Hearing Aid Speech Mapping Verification: Some Explanations for Puzzling Outcomes

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Greetings from North Dakota's largest island!

Welcome To "The Club"

For the non-believers . . .

(future resource)

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

AudiologyOnline Webinar
September 13, 2017 (11:00 CDT)

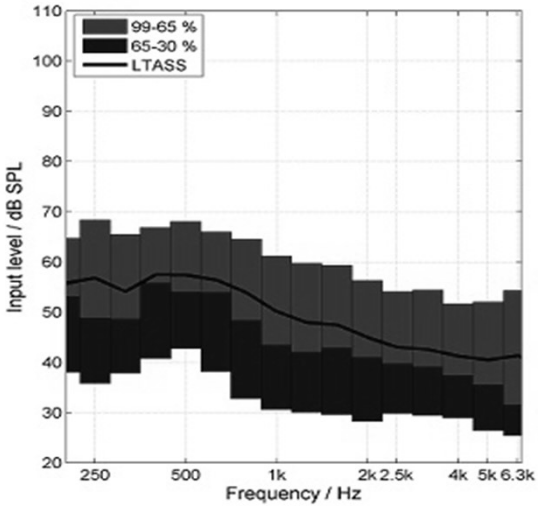
(and will be available on demand)

Flying by the seat of your pants precedes crashing by the seat of your pants.

Some background for our discussion:

- All verification will be using the REAR (i.e., "speechmapping").
- For most cases, NAL-NL2 will be used as the prescriptive method
- For most cases, soft, average and loud will refer to 55, 65 and 75 dB SPL respectively.
- The input signal used will be the ISTS.

Reminder regarding real-speech signals: Forget about the "old days" when the input signal was equalized across frequencies!



I just don't understand why . . .

. . . there are times when I increase gain in the fitting software in the higher frequencies to match targets, but I don't see any increase in the REAR output.

Most probable reason: Fitting is open and incorrect equalization is being used.

- Concurrent equalization: Reference microphone continually monitors test signal during measurements—default on most probe-mic equipment
- Stored equalization: Calibration is conducted before testing; reference mic is "turned off" during testing—usually requires you to "select" to activate.

Potential equalization problem if you forget to select "stored":

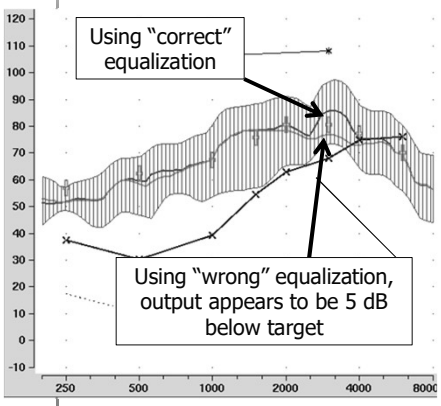
- Sound leaking out of ear is picked up by reference mic
- Sound leaking out of ear may be greater than the input to reference mic from loudspeaker
- Reference mic thinks it is output from loudspeaker, and so loudspeaker output to ear is then turned down
- The result will be less measured hearing aid output (and gain) than is actually present.

Magnitude of problem usually related to:

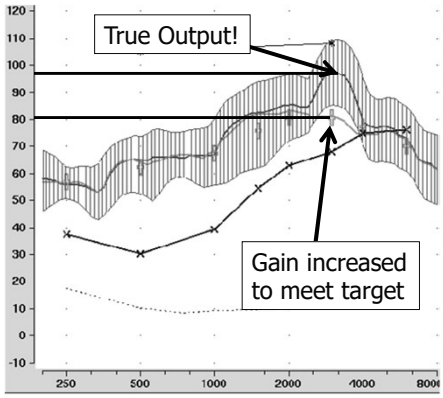
- Gain/output of hearing aid
- Goodness of feedback reduction algorithm
- Location of reference mic
- Openness of the fit
- Residual ear canal resonance of the patient

Very likely clinical results when wrong equalization is used . . .

Initial attempt to match target



After maximizing gain



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gain in the fitting s
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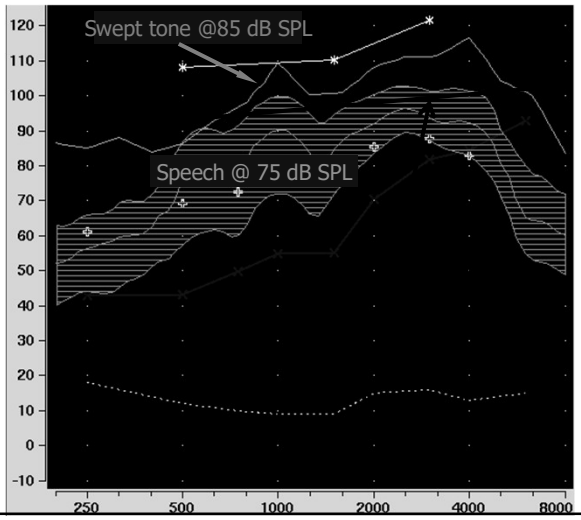
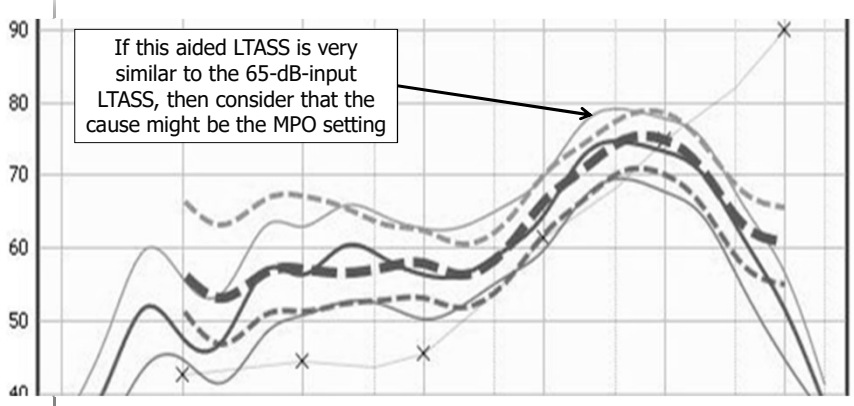
Another possible reason for this outcome . . .
(if it's only observed for the loud input level)

Consider the relationship between the MPO setting and the peaks of speech:



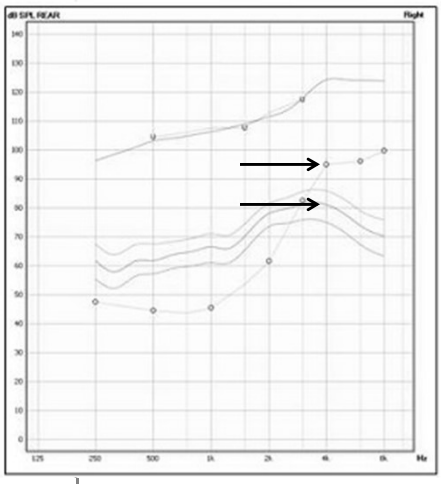
If you see a systematic separation for the output for the three different inputs, then you can be quite certain that a "too low MPO" is not an issue.

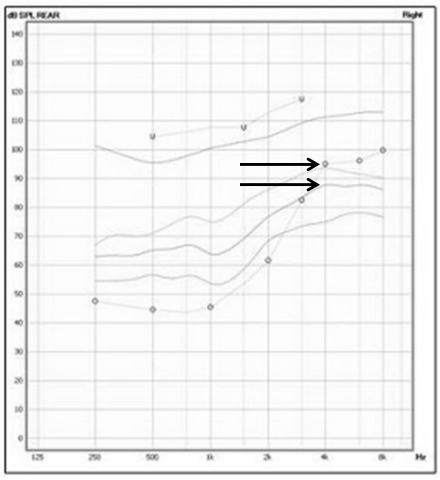


I just don't understand why . . .

. . . there are times in the high frequencies when the fitting targets are actually below the patient's hearing thresholds.

Fitting targets compared to patient thresholds for NAL-NL2 (left) and DSL V5 (right)

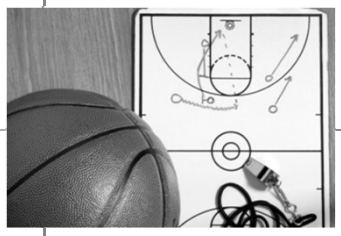




Reasons why the targets are below the thresholds in the high frequencies:

- Consider the complete speech spectrum, not just the "average line."
- You only have so much loudness to use—use it effectively.
- There is a point where extra audibility does not equate to increases speech understanding. This is referred to as "effective audibility."
- The overall fitting must be reasonably "comfortable" for patients, or they will turn down gain and reduce audibility for ALL frequencies.

A basketball analogy to help explain the concept of "effective audibility" (mostly stolen from Harvey Dillon)



You are the coach, and your team has nine players, but their ages are quite diverse:

A 20-year-old, a 30-year-old, a 40-year-old, a 50-year-old, a 60-year-old, a 70-year-old, an 80-year-old, a 90-year-old, and yes, one guy who is 100-years-old.

You pick the five youngest guys for your starting five.

The nine players on the team you are playing against are all 20-year-olds

The first half is winding down, but amazingly, you are still in the game—only 12 points behind. But . . . Your starting five are exhausted. The other team has scored 10 consecutive points.

Who are you going to put in? The youngest guy on your bench is 70-years-old. He can catch and do basic defense—but, running and jumping is not an option!

And actually, all your team is exhausted (the other team is using all nine of their players and running the ball). Are you really going to put in your 80-year old? Your 90-year-old? Or, (gasp) your 100-year-old?

Or, are you better off to simply keep playing your five youngest guys, even if they are tired?

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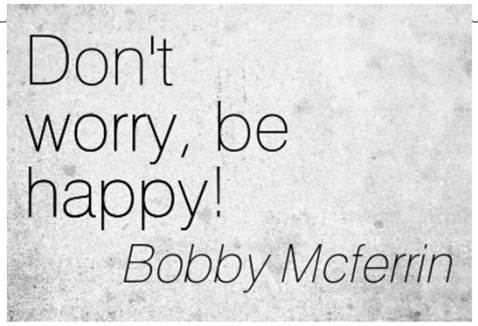
The bottom line . . .



There is no need to try to "out-think" the NAL and DSL folks—they know what they are doing!

I just don't understand why . . .

. . . there are times when the output exceeds target, and I notice that the aided SII is bigger. Isn't bigger better? What SII number should I try to achieve?

Let's take a look at "expected" SIIs for five different audiograms for the NL2 and the DSL

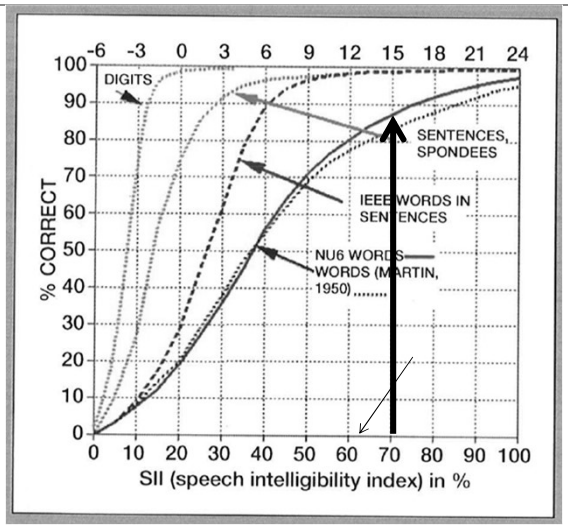
Table 3. Speech Intelligibility Index (SII) Value for the A-1 Through A-5 Sensorineural Losses Using Both the ANSI S3.5-1997 and National Acoustic Laboratories (NAL) SII Methods

	A-1		A-2 **(Upward Sloping)**		A-3	
Prescriptive Method	ANSI SII	NAL SII	ANSI SII	NAL SII	ANSI SII	NAL SII
CAMEQ2-HF	0.71	0.51	0.74	0.61	0.76	0.55
DSL m[i/o]	(0.67)	0.51	(0.71)	0.61	(0.71)	0.55
NAL-NL1	0.69	0.48	0.71	0.58	0.70	0.53
NAL-NL2	(0.67)	0.5	(0.64)	0.59	(0.73)	0.54

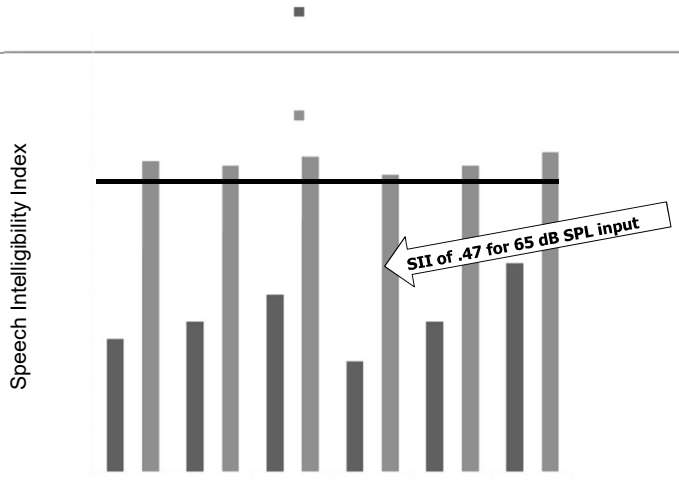
	A-4		A-5		Average	
Prescriptive Method	ANSI SII	NAL SII	ANSI SII	NAL SII	ANSI SII	NAL SII
CAMEQ2-HF	0.77	0.67	0.77	0.63	0.75	0.62
DSL m[i/o]	(0.75)	0.67	(0.72)	0.63	→ 0.70	0.59
NAL-NL1	0.73	0.65	0.71	0.61	0.70	0.57
NAL-NL2	(0.71)	0.66	(0.72)	0.62	→ 0.69	0.58

From Johnson and Dillon (2011), *JAAA*

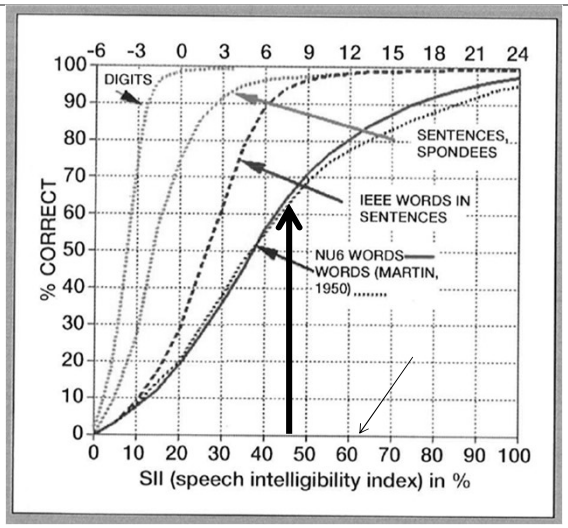
The relationship between SII and speech recognition



SIIs for Manufacturer Proprietary Fittings and NAL-NL2 targets



The relationship between SII and speech recognition

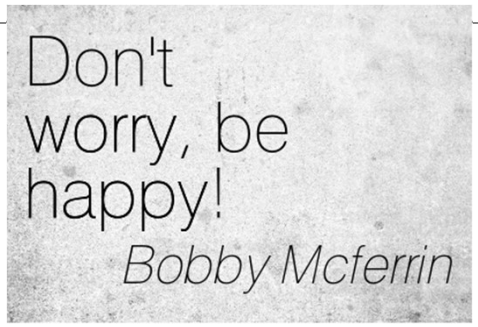


What comes first, the fit to target or the desired SII?

To be clear:

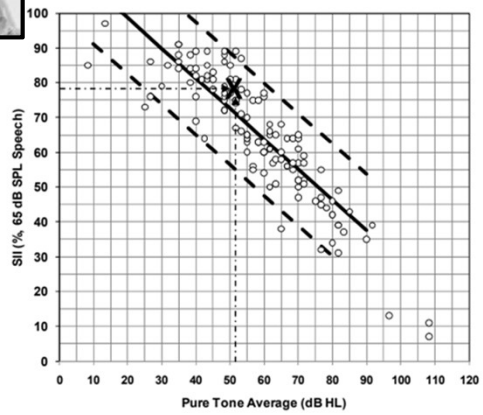
- I am *NOT* saying that you should simply attempt to achieve an SII of around .70, and then all is well.
- What I *AM* saying, is that if you obtain your match to target, for a 65-dB-input signal, you will probably have an SII of around .70

The bottom line . . .



There is no need to try to "out-think" the NAL and DSL folks—they know what they are doing!

But, before you "totally" stop worrying, it's important to point out that we are talking about *adult* fittings. The rules are different for pediatric patients:



Normative data obtained from "acceptable" pediatric fittings
See UWO PedAMP Monitoring Protocol

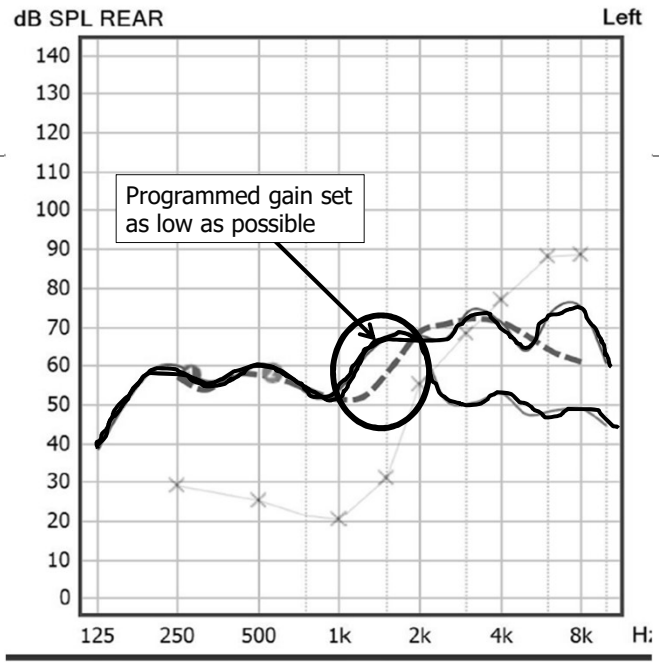
I just don't understand why . . .

. . . "sometimes when I'm doing speech mapping, I have too much gain at a certain region, I then lower gain in the fitting software, but nothing happens in the real ear?"

A seldom-used probe-mic measure that can be your best friend . . .

. . . The Real Ear Occluded Response

- It's an REAR with the hearing aid turned off or muted.
- It tells you the impact that the fitting tip, earmold, or custom hearing aid has on the sound reaching the ear. This is a combination of the effect on the ear canal resonance, concha effects, and occlusion attenuation (e.g., "ear plug" effect).
- If ear is open, the effect will be minimal (e.g. ear canal resonance mostly maintained, no ear plug effect). If the fitting is closed, effect can be 20 dB or greater.

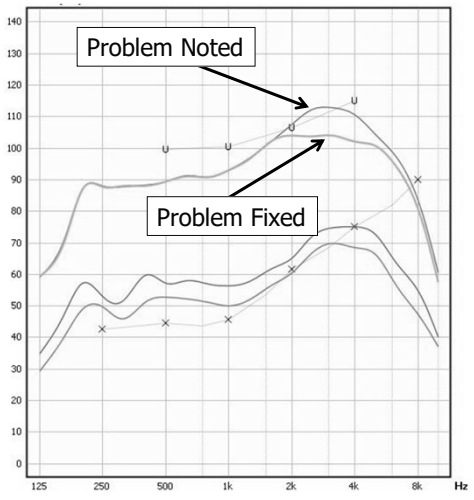


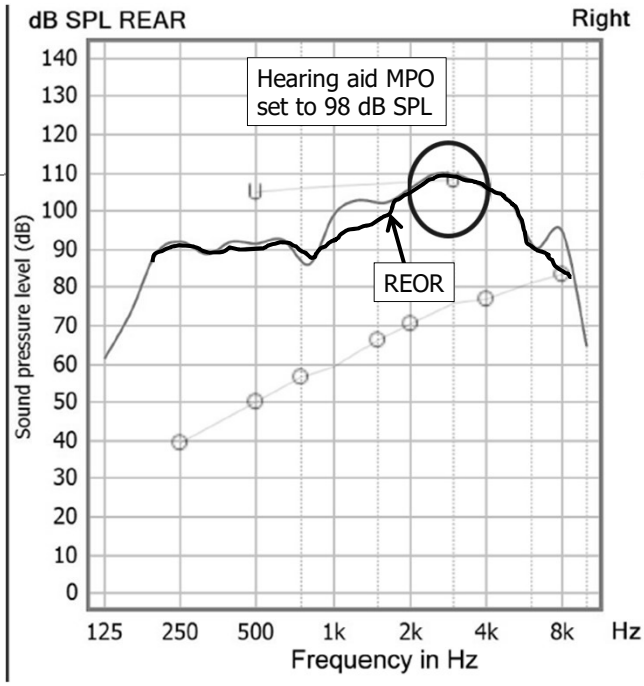
When something in the fitting looks strange, or not just right, you might find the answer by running a quick REOR!

I just don't understand why . . .

. . . "sometimes when I'm doing REAR85 testing, I keep lowering the MPO in the software, but the output on the probe-mic screen doesn't change?"

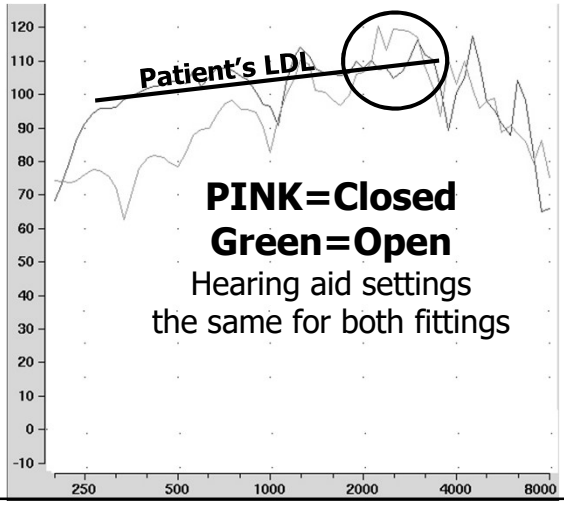
A reminder regarding how you would use the REAR85 with target LDLs for setting the MPO





When something in the fitting looks strange, or not just right, you might find the answer by running a quick REOR!

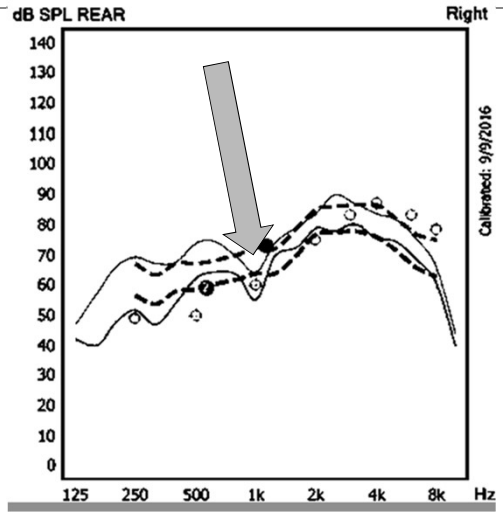
Reminder: In an open fitting, if the ear canal resonance remains, it's very possible that MPO will be higher than if you had used a closed fitting.



I just don't understand why . . .

. . . "sometimes I get a weird dip in my REAR around 1000 to 1500 Hz, which is unrelated to my gain programming. What is going on?"

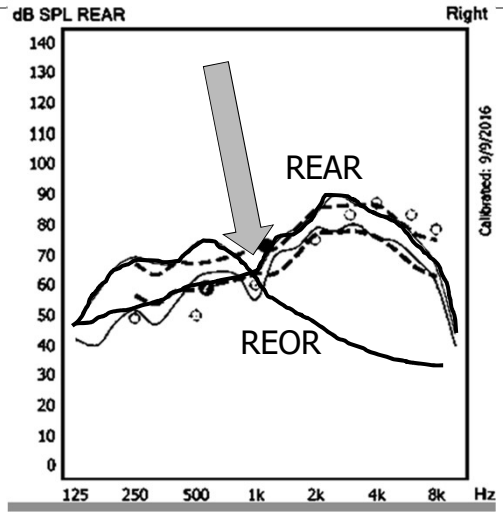
Strange dip in REAR



What is causing the strange dip?

- Some sort of anti-resonance in the ear canal? Maybe could trouble shoot by moving probe tip or fitting tip, or using different size fitting tip.
- A cross-over point in the circuitry of the hearing aid? Maybe a channel crossing for feedback reduction? If so, it should be the same for all patients.

Possibility #3: Back to looking at the REOR

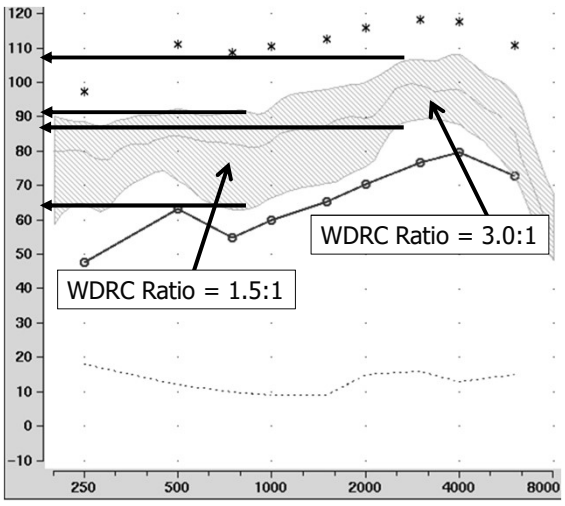


When something in the fitting looks strange, or not just right, you might find the answer by running a quick REOR!

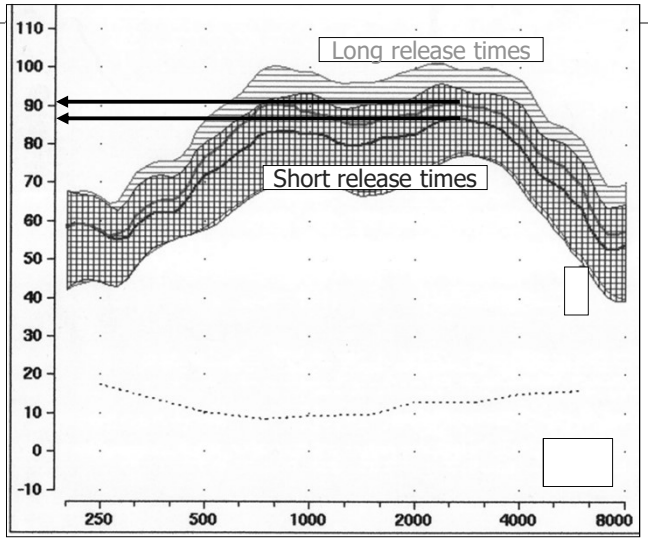
I just don't understand why . . .

. . . "sometimes when I get perfect match to target for soft, I can't get a good match for the 75-dB input—the output is too high. This is even when I have maxed out the "loud sounds" tab in the fitting software."

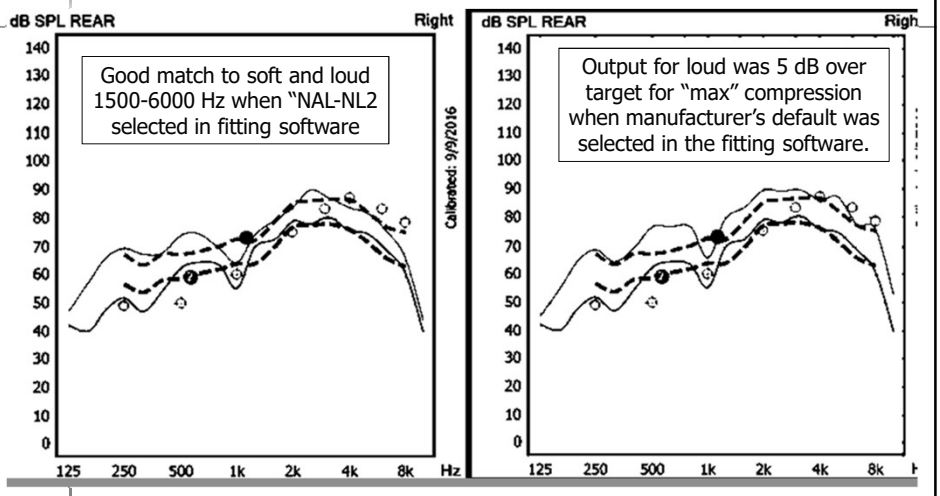
Rethinking compression when the input is real speech:



The effects of release time: 60 msec vs. 1800 msec for a 3:1 ratio



Going back to our previous patient



Practical solutions and/or compromises:

- Check with your favorite manufacturer to see if they use different compression strategies.
- Get as close as possible for loud, check with patient behaviorally to ensure that loud speech is not too loud—often it's okay even though it's 5 dB or so above target.
- Fit to average first, and then accept that soft might not be quite loud enough (e.g., if you apply less-than-prescribed gain for soft, you won't need as much compression to bring in loud).

I just don't understand why . . .

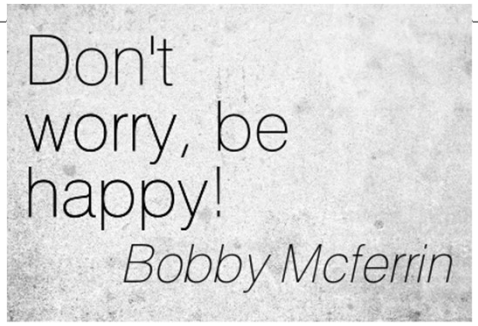
. . . that sometimes I have found that it's easier to obtain a match to NAL-NL1 targets than those of NAL-NL2. Okay to just keep using NAL-NL1?

Consider this analogy:

Introduced the same time as NAL-NL1

Improved version after 15 years of R & D

The bottom line . . .



There is no need to try to "out-think" the NAL and DSL folks—they know what they are doing!

Thank you "Club Members!" You've made a very wise club decision!