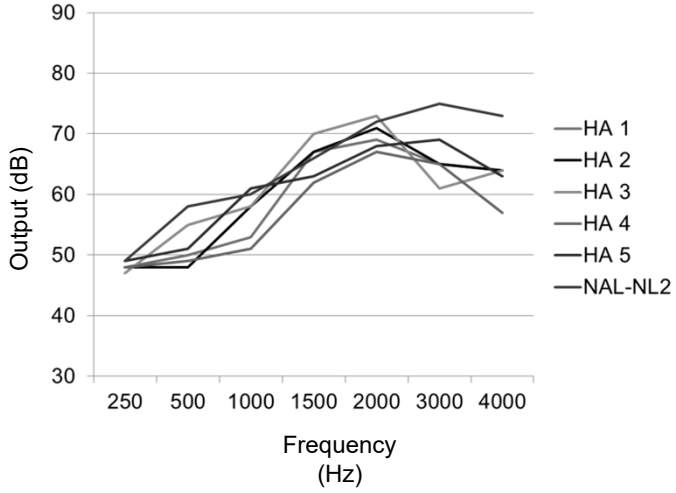
One more reason why probe-mic verification is crucial in any Best Practice protocol

By Jordan Sanders, BS, Tina M. Stoody, PhD, Jennifer E. Weber, AuD, and H. Gustav Mueller, PhD

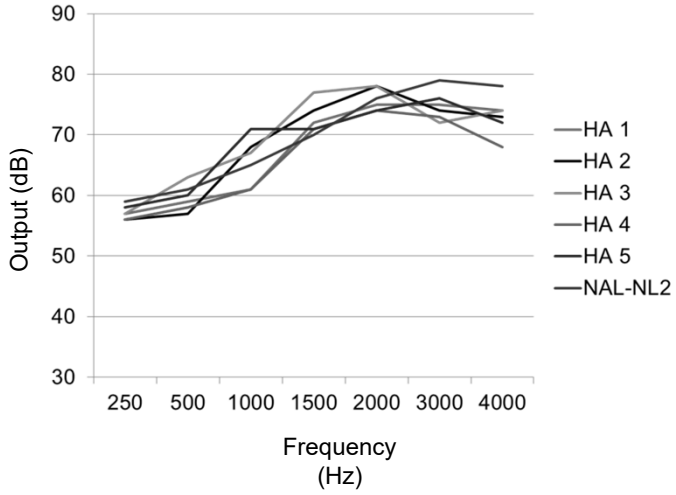
Protocol for Sanders et al, 2015

- Selected the premier hearing aid from the five leading manufacturers.
- Selected the manufacturer's "default" fitting in the software for typical downward sloping hearing loss; entered appropriate data for earmold plumbing, etc.
- Matched all fitting and patient characteristics between software and probe-mic equipment.
- Conducted probe-mic measures using speech mapping (male passage from the Verifit); 16 ears tested (8 male, 8 female)

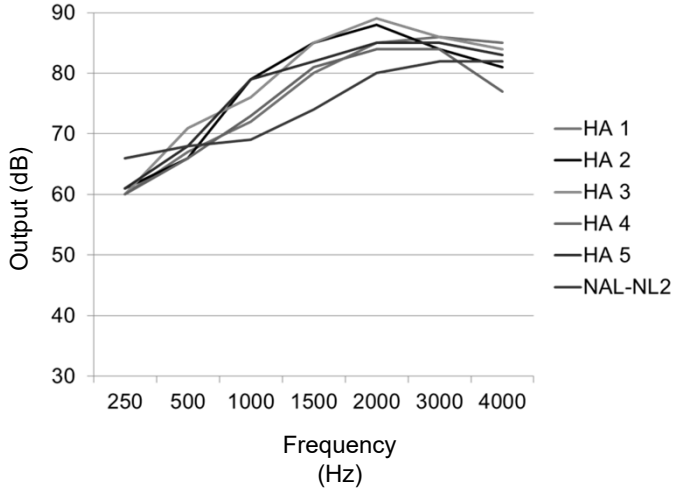
Input=55 dB SPL: Real Speech of Verifit System



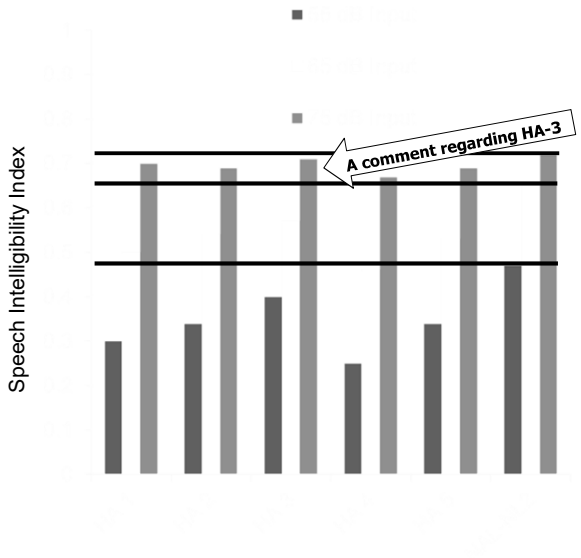
Input=65 dB SPL: Real Speech of Verifit System



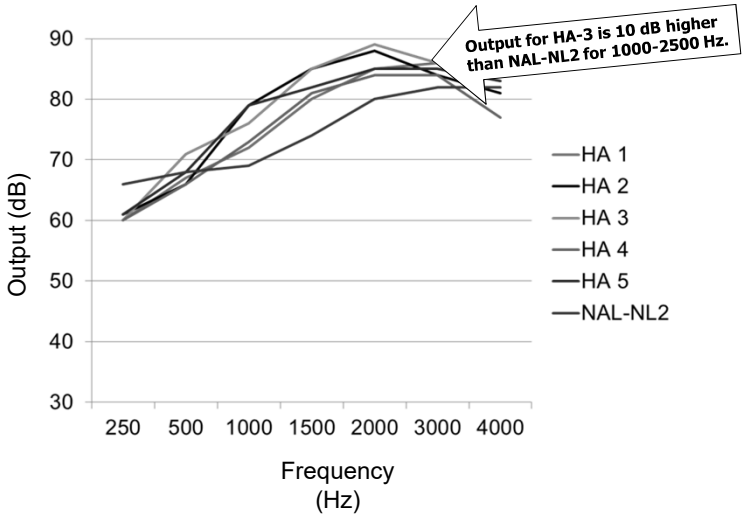
Input=75 dB SPL: Real Speech of Verifit System



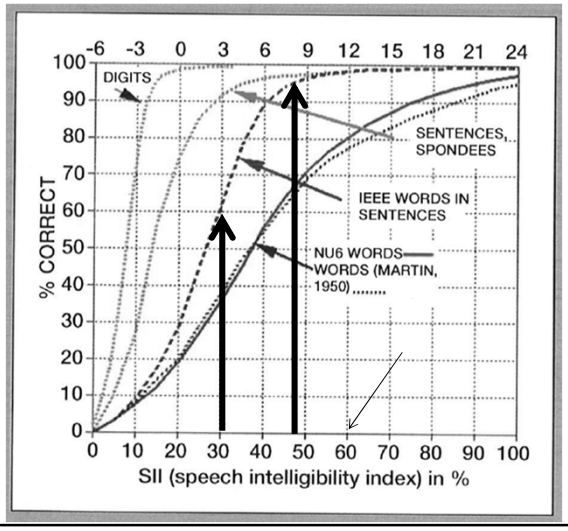
SIIs for Manufacturer Proprietary Fittings and NAL-NL2 targets



Input=75 dB SPL: Real Speech of Verifit System



Relating the SII (soft intputs) to speech recognition



The importance of audibility in successful amplification of hearing loss

Ron Leavitt and Carol Flexer

Hearing Review, 2012

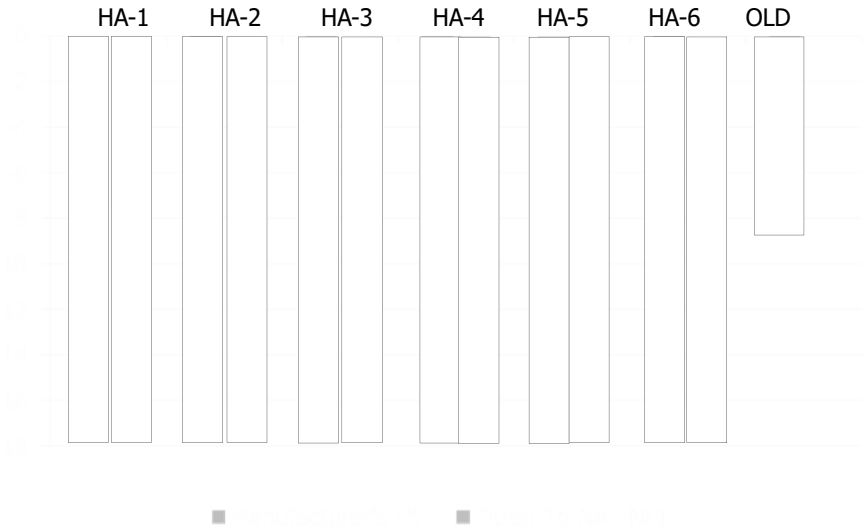
What they did . . .

- Selected the premier product from each of the "Big Six," and programmed these hearing aids to each manufacturer's recommended fitting. All special features were activated.
- For benchmarking purposes, they added a 7th hearing aid—a circa 2002 single-channel analog instrument, which they programmed to NAL-NL1.

What they did . . .

- The subjects were all experienced hearing aid users with typical downward sloping hearing losses.
- The subjects, fitted bilaterally, were tested with all seven sets of instruments. The speech recognition test was the QuickSIN, presented at 57 dB SPL.
- Following the initial testing, all hearing aids were re-programmed to NAL-NL1 and QuickSIN testing was repeated

Performance for the aided QuickSIN presented soundfield at 57 dB SPL. Bars indicate "SNR-Loss": The average SNR *disadvantage* compared to individuals with normal hearing

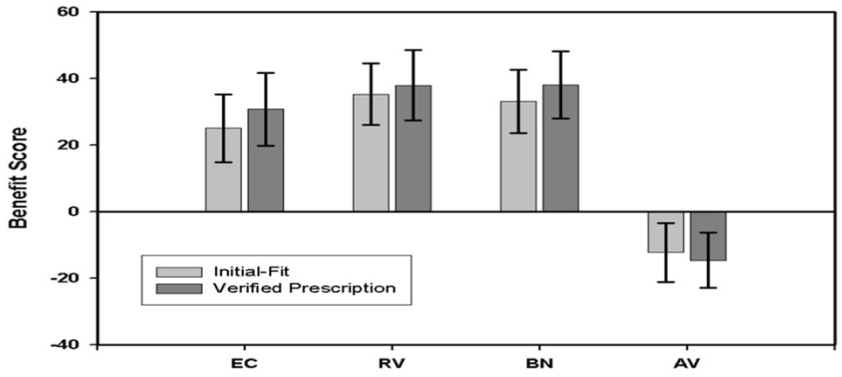


Initial-Fit Approach Versus Verified Prescription: Comparing Self-Perceived Hearing Aid Benefit

Abrams, H., Chisolm, T., McManus, M., McArdle, R.

Journal of the American Academy of Audiology, 23(10), 768-778

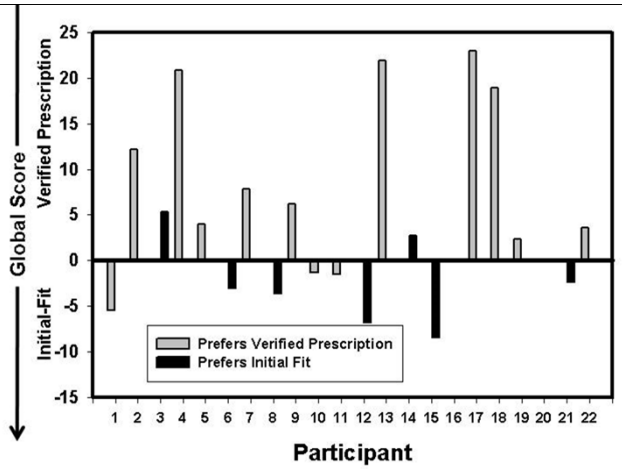
APHAB real-world benefit scores for the two conditions. Significant for EC, RV and BN.



Preference for "initial" versus "verified prescriptive" fitting plotted as a function of difference in APHAB Global score.

APHAB scores significantly better for those fitted to the NAL

15/22 preferred the verified prescription fitting

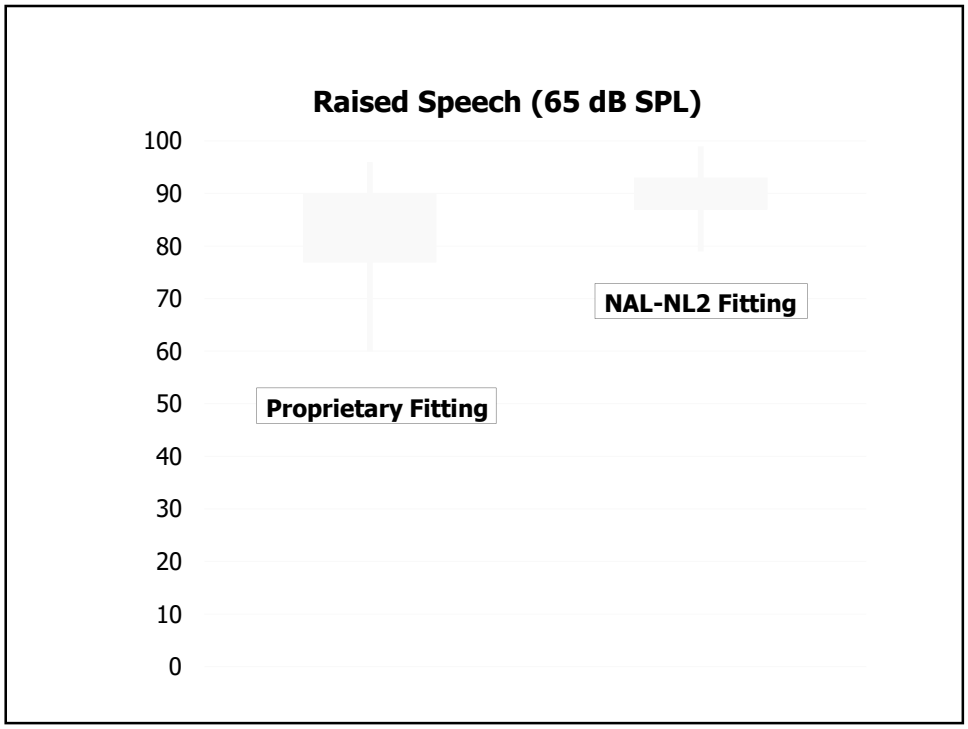


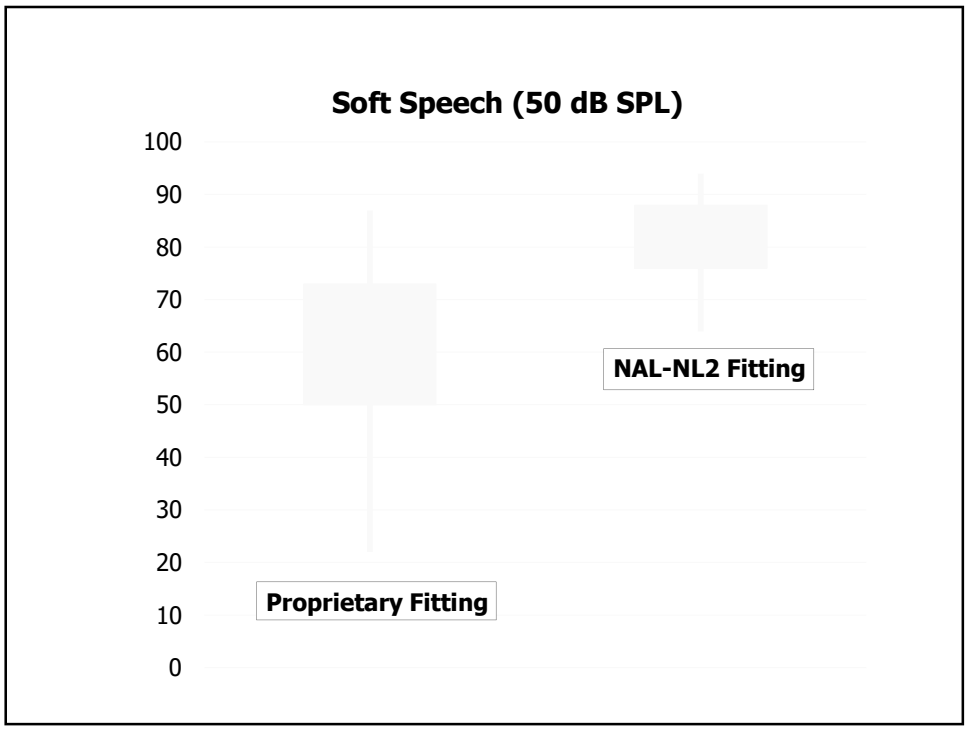
Very recent (soon to be in *JAAA)* research on this topic by Mike Valente . . .

- Double-blind randomized crossover design (24 participants)
- Mild-moderate downward-sloping bilateral hearing losses; all were new users.
- Fitted to either NAL-NL2 or manufacturer's proprietary algorithm.
- Testing included speech recognition in quiet and in noise (HINT), subjective responses for the Abbreviated Profile of Hearing Aid Benefit (APHAB) and the Speech, Spatial and Qualities of Hearing (SSQ) questionnaire.

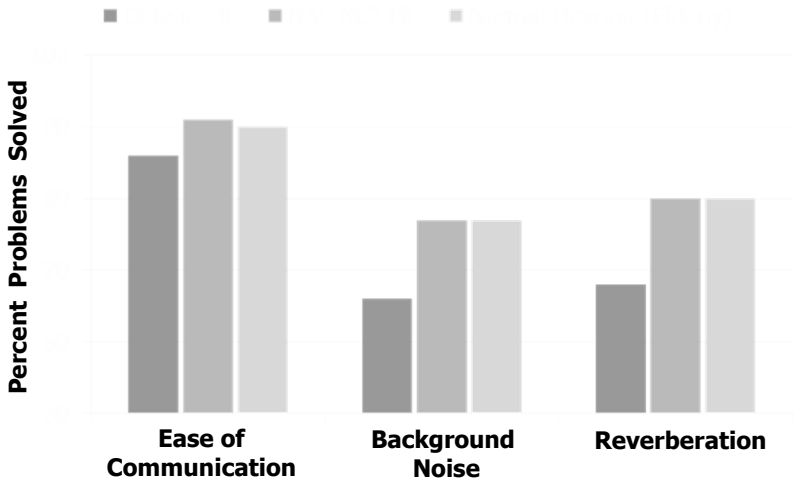
Valente et al (2017) . . . The Results

- Laboratory performance for speech recognition significantly better for NAL-NL2 fitting.
- Real world self-assessment inventories significantly better for NAL-NL2 fitting.
- After real-world trial, 19 of 24 preferred the NAL-NL2 algorithm.


Raised Speech (65 dB SPL)
100
90
80
70
60
50
40
30
20
10
0
NAL-NL2 Fitting
Proprietary Fitting


Soft Speech (50 dB SPL)
100
90
80
70
60
50
40
30
20
10
0
NAL-NL2 Fitting
Proprietary Fitting

Valente et al (2017) APHAB data compared to older people with normal hearing



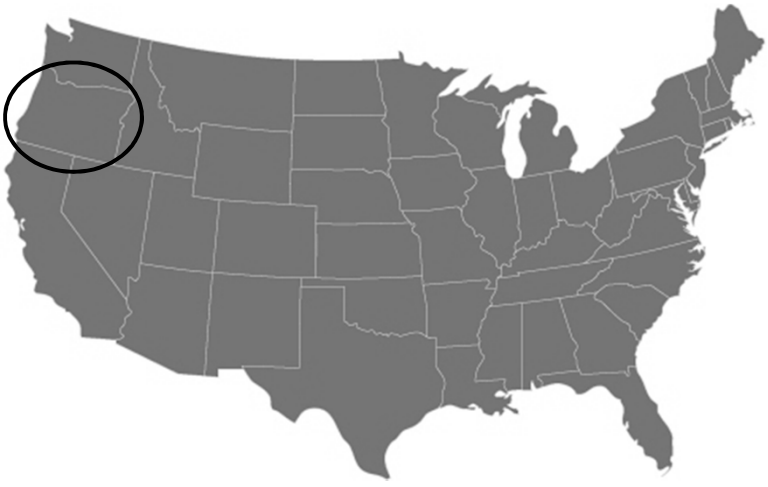
Who won the competition?

Verified Prescriptive Fitting
vs.
Proprietary Default Fitting

Weighing the research evidence . . .

It would be professionally irresponsible *NOT* to fit your patients to validated prescriptive targets.

How many people in the U.S. are suffering from being fitted incorrectly?



FITTING PROCEDURES

Hearing Aid Programming Practices in Oregon: Fitting Errors and Real Ear Measurements

Published on June 6, 2017

Under-fitting to well-established real-ear targets results in decreased hearing aid utility

Research | June 2017 *Hearing Review*

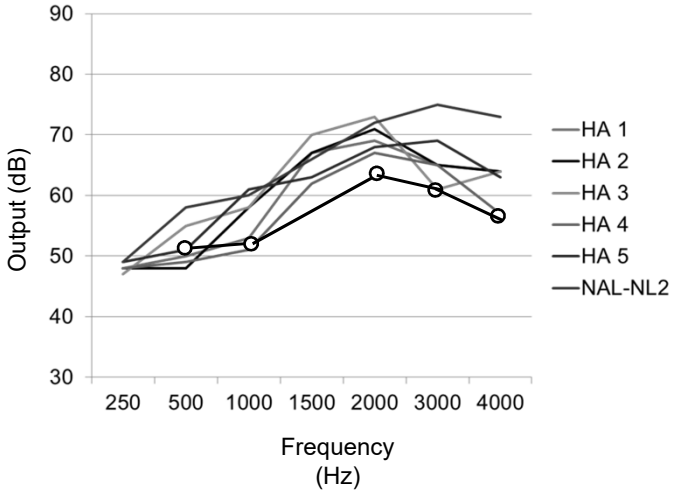
By Ron Leavitt, AuD, Ruth Bentler, PhD, and Carol Flexer, PhD

- Total of 97 patients (176 fittings).
- Experienced hearing aid users (mean age 75 years) who came to clinic, but had been fitted elsewhere
- Hearing aids from 16 different manufacturers
- Probe mic testing was conducted (60 dB SPL input), and the deviations (rms error) from NAL-NL2 target were calculated

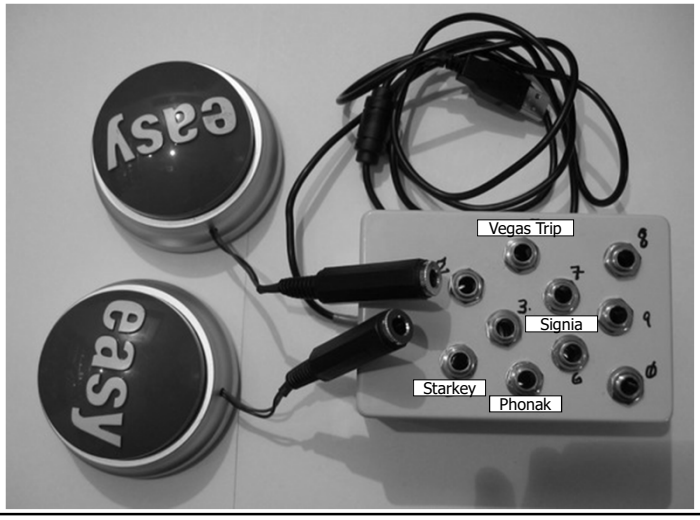
Results of Leavitt et al (2017) target match study . . .

- Mismatch from target by 10 dB or more = 72%
- Mismatch from target by 5 dB or more = 98%
- Fitting error the same for newer vs older hearing aids.
- Fitting error smaller for 5 of the Big 6 companies than the other 11 brands
- Fitting error no different for hearing aids fitted by audiologists vs. hearing instrument specialists

Leavitt et al (2017) data plotted with Sanders et al, 2015 data. Not an apples to apples comparison (Leavitt group had more hearing loss), but note pattern is very similar.



So what if you just push the "NAL Easy Button" in the fitting software? Will you then obtain a NAL fitting in the real ear?



So let's have some friendly competition . . .

Verified Prescriptive Fitting
vs.
Click on the Magic NAL-NL2 button

Probability of NAL fit when selecting "NAL" in the fitting software:

- Aazh and Moore (2007): Programmed to the manufacturer's NAL using four different types of hearing aids on 42 ears. Only 36% of fittings were within +/-10 dB of NAL targets. After re-programming, 83% were within +/-10 dB (100% for hearing aids with four or more channels).
- Aazh et al (2012): Of 51 fittings, after programming to the manufacturer's NAL, only 29% were within 10 dB of NAL targets; after re-programming, a match was obtained for 82% of the fittings.

So maybe things have gotten better?
Or the problem is only with one
or two manufacturers?

RESEARCH

Manufacturers' NAL-NL2 Fittings Fail Real-ear Verification

Published on February 16, 2015

Research | March 2015 *Hearing Review*

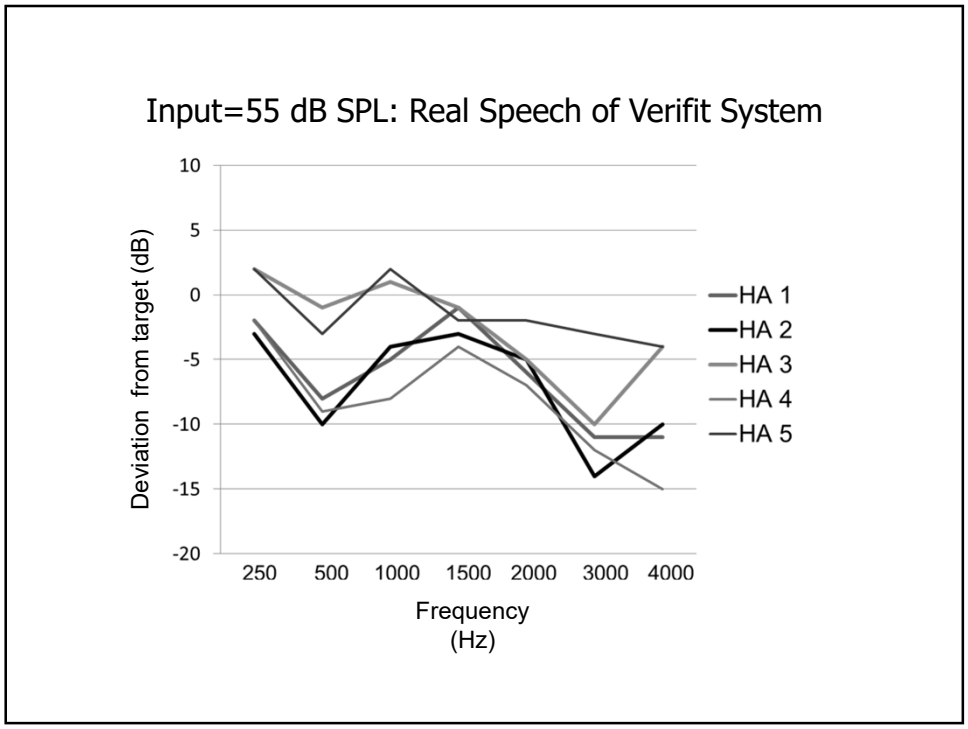
One more reason why probe-mic verification is crucial in any Best Practice protocol

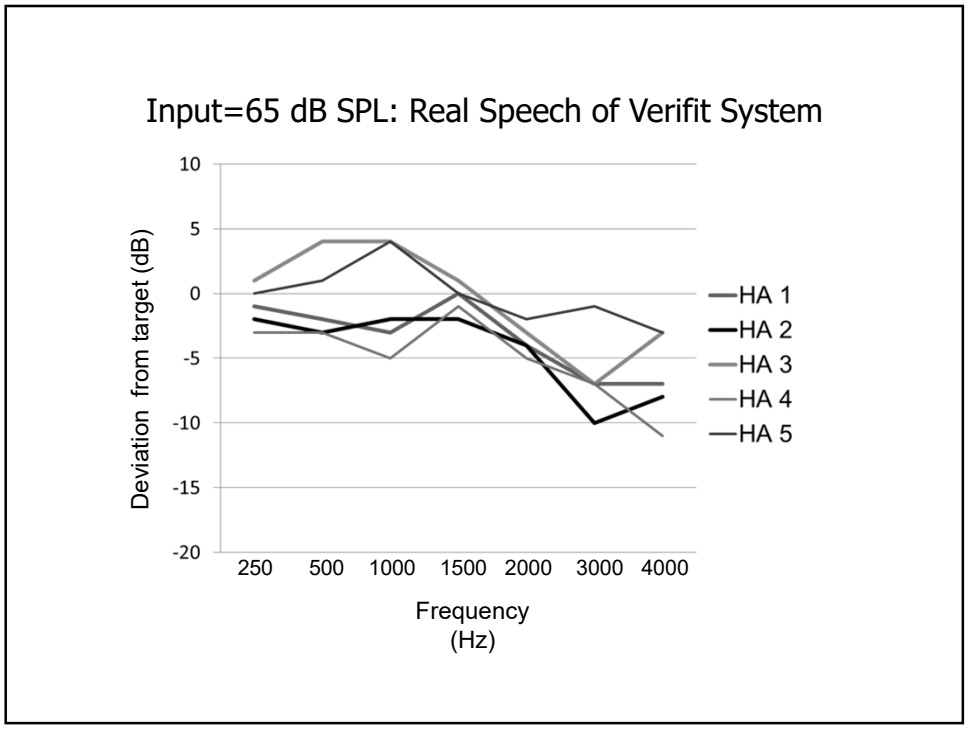
By Jordan Sanders, BS, Tina M. Stoody, PhD, Jennifer E. Weber, AuD, and H. Gustav Mueller, PhD

The recent Sanders et al study . . .

Data collected December 2014 (Sanders et al, 2015):

- Selected the premier hearing aid from the five leading manufacturers.
- Selected "NAL-NL2" fit in the manufacturer's software; programmed for typical downward sloping hearing loss
- Matched all fitting and patient characteristics between software and probe-mic equipment.
- Conducted verification using speech mapping (male passage from the Verifit); 16 ears tested (8 male, 8 female)


Input=55 dB SPL: Real Speech of Verifit System
Deviation from target (dB)
10
5
0
-5
-10
-15
-20
250
500
1000
1500
2000
3000
4000
Frequency (Hz)
HA 1
HA 2
HA 3
HA 4
HA 5


Input=65 dB SPL: Real Speech of Verifit System
Deviation from target (dB)
10
5
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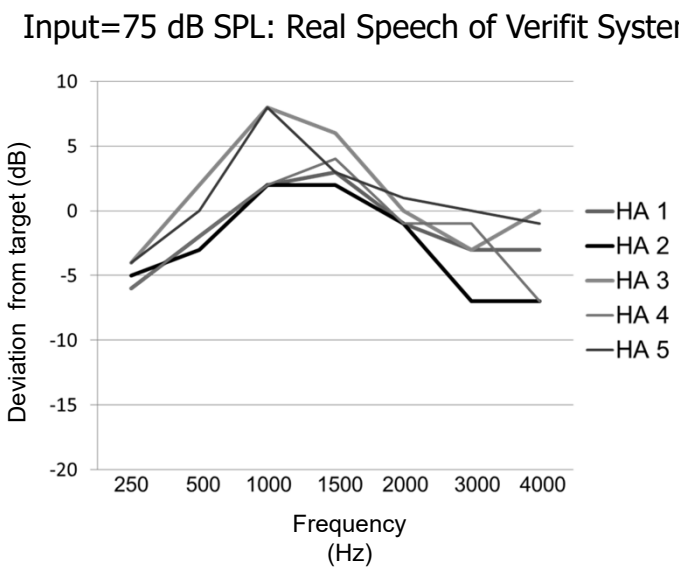
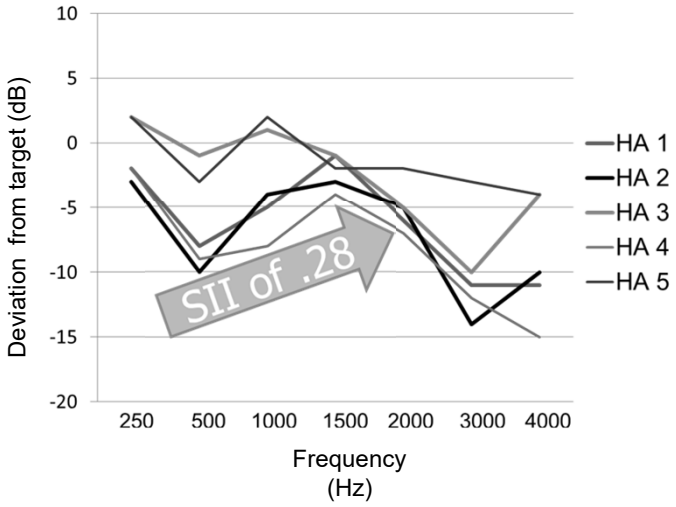
-15
-20
250
500
1000
1500
2000
3000
4000
Frequency (Hz)
HA 1
HA 2
HA 3
HA 4
HA 5



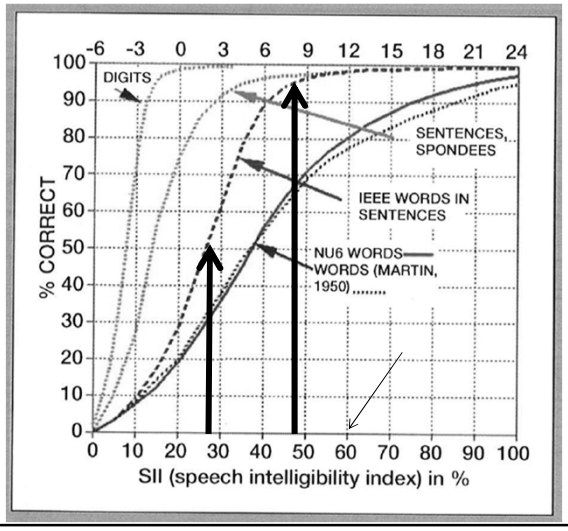
By the numbers:

- For the 55 dB SPL input signal (just below average speech), 74% of the 80 fittings were 10 dB or more from NAL-NL2 targets.
- If we eliminate the one product that was "mostly okay," then 86% of the remaining 64 fittings were 10 dB or more from NAL-NL2 targets.
- For the raised speech signal (65 dB SPL), things were a little better, but still, 55% of the fittings were >10 dB from target.

Input=55 dB SPL: Real Speech of Verifit System



Relating the SII (soft inputs) to speech recognition—we have the same problem that we did for the proprietary fittings



Things just don't seem right in the World

Which takes us back to this slide from the beginning of this talk

Something I made up.

Something a hearing aid manufacturer made up.

Something that has been validated with 30-40 years of research.

How can you ensure that your fitting goals are being met?

Click on the manufacturer's "Magic Button"

Ask the Patient.

Conduct probe-mic verification.

And here is the really good news . . .

In addition to increasing the benefit and satisfaction with hearing aids for your patients, conducting probe-mic verification will:

- Increase your patient's loyalty
- Increase your patient's perceptions of your services

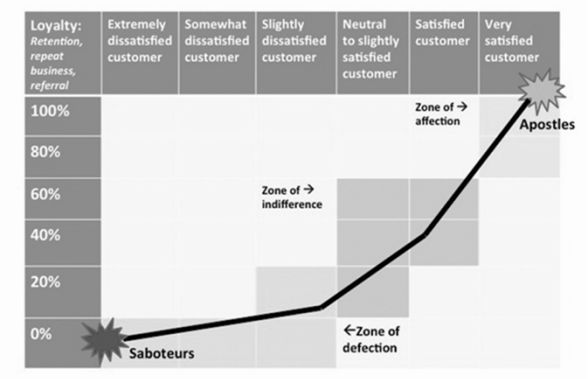
What Is Your Customer Loyalty Quotient (CLQ)?

PUBLISHED ON AUGUST 20, 2014

Cover Story | September 2014 *Hearing Review*

Applying Deming and Heskett's principles to hearing healthcare practices | *Hearing Review* September 2014

By Sergei Kochkin, PhD; Laura Dennison, AuD, BC-HIS; and Linda Jackson



Data used by Kochkin:

The total national sample of hearing aid consumers (excluding direct mail customers) were asked to rate their HHP on seven factors using a 7-point Likert scale: "Very dissatisfied," "Dissatisfied," "Somewhat dissatisfied," "Neutral" (equally satisfied and dissatisfied), "Somewhat satisfied," "Satisfied," and "Very satisfied."

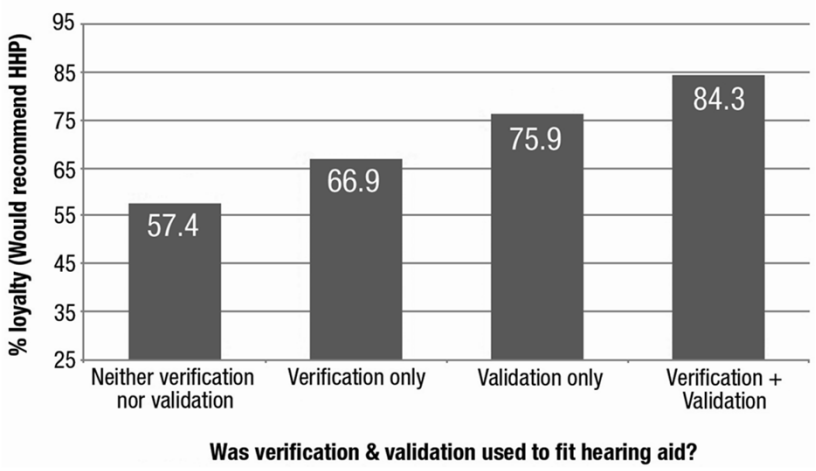
Likert ratings on the following factors were captured:

- *Professionalism*
- *Knowledge level*
- *Explained care of the hearing aid*
- *Explained hearing aid expectations*
- *Quality of service during the hearing aid fitting*
- *Quality of service post-fitting*
- *Level of empathy*

As part of the large MarkeTrak VIII study (n=2,000 or so), Kochkin also had data for:

- What tests were administered to each patient during the fitting process
- The overall hearing aid satisfaction level for each patient following the fitting

Which then provides the data needed to create this chart:



Improving Patient Perception of Clinical Services Through Real-ear Measurements.

Amlani AM, Pumford J, Gessling E.

Hearing Review. 23(12):12.

What they asked . . .

- Does the act of conducting probe-microphone verification improve the patient's perceptions of the fitting process?

What they did . . .

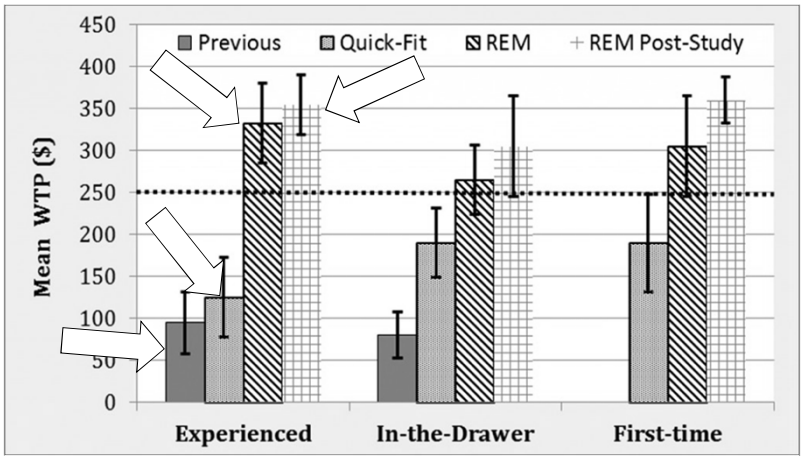
- Three groups, 20 in each group (mean age 67)
  - Group 1: Experienced hearing aid users
  - Group 2: Owners of hearing aids, but not using them—labeled "In the drawer."
  - Group 3: New hearing aid users
- The same protocol was followed for each patient except:
  - ½ of each group had fitting targets verified with probe-microphone measures
  - The other ½ had hearing aids fitted using "Quick Fit' (NAL-NL2); adjustments made based on user comments while listening to the CST passages.

What they did . . .

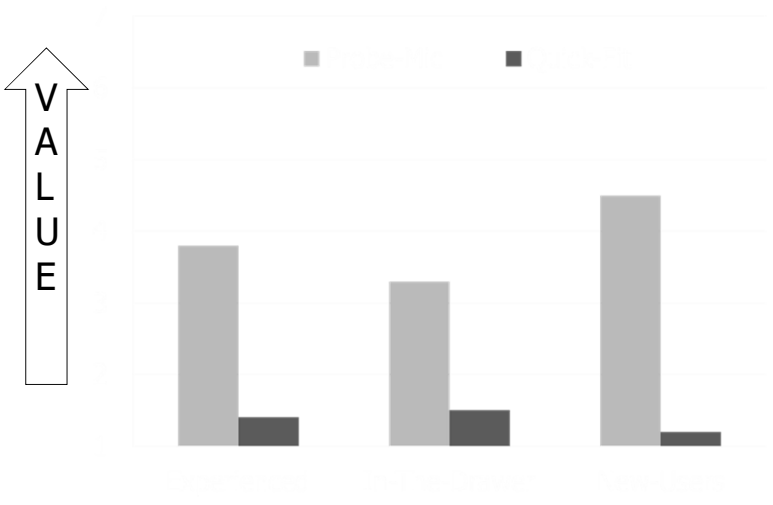
Delivered two different post-fitting questionnaires:

- Willingness to pay (anchored at $250.00)
- SERVAL: 14-item scale that measures attitude and behavior toward perceived value in five dimensions: emotion, perceived quality, price, perceived value, and behavioral intent on a 1 to 7 scale.

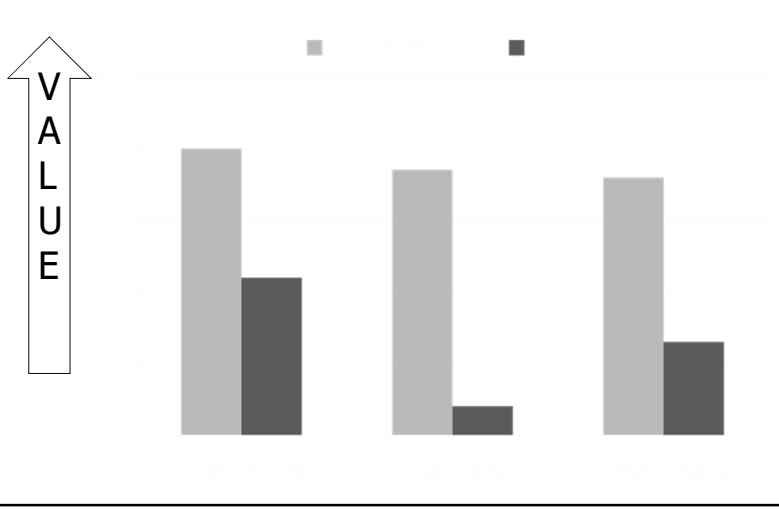
What they found . . .



"The service I obtained was outstanding"



"The service I obtained improved my perception of the product"



And one more thing—for those of you who think that probe-mic verification "takes too much time"

Help may be on the way!

Ready for prime time (we think): "probe-mic auto-fit"

- For at least 10 years, one manufacturer has had a system that automatically fits the hearing aid via probe-mic testing to prescriptive targets. Unfortunately, this was limited to using one specific hearing aid manufacturer and one specific probe-mic system. It never really caught on.
- But things are changing: Inter Module Communication (IMC) within the Noah environment allows fitting and verification tools to exchange data. Now evolving into IMC standard (IMC 2) which allows not just for real-time data exchange but also device control.

Most of the players at this time:

Hearing Aids

- Signia
- ReSound
- Phonak
- Oticon

Probe-Mic Systems

- Otometrics
- Unity
- Interacoustics
- MedRx

A few things to consider:

- Are calculations made using in-situ RECD, or external input signal?
- Is the match to target made to the target in the probe-mic equipment, or the target in the fitting software?
- Are the measures valid and reliable?

And here is a great topic to end with . . .

HEARING AIDS

Is this the dispensing model of the near future?

The Effects of Service-Delivery Model and Purchase Price on Hearing-Aid Outcomes in Older Adults: A Randomized Double-Blind Placebo-Controlled Clinical Trial OPEN ACCESS

Larry E. Humes, Sara E. Rogers, Tera M. Quigley, Anna K. Main, Dana L. Kinney, and Christine Herring

Tags: hearing aids, placebos, delivery of health care, measures of outcome

American Journal of Audiology, March 2017, Vol. 26, 53-79. doi:10.1044/2017_AJA-16-0111

What they concluded…
Best Practice model vs. "Consumer Decides"

- Hearing aids are efficacious for older adults (with mild-to-moderate loss) for both service deliver models
- The consumer decides model yielded only slightly poorer outcomes than the Best Practice model

So do we need audiologists to fit hearing aids?

Let's look a little deeper into the article!

How good are new hearing aid users at picking the hearing aid that is best for them?

Hearing aid chosen	Audiogram best match		
	X	Y	Z
Left ear **71% picked wrong aid**			
X	6	18	6
Y	0	7	7
Z	1	4	2
Right ear **73% picked wrong aid**			
X	6	23	4
Y	1	6	4
Z	1	4	2

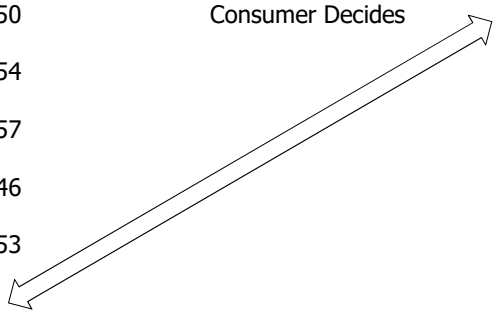
Thank goodness—we are still needed in the world . . .

BUT WAIT . . .

Some interesting SII comparisons

SIIs from Sanders et al (2015) (Manufacturer's "First Fit")		SIIs from Humes et al (2017)	
NAL-NL2	67	Best Practice (NAL-NL2)	65
HA 1	50	Consumer Decides	60
HA 2	54		
HA 3	57		
HA 4	46		
HA 5	53		

Average = 52



Gus, you of all people should know that the lyrics were about probe-mic measures!

I thought "probe" was only true in fairy tales

Meant for someone else but not for me.

"First Fit" was out to get me

That's the way it seemed.

Disappointment haunted all my dreams.

Interesting . . . And what happened next?

Then I saw the curves, now I'm a believer

Not a trace of dB doubt in my mind.

I'm in love, I'm a believer!

I couldn't leave "probe" if I tried.

Hearing Aid Verification: What you can't buy over the counter!

H. Gustav Mueller

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