Fit to Optimize Audibility or Fit to Patient Preference? A Review of the Evidence.

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Unitron

Over the next hour…

- Review two different fitting philosophies, including germane studies
- Pain points experienced by clinicians and patients related to initial use of amplification
- Provide a sensible approach bridging two different fitting approaches

Fitting philosophy is a bit like musical tastes

- No “right” answer
- May reflect your core personal beliefs
- The one question litmus test

Clinical Question

- When it comes to patient success what do you consider most important?

Two approaches

- Immediate patient acceptance: “I want my patient to like it from Day 1.”
- Long-term benefit: “Initial use might be challenging, but stick with it awhile and your frustration will be rewarded.”

Immediate Acceptance – Katy Perry

Long term benefit - Radiohead

Each require a prescriptive approach

- Long-term benefit – independently-derived fitting formula designed to optimize audibility and comfort
- Immediate acceptance – often rely on a proprietary target that often has less gain than independently-derived targets

Immediate acceptance approach

- "Give the patient what he wants" on Day 1
- Use a prescriptive target that provides immediate patient acceptance
- Prescriptive target often undershoots gain by as much as 20 dB in the high frequencies

Long-term benefit approach

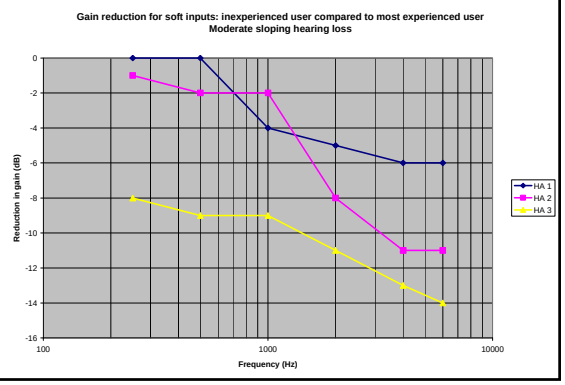
- "Give the patient what he needs"
- Restore audibility and provide comfort for soft, average and loud inputs
- Rely on independently-derived prescriptive formula: DSL or NAL family of targets

Each approach has drawbacks

Long-term benefit drawbacks

- Matching a NAL or DSL target often results in patient complaints of "too harsh"
- May lead to non-use , in-the-drawer or low benefit
- Manufacturers "first fit" and acclimatization managers attempt to address this issue by "easing" patients into optimal gain

Adaptation Managers

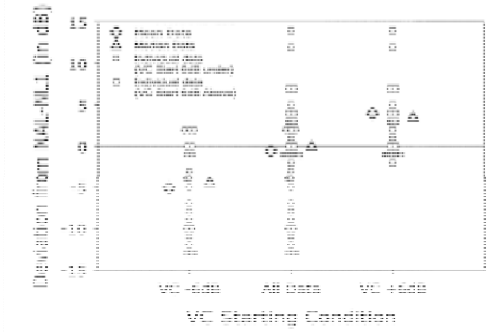


First Fit Acceptance Drawbacks

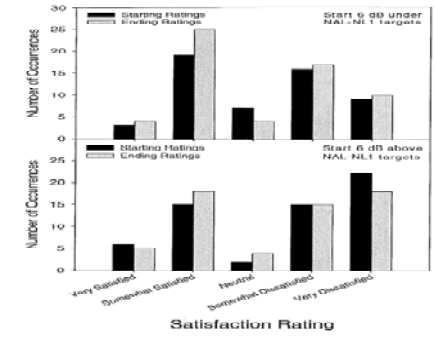
- Patient may never receive the proper amount of gain to make lost speech cues audible
- May lead to low benefit, in-the-drawer and non-use

Starting Point Matters

- Mueller, et al, JAAA, Dec, 2008
- 22 participants, fitted with trainable hearing aids
- Matched prescriptive (NAL-NL1) target and then altered overall starting point for gain by +6 dB and – 6 dB.
- Looked at “preferred gain” and satisfaction ratings 10 to 14 days later



Mueller, et al, 2008



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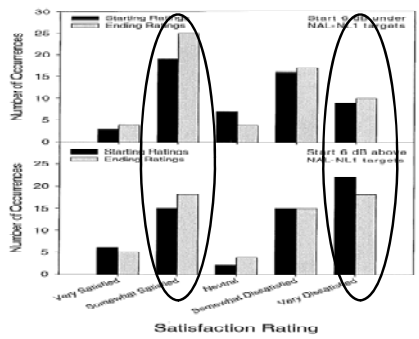

Mueller, et al, 2008

Results

1. Participants tend to train around initial starting point.

2. There's a substantial amount of individual differences in preferred gain.

3. When starting gain was +6 dB above target , participants were less satisfied with loudness compared to when starting point was – 6 dB below target.

Prescriptive Fitting Approaches

Prescriptive Fitting

- Lybarger, 1963
- ½ gain rule
- Loudness normalization vs. equalization

Normalization vs. Equalization

- Normalization: restore loudness perception - at each frequency – of the listener to the same loudness perceived by a listener with normal hearing
  - Examples: Original DSL, Fig6, IHFF
- Not used clinically since they are not available in any current probe mic equipment or fitting software

Normalization vs. Equalization

- Equalization: Equalize the perception of loudness over a range of frequencies, instead of having lower frequencies dominate loudness (this is the case with loudness for those with normal hearing)
  - Examples: DSL i/o v.5, NAL-NL2, and CAMEQ2-HF

Two popular validated prescriptive approaches for adults

- NAL-NL2
- First published in 1976, with several updates since then.
- Goal is to maximize speech intelligibility at the preferred listening level of the patient.
- Underlying philosophy: Intelligibility is maximized when all bands on speech have the same loudness.
- New NAL-NL2 calls for about 3 dB less relative to the NL1 formula.
- ***Loudness Equalization Procedure***

- DSL [i/o] v5
- Have been used since the early 1990s, primarily with pediatric fittings.
- Goal is to maximize speech intelligibility by restoring audibility across the frequency range.
- Underlying philosophy: Intelligibility is maximized when all bands of speech are audible and comfortably loud.
- ***Loudness Equalization Procedure***

Normalization vs. Equalization

- Only the loudness equalization formulas are used clinically today
- CAMEQ2-HF, DSL i/o v5 and NAL-NL2 generic formula
- Many manufacturers have developed their own formula

NAL-NL2 vs. DSL m(i/o) v5

J Am Acad Audiol 22:441–459 (2011)

A Comparison of Gain for Adults from Generic Hearing Aid Prescriptive Methods: Impacts on Predicted Loudness, Frequency Bandwidth, and Speech Intelligibility

DOI: 10.3766/jaaa.22.7.5

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Harvey Dillon‡

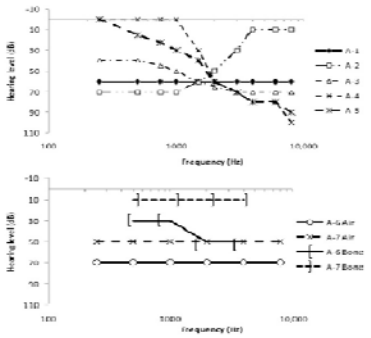


Figure 1. Top panel: Audiograms 1–5 (A-1 through A-5)—same sensorineural hearing losses as in Byrne et al (2001). Bottom panel: Audiograms 6–7 (A 6 through A 7)—mixed and conductive hearing losses.

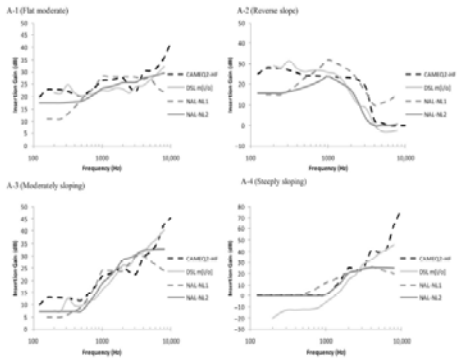


Figure 3. Insertion gain values for A-1, A-2, A-3, and A-4 for a 65 dB SPL soundfield input level.

Table 1. Compression Ratios for Each Prescriptive Method Over the Range of 50–80 dB SPL Input Levels Assuming the International Long-Term Average Speech Spectrum of Byrne et al (1994)

Audiogram and Prescriptive Method	500 Hz	2000 Hz
A-1		
Cambridge Method for Loudness Equalization 2—High-Frequency (CAMEQ2-HF)	1.5	2.3
Desired Sensation Level Multistage Input/Output (DSL m[i/o])	1.3	1.5
National Acoustic Laboratories—Non-linear 1 (NAL-NL1)	1.2	2.3
National Acoustic Laboratories—Non-linear 2 (NAL-NL2)	2.6	2.7
A-2		
CAMEQ2-HF	1.6	2.3
DSL m[i/o]	1.3	1.1
NAL-NL1	1.3	2.1
NAL-NL2	1.6	1.4
A-3		
CAMEQ2-HF	1.3	2.0
DSL m[i/o]	1.2	1.5
NAL-NL1	1.2	2.3
NAL-NL2	2.0	2.5
A-4		
CAMEQ2-HF	1.1	1.9
DSL m[i/o]	1.0	1.8
NAL-NL1	1.0	1.9
NAL-NL2	1.0	1.7
A-5		
CAMEQ2-HF	1.1	1.9
DSL m[i/o]	1.0	1.8
NAL-NL1	1.0	2.0
NAL-NL2	1.1	2.1

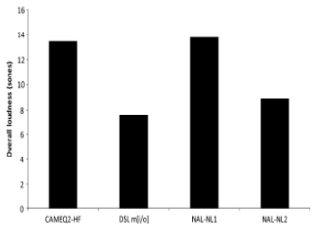


Figure 7. Overall loudness of each prescriptive method averaged across the five sensorineural hearing losses (A-1 through A-5) based on a 65 dB international long-term average speech spectrum input in quiet.

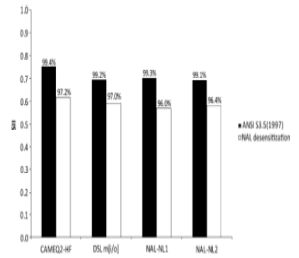


Figure 8. Average Speech Intelligibility Index (SII) value for speech in quiet across the five sensorineural hearing losses for each prescriptive method using both the ANSI S3.5-1997 and the National Acoustic Laboratories SII methods. Also shown is the SII transformed value into a predicted speech recognition score (% correct) for the Connected Speech Test (Cox et al, 1987) using the transfer function of Humes (2002).

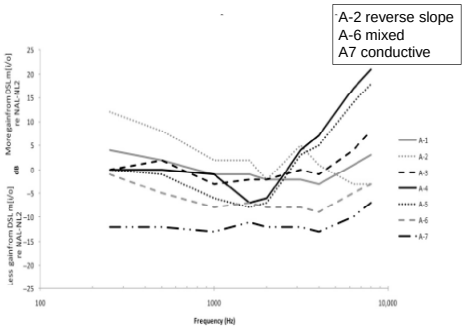
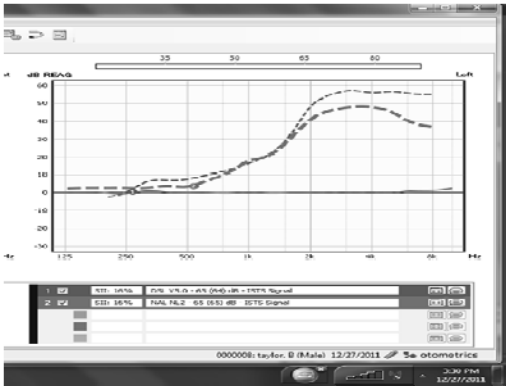


Figure 12. Frequency-specific differences in insertion gains prescribed by Desired Sensation Level Multistage Input/Output (DSL m[i/o]) and National Acoustic Laboratories—Non-linear 2 (NAL-NL2) for each of the seven hearing losses at select 1/3-octave bands. The data are reported as DSL m[i/o] – NAL-NL2. Negative numbers indicate less gain from DSL m[i/o], and positive numbers indicate more gain from DSL m[i/o], for a 65 dB SPL input re: NAL-NL2.



NAL-NL2 vs. DSL m (i/o) v5

- For most hearing loss configurations prescribed insertion gain, loudness and SII are very similar
- Both have similar goal of optimizing intelligibility and maintaining overall comfort

Preferred Gain and the NAL-RP Formula: An Evidence-Based Review

- Mueller, JAAA, 2005
- Question: "Are there real world outcome measures from adult patients that show a preference for the gain prescribed by a specific prescriptive fitting procedure?"
- 11 studies met criteria and were included in the review
- Findings: Gain similar (or about 3 dB less) to the NAL-RP formula was preferred

Preferred Gain Relative to Prescriptive Targets

- Convery, 2005 meta-analysis of gain preference over time found very little support for gain adaptation in new users
  - 98 new
  - 77 experienced
  - Average difference in preferred gain between two groups was no more than 2 dB, with new users preferring less gain than experienced users
  - Difference in preferred gain did not change over 1 year period

Preferred Gain Relative to Prescriptive Targets

- Other studies show similar results:
  - 2.6 dB lower gain on average (Marriage, et al 2004) for new vs. experienced users
  - No significant differences in gain preferences for new compared to experienced users (Smeds, et al, 2006)

Differing Points of View

- Although there is evidence supporting the effectiveness of NAL and DSL gain targets as starting point of fitting
- Popular view remains: New users require less gain than experienced users

First Fit Acceptance Approach

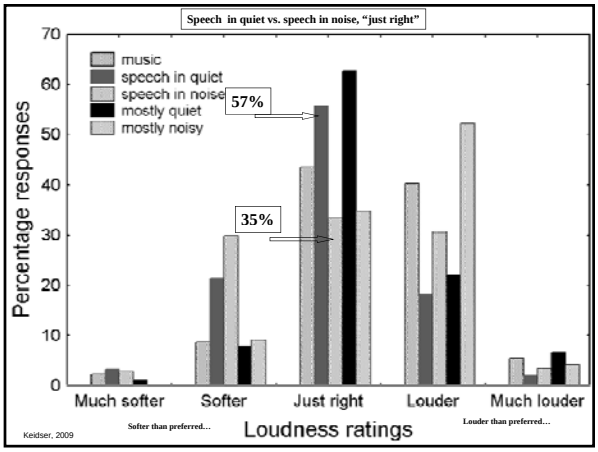
- Thesis: New hearing aid users prefer less gain than experienced hearing aid users
- Implication: new hearing aid users prefer a gradual increase in gain after fitting to accommodate auditory acclimatization factors

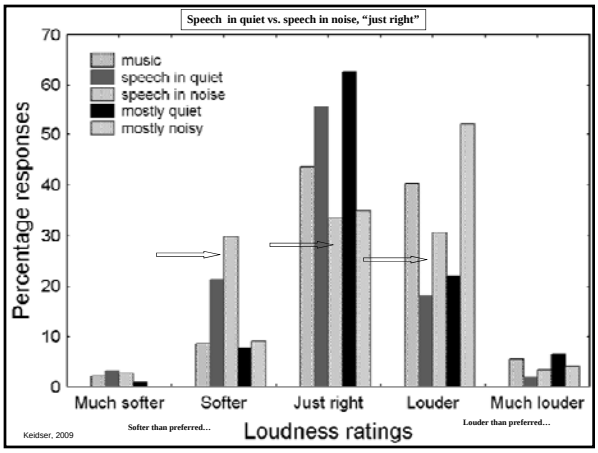
First Fit Acceptance Approach

- In response to this, manufacturers have developed gain adaptation tools
- Clinician selects reduced gain levels relative to the target before verification procedures
- Some of these tools are automatic adaptation managers

Gain preferences for experienced users

- Keidser, 2009
- 28 experienced hearing aid users
- All fitted with NAL-NL1, <u>less 3dB overall gain</u>
- Kept a diary for 2 weeks documenting listening environments they encountered daily into 5 possible situations
  - Speech in quiet = 155 (highest number of reports)
  - Mostly quiet = 91 (fewest reports)





Variation in preferred gain with experience for hearing aid users. IJA. Keidser et al 2008

Table 1. An overview of the general profile of the study participants.

Parameter	*New users (N = 50)*	*Experienced users (N = 26)*
Average experience with amplification (years) and range	0	11.2 [3.5, 26]
Male/female ratio (%)	50/50	73/27
Average age (years) and range	70.3 [33, 87]	74.6 [40, 91]
Bilateral/unilateral fit ratio (%)	72/28	77/23
Average 4FA HTL (dB HL) and range	39.6 [21.3, 55.0]	46.1 [33.8, 63.1]
Average LFA HTL (dB HL) and range	28.6 [5.0, 58.3]	33.6 [15.0, 58.3]
Average HFA HTL (dB HL) and range	49.3 [32.5, 67.5]	57.7 [43.3, 75.0]
Slope (dB) and range	20.7 [−19.2, 43.3]	24.3 [0.0, 54.2]

Methods

- All fitted with Siemens Music Pro
- Three programs
  - NAL-NL1 response
  - NAL-NL1 with 6 dB high frequency cut at 3 KHz (HFC)
  - NAL-NL1 with 6 dB low frequency cut at 500 Hz (LFC)
- Participants were asked their preferred program at 1 month, 4 months and 13 months post fitting
- Aided loudness for the NAL-NL1 program was also obtained at these intervals

Results – gain preferences

Table 3. The distribution of preferences in percent for each response shape by experienced and new hearing-aid users at each test appointment.

Preferred response shape	*Experienced 1 month*	*New 1 month*	*New 4 month*	*New 13 month*
NAL-NL1	42%	35%	31%	40%
HFC	50%	56%	62%	52%
LFC	8%	10%	8%	8%

Results – gain preferences

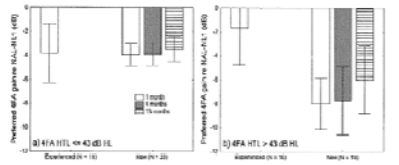


Figure 6. The average preferred 4FA gain relative to NAL-NL1 one, four, and thirteen months post-fitting by experienced and new HA users with (a) mild hearing loss, and (b) more than a mild hearing loss. The bars show the 95% confidence bands.

Results –comfortable loudness

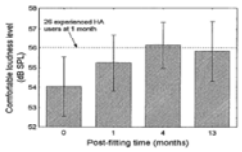


Figure 7. The average comfortable loudness levels measured on new HA users at the fitting appointment and at one, four, and thirteen months post-fitting. The bars show the 95% confidence bands. The broken horizontal line shows the average comfortable loudness level measured on the experienced HA users at their one month test appointment.

Conclusions

- New users prefer less overall gain than experienced hearing aid users
- After 13 months gain adaption was 3 dB for those with 4FA HTL of 55 dB HL
- A change in comfortable loudness among new users over the first 4 months was 2 dB
- NAL-NL1 overprescribed gain by about 3 dB for 65 dB SPL inputs

Alternatives to Prescriptive Fitting Approaches

J Am Acad Audiol 20:607–620 (2009)

A Naturalistic Approach to Assessing Hearing Aid Candidacy and Motivating Hearing Aid Use

DOI: 10.3766/jaaa.20.10.3

Therese C. Walden*
Brian E. Walden*
Van Summers*
Ken W. Grant*

Table 1. Everyday Listening Situations That Are Most Frequently Reported to Be Problematic by Patients Who Are Nonusers of Hearing Aids and Are Seeking an Evaluation of Their Hearing

- Listening to child in quiet
- Conversation with TV in background
- Talking in a restaurant
- Listening in large theater or sanctuary
- Listening in conference room or classroom
- At the movies
- Conversation at cocktail party
- Conversation in car with radio playing in background
- Dinner conversation
- Listening to child at play outdoors
- Conversation with someone in another room
- Listening to vocal music
- Listening to instrumental music
- Hearing the sounds of nature

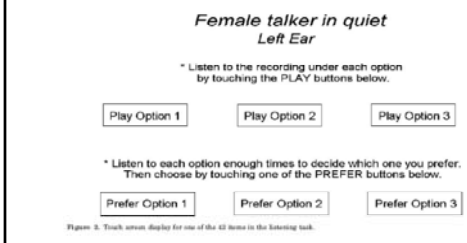
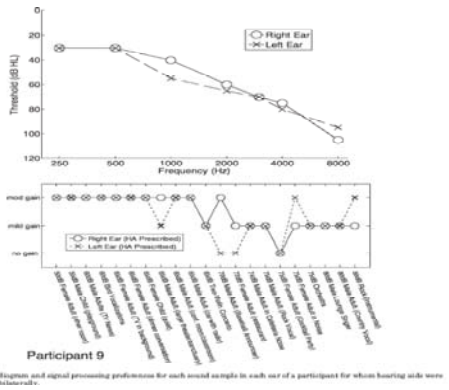


Figure 3. Touch screen display for one of the 42 items in the listening task.

New Approach

- Transitioning from acceptance to long term benefit
- Revew Convery and Keidser study



Conclusions

- Preferences for amplified sounds were predictive of hearing aid candidacy
- Not sufficient to replace traditional determinations of candidacy
- A quick and intuitive method of demonstrating potential benefit

Patient-driven approach

Amplifit 3

Audiologist-driven vs. Patient-driven fine tuning of hearing instruments. Trends in Amplification. Boymans & Dreschler, 2011

- N =73
- Compared prescriptive fitting process to Amplifit during fine tuning procedure
- Audiologist-drive resulted in higher gain values
- Overall performance of speech perception favored audiologist-driven approach for 2/3 of participants

Regardless of your fitting philosophy..

- What you start with (optimized patient acceptance) is often very different than what is needed to achieve long term benefit

By-product of both approaches
Time = Money

- Unless the patient comes in for numerous visits for adjustments and tweaks
- Compromises are the result

A sensible hybrid approach

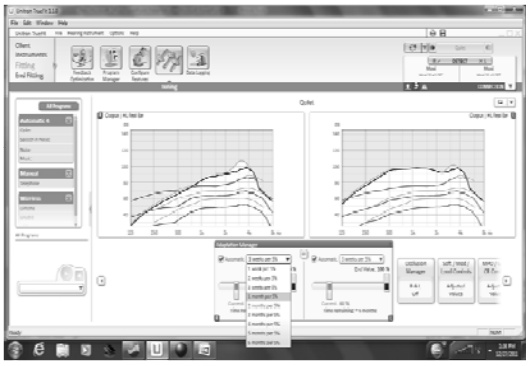
- Goals:
  - Initial acceptance (keep the devices in the ears)
  - Long-term benefit (sufficient audibility to hear missing speech sounds)
- Automatically transition from immediate acceptance to long term benefit

Hybrid Approach

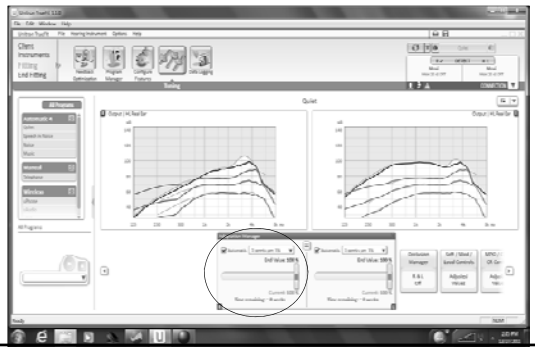
1. Match NAL or DSL target and verify with probe mic measures
2. Reduce overall gain 3 to 10 dB (use sound simulator and Cox loudness contours to help establish these)
3. Set AAM to transition to optimal gain over 6 to 12 week period

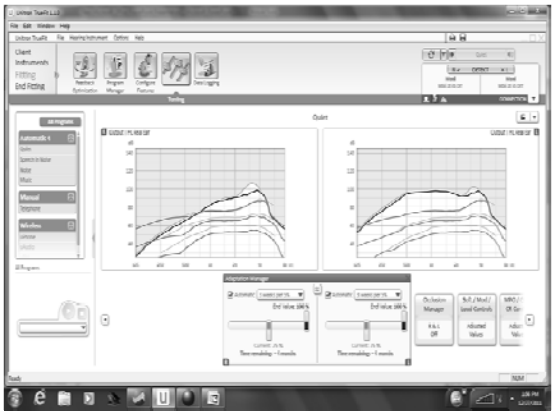
- 6 to 12 weeks of acclimation time from one to the other
  - Gatehouse, 1992
  - Arlinger, 1996

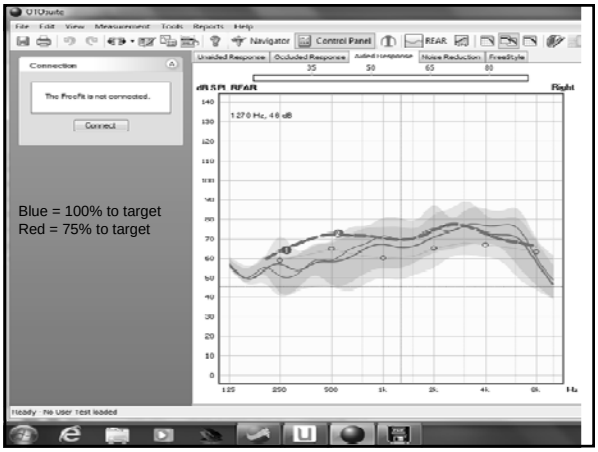
Unitron Automatic Adaptation Manager



Match to 100% of target and verifiy with probe mic







General Conclusions

- There is evidence to support both an “immediate acceptance” and “long-term benefit approach
- Both approaches rely on prescriptive formula values
- Automatic Adaptation Manager (AAM) allows you to have it both ways
- Need for Probe Mic in verification is still critical

thanks

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