RESEARCH QUICK TAKES

6.1: Hearing Aid Fitting Toolbox: Monosyllabic word recognition measures

Brian Taylor & Gus Mueller

Research Quick Takes Volume 6

How-to.....

Hearing Aid Fitting Toolbox:

6.1: Monosyllabic word recognition measures (NU-6 ordered by difficulty, recorded)

6.2: Speech-in-noise testing (Quick SIN)

6.3: Setting the MPO (LDL testing)

6.4: Pre-fitting needs assessment (HHIA, APHAB, COSI)

6.5: Verification with REM (matching validated targets)

6.6: Aided soundfield measures

6.7: Identification and treatment of the hearing aid occlusion effect

6.8: Self-assessment outcome measures

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Three reasons for conducting pre-fitting monosyllabic measures:

- What is the maximum performance possible for this patient? That is, when enough, but not too much audibility is present—what score is obtained? We would expect that, if fitted properly, the *aided performance* will equal, or because of frequency shaping, maybe even exceed this value.

- Is there is a significant difference in the PB-Max between ears. This could impact hearing aid selection and post-fitting counseling.

- The PB-Max score also can be used to determine when to consider eliminating an ear in the hearing aid fitting process (employ CROS or BiCROS), or when to consider referring for a cochlear implant evaluation.

THE WORDS ARE NOT THE TEST
THE TEST IS THE TEST

The TEST is:

- NU#6 word lists
- Auditec of St. Louis recordings
- 50-word lists

Step 1: Use appropriate presentation level

Most probable level that will ensure maximum performance:

- Loud enough to maximize audibility
- Does not exceed patient's LDL

The SL values shown below are added to the 2000 Hz threshold to obtain the presentation level:

- 2000 Hz Threshold <50 dB HL: 25 dB SL
- 2000 Hz Threshold 50–55 dB HL: 20 dB SL
- 2000 Hz Threshold 60–65 dB HL: 15 dB SL
- 2000 Hz Threshold 70–75 dB HL: 10 dB SL

Guthrie and Mackersie (2009):

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When the “2K + X” approach might not work:

- When the recommended SL results in exceeding the patient’s loudness discomfort level (LDL). Note: Be sure that it really is exceeding the LDL, and not simply “louder than they would like.”
- When the hearing threshold at 2000 Hz is 80 dB or greater.
- When the patient has an upward sloping loss, and relatively normal hearing at 2000 Hz.

In these cases, we recommend that you carefully measure the patient’s LDL for speech, and then conduct testing 5 dB below this level.

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Step 2: Always use validated 50-word list

Reasons why?

- Inter-list equivalency is for 50-words
- Greater sample size aids in determining significant differences
- First 25 words vs. 2nd 25 words not balanced for difficulty

- Note that 8 of the 10 hardest words on the list are on the first ½.

- If you used a ½ List, and if the patient simply missed the 10 hardest words, and you tested the right ear first, his scores would be 68% for the right ear, and 92% for the left ear.

Step 3: Always use the recorded NU-6 "ordered by difficulty" 50-word list

Reasons why?

- It is the same 50 words, just ordered differently
- On average, should save time for 25% of patients
- There is not a downside—worse case is that you give all 50 words (which you would have anyway)

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List 1	% Error
Death	66.22
Knock	52.25
Laud	50.90
Puff	50.00
Keen	48.65
Burn	48.20
Take	44.59
Third	44.14
Met	43.69
Pool	42.79
Kite	41.44
Hurl	41.99
Jar	40.09
Fat	39.19
Sell	37.84
Tip	36.49
Lot	34.23
Chalk	33.78
Week	32.98
Which	32.98
Page	32.98
Gap	31.08
Shout	31.08
Dime	30.18
Hash	29.28

- If the patient only misses 1 word out of the first 10, you can conclude testing (Score of =/>96%)
- If the patient only misses 3 words out of the first 25, you can conclude testing (Score of =/>94%)
- If the patient misses more than 3 out of the first 25, you present the full 50 word list—what you would have done anyway

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Step 4: Always use “critical difference” to interpret findings

Reasons why?

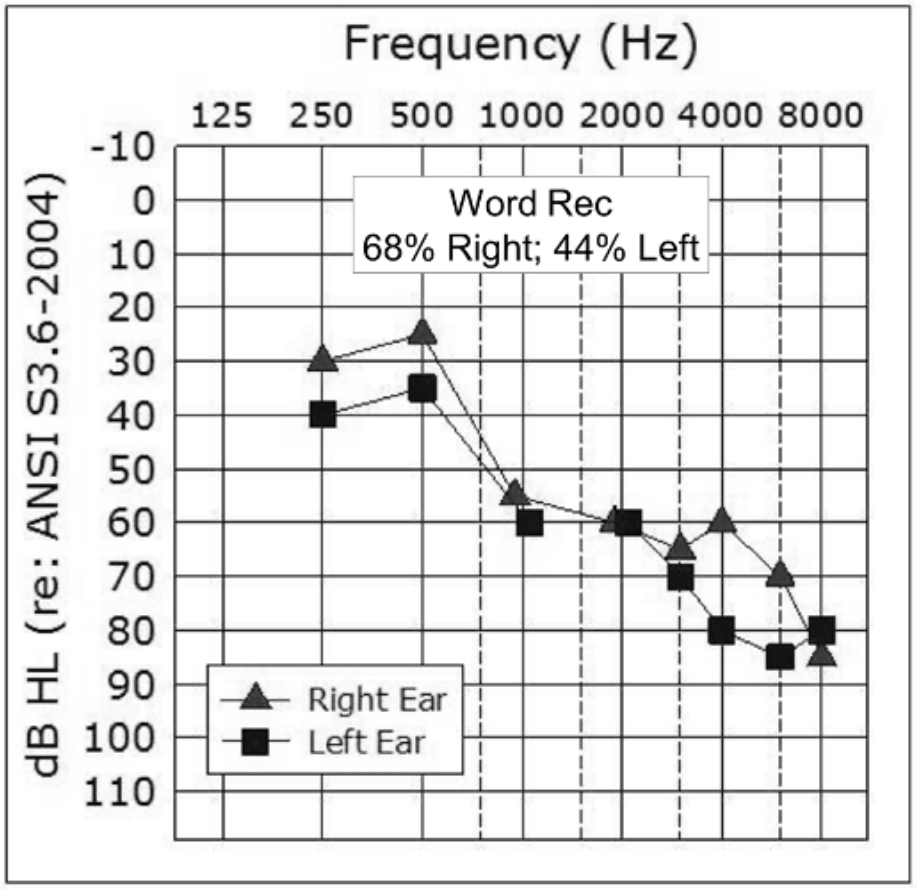
- Knowing when a difference is really a difference is important for patient counseling.
- Knowing when a difference is really a difference can alter the hearing aid fitting.

When is a difference really a difference?

Score %	N = 50	N = 25		Score %	N = 50	N = 25
0	0-4	0-8		52	34-70	28-76
2	0-10			54	36-72	
4	0-14	0-20		56	38-74	32-80
6	2-18			58	40-76	
8	2-22	0-28		60	42-78	36-84
10	2-24			62	44-78	
12	4-26	4-32		64	46-80	40-64
14	4-30			66	48-82	
16	6-32	4-40		68	50-84	44-88
18	6-34			70	52-86	
20	8-36	4-44		72	54-86	48-92
22	8-40			74	56-88	
24	10-42	8-48		76	58-90	52-92
26	12-44			78	60-92	
28	14-46	8-52		80	64-92	56-96
30	14-48			82	66-94	
32	16-50	12-56		84	68-94	60-96
34	18-52			86	70-96	
36	20-54	16-60		88	74-96	68-96
38	22-56			90	76-98	
40	22-58	16-64		92	78-98	72-100
42	24-60			94	82-98	
44	26-62	20-68		96	86-100	80-100
46	28-64			98	90-100	
48	30-66	24-72		100	96-100	92-100
50	32-68					

Thornton and Raffin critical differences (.05 level of confidence). These values were validated with both the W-22 and NU-6 word lists.

The critical difference can be observed by either using the best or the worse of the two scores under comparison.



Sample audiogram for patient with reduced word recognition in both ears.

Right=68%

Left=44%

Are these two scores the same or are they different?

Score %	N = 50	N = 25		Score %	N = 50	N = 25
0	0-4	0-8		52	34-70	28-76
2	0-10			54	36-72	
4	0-14	0-20		56	38-74	32-80
6	2-18			58	40-76	
8	2-22	0-28		60	42-78	36-84
10	2-24			62	44-78	
12	4-26	4-32		64	46-80	40-64
14	4-30			66	48-82	
16	6-32	4-40		68	50-84	44-88
18	6-34			70	52-86	
20	8-36	4-44		72	54-86	48-92
22	8-40			74	56-88	
24	10-42	8-48		76	58-90	52-92
26	12-44			78	60-92	
28	14-46	8-52		80	64-92	56-96
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34	18-52			86	70-96	
36	20-54	16-60		88	74-96	68-96
38	22-56			90	76-98	
40	22-58	16-64		92	78-98	72-100
42	24-60			94	82-98	
44	26-62	20-68		96	86-100	80-100
46	28-64			98	90-100	
48	30-66	24-72		100	96-100	92-100
50	32-68					

Notice that if you pick the lower score (44%) anything larger than 62% would be significant.

Notice that if you pick the higher score (68%), anything smaller than 50% would be significantly different.

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Some examples of using the critical difference chart:

- A patient with a score of 72% in the right ear, and 60% in the left, asks you if his speech understanding is better in one ear? You say "No" (because it isn't).

- You just did testing for a post-op stapedectomy, and the patient's word rec score dropped from 88% on the pre-op to 76% on post op. Do you tell the physician or state in chart notes that word recognition dropped following surgery?
  No (because it didn't).

- Three years ago, a patient's score in her right ear was 92%, today it's 74% and she asks if it's gotten worse? You say: Yes (because it has).

Step 5: Always use “red flag” chart to determine when a word recognition score is unusually low.

Reasons why?

- We know that word recognition decreases when hearing loss is present, but it’s difficult to know when the descrease is greater than what would be expected from a cochlear pathology.
- The chart provided by Dubno provides guidance (Note: Only can be used if patient was tested with 50-word list of NU-6, Auditec of St. Louis recording).

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- Take the pure-tone average for 500, 1000 and 2000Hz.
- Note the speech recognition score that would be abnormally low for this average.

PTA	CUT-OFF SCORE
0.0	98
1.7	96
3.3	96
5.0	96
6.7	94
8.3	94
10.0	92
11.7	92
13.3	90
15.0	90
16.7	88
18.3	86
20.0	86
21.7	84
23.3	82
25.0	80
26.7	78
28.3	76
30.0	74
31.7	72
33.3	70
35.0	68
36.7	66
38.3	64
40.0	62
41.7	60
43.3	58
45.0	56
46.7	52
48.3	50
50.0	48
51.7	46
53.3	44
55.0	42
56.7	40
58.3	38
60.0	38
61.7	36
63.3	34
65.0	32
66.7	30
68.3	30
70.0	28
71.7	26

This is for previous sample patient who had a 44% speech recognition and 52 dB PTA.

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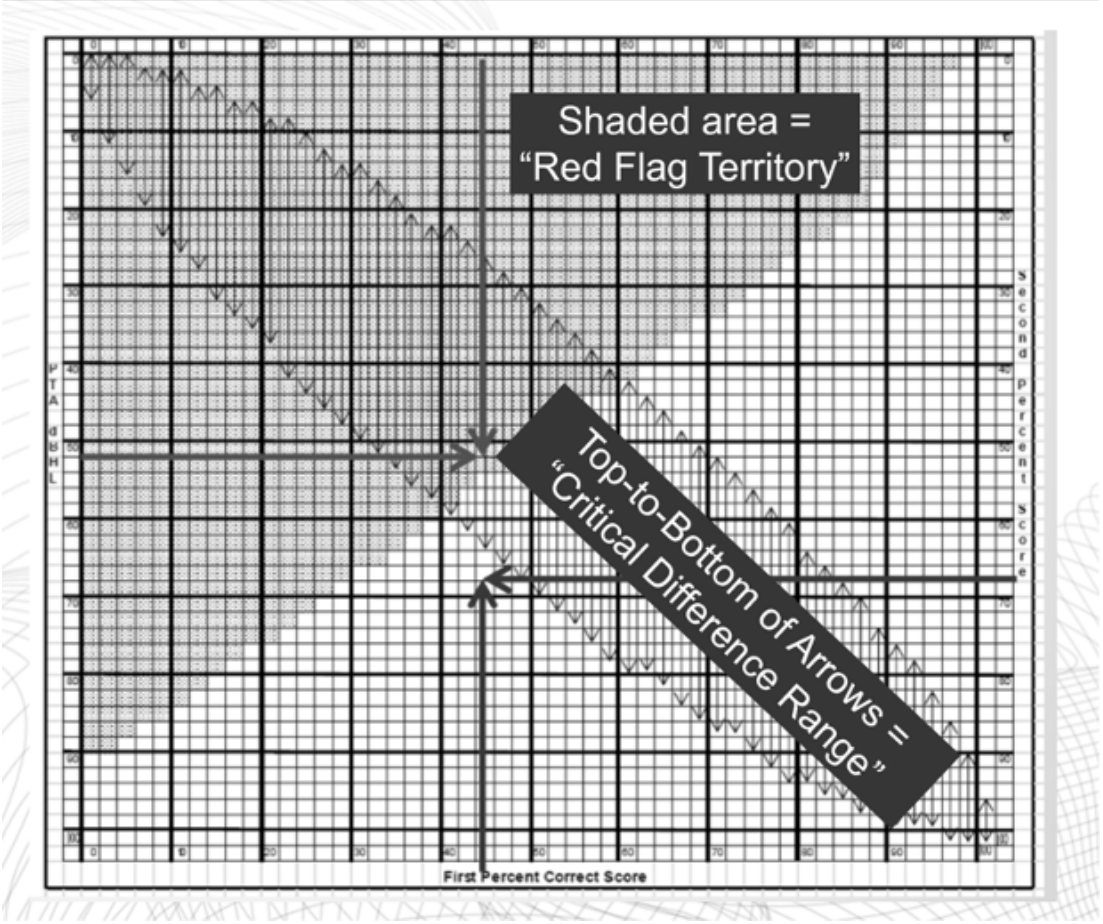
The Linda Thibodeau SPRINT chart combines the critical difference data, and the “red flag” data



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TIP #1

ALWAYS USE A PRESENTATION LEVEL THAT ENSURES AS MUCH AUDIBILITY AS POSSIBLE WITHOUT BEING UNCOMFORTABLY LOUD.

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TIP #2

ALWAYS USE A COMPLETE 50-WORD LIST
(UNLESS THE PATIENT PASSES AN “ORDERED BY DIFFICULTY” SCREENING).

TIP #3:

ALWAYS USE THE AUDITEC NU-6 ORDERED BY DIFFICULTY (VERSION II) RECORDING AND CONCLUDE TESTING IF THE PATIENT PASSES THE SCREENING GUIDELINES.

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GUS AND BEN'S TIP #4

ALWAYS USE THE THORNTON AND RAFFIN CHART TO DETERMINE WHEN A DIFFERENCE REALLY IS A DIFFERENCE.

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GUS AND BEN'S TIP #5

ALWAYS USE THE DUBNO DATA (SPRINT CHART) TO DETERMINE WHEN A SPEECH RECOGNITION SCORE IS ABNORMALLY LOW

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What if an HCP was bold enough to conduct live-voice speech recognition testing?

- You cannot compare to previous testing.
- You cannot compare one ear to the other.
- You cannot use the Thornton-Raffin critical differences.
- You cannot use the Dubno “red flag” data.
- You cannot use the 10-word screening.

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RESEARCH QUICK TAKES

6.2: Hearing Aid Fitting Toolbox: Speech-in-noise testing.

Brian Taylor & Gus Mueller

Let’s do a little comparison to our friends in optometry…

You walk into their office with a complaint of trouble seeing things at a distance. What do they do?

Have you read the Snellen Eye Chart at distance of 20 feet.

What if your main problem is reading magazines and newspapers?

They have you read different size print at arms length.

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Life sounds brilliant.

Trouble differentiating colors?

They conduct a standardized color differentiation test

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Life sounds brilliant.

So now let’s jump to Hearing Care Professionals

- The typical new potential hearing aid candidate walks in the door with the complaint of understanding speech in background noise.
- What does the average HCP do?

Assess speech understanding in quiet!

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Life sounds brilliant.

Consider the following data from Richard Wilson's research based on comparing speech-in-quiet vs. speech-in-noise findings for over 3000 individuals:

- Approximately 70% of the patients had speech recognition performance in quiet (NU-6) that were good or excellent, but only 6.9% of these very same patients had normal speech-in-noise scores.

- Of the total, only 222 (6%) had normal performance for the speech-in-noise test; 218 (98.5%) of these same patients also had normal performance for the NU#6.

The point being . . . if speech-in-noise is normal, there is no reason to test speech-in-quiet.

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Reasons for routinely conducting speech-in-noise testing

- Most patients report that understanding speech in background noise is the reason they are considering the use of hearing aids. To *not* do testing to examine the patient's primary complaint is illogical and not fair to the patient.

- The testing will help identify an ear-asymmetry that might exist that was not present in the pure-tone audiometric results.

- For patients with normal, or near-normal hearing, speech-in-noise testing might reveal why the patient is having problems, and help guide the potential of a hearing aid fitting ("Hidden" hearing loss may not really be "hidden").

Reasons for routinely conducting speech-in-noise testing

- The results of the testing will help with decisions regarding hearing aid technology and assistive devices.

- The pre-fitting speech-in-noise results will provide values that later can be used to determine the "goodness" of the subsequent fitting (e.g., aided performance should be at least as good as the optimum earphone score).

- The results of the testing will be very useful for counseling, both at the time of the fitting and on follow-up visits. This testing will help the HCP provide realistic expectations for the patient when he or she is using the hearing aids in the real world.

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The QuickSIN: A reasonable choice for clinicians

- Recorded with 6 different S/N ratios
- Six sentences/list; only one sentence at each level (yes, it is quick!)
- Female talker with four competing talkers (yes there is informational masking)
- Recommended presentation level: 70-75 HL, or “Loud, But Okay” loudness rating
- Very easy to administer (use two lists) Fairly easy to score (automated scoring with many audiometers)

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The QuickSIN: A sample list of six scored sentences

List 1		**Score**
1. A white silk jacket goes with any shoes.	S/N 25	5
2. The child crawled into the dense grass.	S/N 20	5
3. Footprints showed the path he took up the beach.	S/N 15	4
4. A vent near the edge brought in fresh air.	S/N 10	3
5. It is a band of steel three inches wide.	S/N 5	2
6. The weight of the package was seen on the high scale.	S/N 0	0
25.5 - TOTAL = ***6.5*** SNR Loss	**TOTAL**	19

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Suggested interpretation of QuickSin SNR Loss findings:

- **0-3 dB**: Normal or near-normal
- **4-7 dB**: Mild
- **8-15 dB**: Moderate
- **>15 dB:** Severe

Note 1: The QuickSIN is scored as SNR-Loss, not SRT-50. That is, the average performance for normal (2 dB SNR) is subtracted from the SRT-50 to calculate SNR-Loss (deviation from normal hearing).

Note 2: Research by McArdle and Wilson (2006) revealed that Lists 4, 5,13 and 16 were not within critical range for people with hearing loss.

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The QuickSIN: Critical difference values are available

Lists per Condition	1	2	3	4	5	6	7	8	9
95% C.D. ±, in dB	3.9	2.7	2.2	1.9	1.7	1.6	1.5	1.4	1.3
90% C.D. ±, in dB	3.2	2.2	1.8	1.6	1.4	1.3	1.2	1.1	1.1
80% C.D. ±, in dB	2.5	1.8	1.5	1.3	1.1	1.0	1.0	0.9	0.8

Note: Research by McArdle and Wilson (2006) revealed that Lists 4, 5,13 and 16 were not within critical range for people with hearing loss

Clinical use of speech-in-noise test findings #1:

- Patient (a young woman) says she is really struggling to understand at work; exhausted at the end of the day.
- Her pure-tone thresholds are no worse than 15 dB at any frequency, and she scored 100% on the NU#6 monosyllabic words-in-quiet list. Immittance/reflexes also normal.

Her QuickSIN scores are 5 dB for the right ear, and 6 dB for the left.

Clinical use of speech-in-noise test findings #1:

- Without SIN results: You might think she has some other things going on in her life? Not doing well at work? Maybe she just gets frustrated easily? Maybe she has attention problems?

After SIN testing: You quickly realize she has a legitimate complaint and a real problem, and counsel accordingly. Hearing aid candidate . . . Maybe.

Clinical use of speech-in-noise test findings #2:

- Patient with bilateral high-frequency loss really wants the smallest iCIC products available, although you know that he will do much better in background noise using bilateral beamforming mini-BTEs.

His QuickSIN scores are 2 dB for right ear and 1.5 dB for the left.

Clinical use of speech-in-noise test findings #2:

- Without SIN results: You promote all the advantages of directional processing, point out that the mini-BTE style really isn't all that visible—you can match his hair color, etc.

After SIN testing: You realize that if you just give him good audibility, he will do as well in background noise as someone with normal hearing—he doesn't really need directional processing. Maybe just let him have the style he wants.

Clinical use of speech-in-noise test findings #3:

- Patient insists that she will only wear one hearing aid (for now at least).
- Hearing loss is 40-60 dB, fairly symmetrical, and word recognition is 84-88% in both ears

Her QuickSIN scores are 5 dB for right ear and 10 dB for the left.

Clinical use of speech-in-noise test findings #3:

- Without SIN results: You have a discussion with her regarding what ear to fit. Maybe go with the ear she uses on the phone? Ask her preference? Talking in a car matter—driver or passenger?

After SIN testing: With confidence, you are going to fit the right ear, the ear with the best QuickSIN score.

Clinical use of speech-in-noise test findings #4:

- Patient is anxious to obtain hearing aids as he is having trouble understanding dinner at his two favorite restaurants. This is item #1 on his COSI.
- You've been to those restaurants (or ones like them) and know that the SNR is about +8 dB (using your handy cell phone app).

His QuickSIN scores are 4 dB for both ears.

Clinical use of speech-in-noise test findings #4:

- Without SIN results: You will be more or less neutral in your counseling, not trying to get his hopes up about understanding in a noisy restaurant.

After SIN testing: With confidence, you know that with good directional processing, and his relatively good QuickSIN performance, with his new hearing aids he should understand most everything in his favorite restaurants.

Clinical use of speech-in-noise test findings #5:

- Patient is anxious to obtain hearing aids as she is having trouble understanding dinner at her two favorite restaurants. This is item #1 on her COSI.
- You've been to those restaurants (or ones like them) and know that the SNR is about +2 dB (using your handy cell phone app).

Her QuickSIN scores are 12 dB for the right and 14 dB for the left.

Clinical use of speech-in-noise test findings #5:

- Without SIN results: You will be more or less neutral in your counseling, not trying to get her hopes up about understanding in a noisy restaurant, expecially the level of noise in her favorite ones.

After SIN testing: With confidence, you know that she has no chance of understanding in these restaurants, even with the best hearing aid technology available. You immediately start conducting realistic counseling, mention the advantage of using remote microphones (or finding restaurants that are much less noisy).

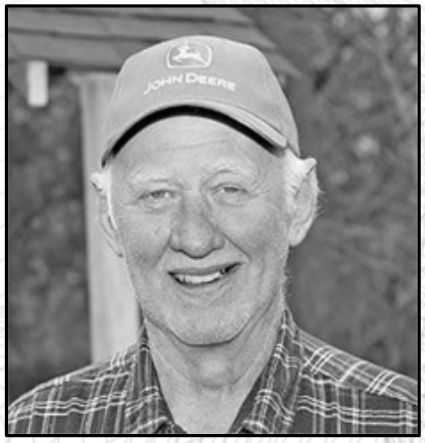
Clinical use of speech-in-noise test findings #6:

- Patient (80-year-old male), using bilateral amplification, says he thinks his right hearing aid isn't working right. Mentions he did have mild stroke about 6-months ago.
- Comparing test results to when he was fitted two years ago: Hearing levels have not changed significantly, nor has word recognition in quiet (~80% in both ears).

QuickSIN scores went from 6 dB to 7 dB for left ear,

but 6 dB to 12 dB for right ear.

Clinical use of speech-in-noise test findings #6:



- Without SIN results: You will conclude that his “hearing” hasn’t changed, and therefore perhaps there really is something wrong with the hearing aid, and you do hearing aid check/electroacoustic measures.

After SIN testing: You recognize that it’s very likely that his complaint is related to his large decrease in speech-in-noise recognition for the right ear, probably related to the stroke. You still may check the hearing aid, but will not be surprised when it checks out fine.

Clinical use of speech-in-noise test findings #7

- Patient just purchased hearing aids a week ago. Specifically was interested in doing better in background noise.
- Back today saying that the hearing aids do not provide any improvem[illegible] in background noise—seriously th[illegible] turning them.

What if we did aided QuickSIN testing in the soundfield?

QuickSIN s[illegible] 8 dB for right ear and 9 dB for the left.

Two possible approaches:

- Conduct soundfield aided bilateral QuickSIN at average-speech level (e.g., 62-65 dB SPL or roughly 50 dB HL)
  - This should help convince YOU that all is well if patient performs at pre-fitting level (should do even slightly better)
- Conduct soundfield aided bilateral QuickSIN at soft-speech level (e.g., 50-55 dB SPL or roughly 40 dB HL)
  - This should help convince THE PATIENT that hearing aids really do work in background noise.

Earphone Pre-testing: Step-by-step test protocol

- Seat patient, give instructions and fit with insert earphones.
- Use the standard QuickSIN recording. Only use the ten lists that are equivalent: 1, 2, 3, 5, 6, 8, 9, 10, 11, and 12.
- Select a presentation level of 70-75 dB HL, or use 5 dB below the speech LDL (patient rating of “Loud, But Okay”).
- Select appropriate masking (speech noise) for the non-test ear: 30 dB below presentation level is usually satisfactory, unless bilateral conductive loss is present.
- Present two QuickSIN lists to each ear. Take average of these two scores for the SNR-Loss for each ear. Test each ear independently; there is no need to test bilaterally, the bilateral score will not be significantly different from the “best ear” score.
- Use the critical difference chart to determine if the right and left ear scores are significantly different, and/or if the scores obtained are different from previous testing.
- Use the SNR-Loss results to counsel the patient regarding expectations with hearing aids (e.g., does he just need audibility, or, advanced directional technology, or, assistive listening devices?).

Verification Testing: Step-by-step test protocol

- Establish HL to SPL difference for calibrated location in soundfield where patient will be sitting (e.g., read SPL values for running speech for fixed HL).
- Seat patient in soundfield calibrated position, and give instructions. Fit the patient with hearing aids programmed to use settings (e.g., NAL-NL2)
- Use the standard QuickSIN recording. Only use the ten lists that are equivalent: 1, 2, 3, 5, 6, 8, 9, 10, 11, and 12.[6]
- Select a presentation level that will result in 65 dB SPL at the calibrated soundfield location (this will be around 50 dB HL, but can vary with equipment/setting).
- Testing conducted aided bilaterally (unless unilateral fitting). Present two QuickSIN lists. Take average of these two scores for the SNR-Loss.
- Use the critical difference chart to determine if these scores or as good or better than the earphone scores. If significantly worse than the earphone scores, re-programming the hearing aids should be considered.
- Use the SNR-Loss results to counsel the patient regarding expectations with hearing aids (e.g., does the patient just need audibility, or, advanced directional technology, or, assistive listening devices?).

Benefit Demonstration: Step-by-step test protocol

- Establish HL to SPL difference for calibrated location in soundfield where patient will be sitting (e.g., read SPL values for running speech for fixed HL).
- Seat patient in soundfield calibrated position, and give instructions.
- Use the standard QuickSIN recording. Only use the ten lists that are equivalent: 1, 2, 3, 5, 6, 8, 9, 10, 11, and 12.
- Select a presentation level that will result in 55 dB SPL at the calibrated soundfield location (this will be around 40 dB HL, but can vary with equipment/setting).
- Testing first conducted bilaterally unaided. Two QuickSIN lists. Take average of these two scores for the SNR-Loss.
- Patient is then fitted bilaterally (unless unilateral fitting) to appropriate use setting (NAL-NL2) and aided bilateral testing is conducted. Two QuickSIN lists. Take average of these two scores for the SNR-Loss.
- Use the critical difference chart to determine if the aided scores are better than the unaided scores.
- Use the SNR-Loss results to counsel the patient regarding aided hearing aid benefit. We have found it beneficial to convert to percent of words correct for each SNR ratio.

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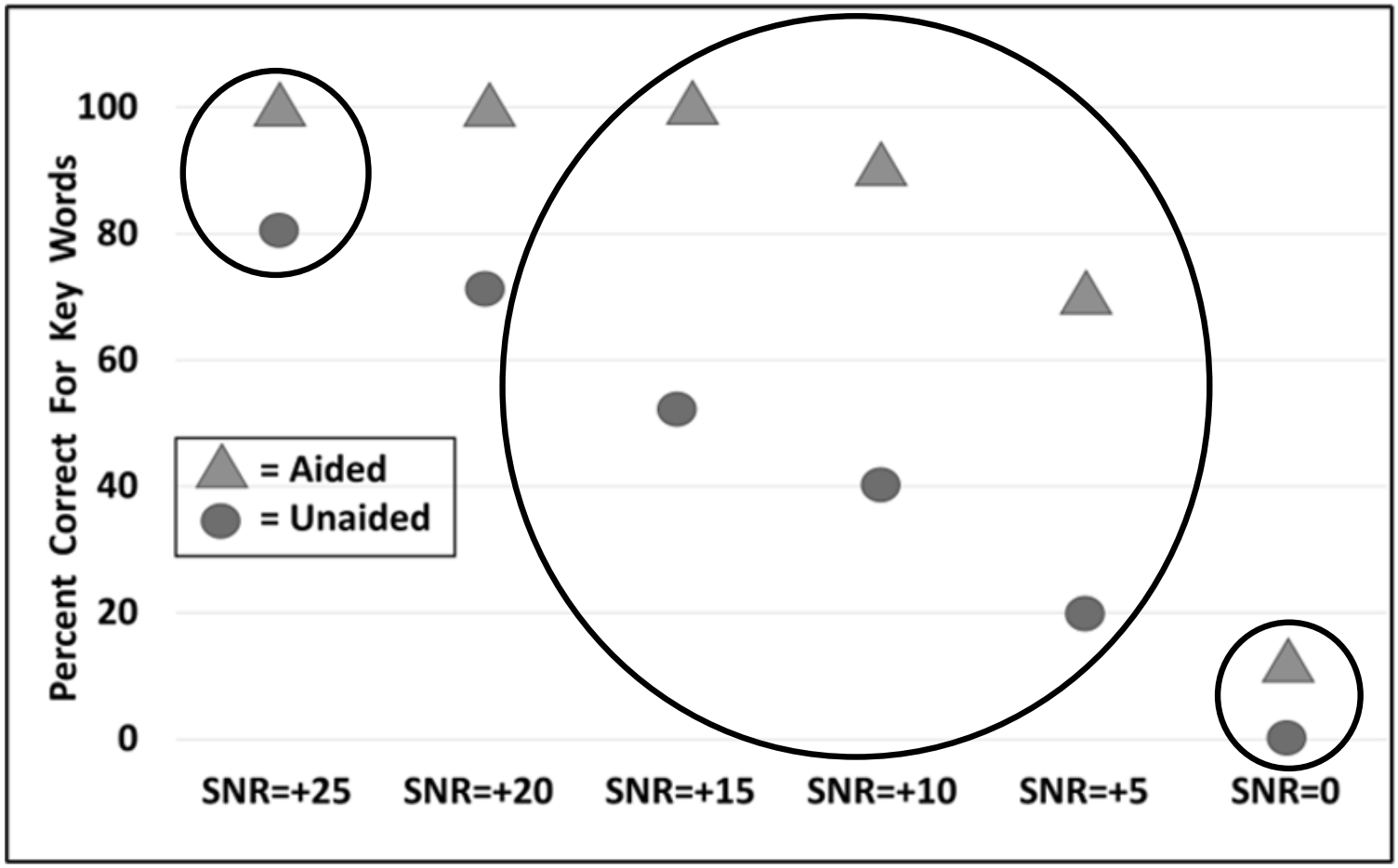

Percent Correct For Key Words
100
80
60
40
20
0
= Aided
= Unaided
SNR=+25
SNR=+20
SNR=+15
SNR=+10
SNR=+5
SNR=0

RESEARCH QUICK TAKES

6.3: Hearing Aid Fitting Toolbox: Getting the maximum output right.

Brian Taylor & Gus Mueller

We need our AGCo set not too “hot” and not too “cold”—but “Just Right”

Option 1: Let the manufacturer do it for you

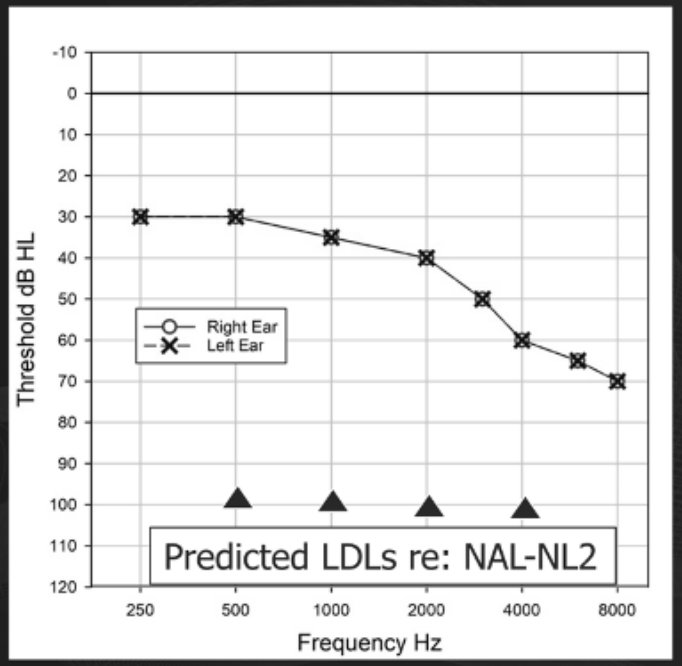
Option 2: Use average values based on degree of hearing loss

Option 3: Measure and apply (a DIY project)

Option 1: Let the manufacturer do it for you

This can be very risky

Recent MPO study—What are the typical manufacturer's settings?



Using this audiogram we:

- Programmed the premier hearing aid from the six major manufacturers to NAL-NL2.
- In a 2-cc coupler, the MPO for each product was assessed (swept tone of 90-dB-SPL)
- The MPO indicated in each manufacturer's fitting software was compared to that prescribed by the NAL (stand-alone software)

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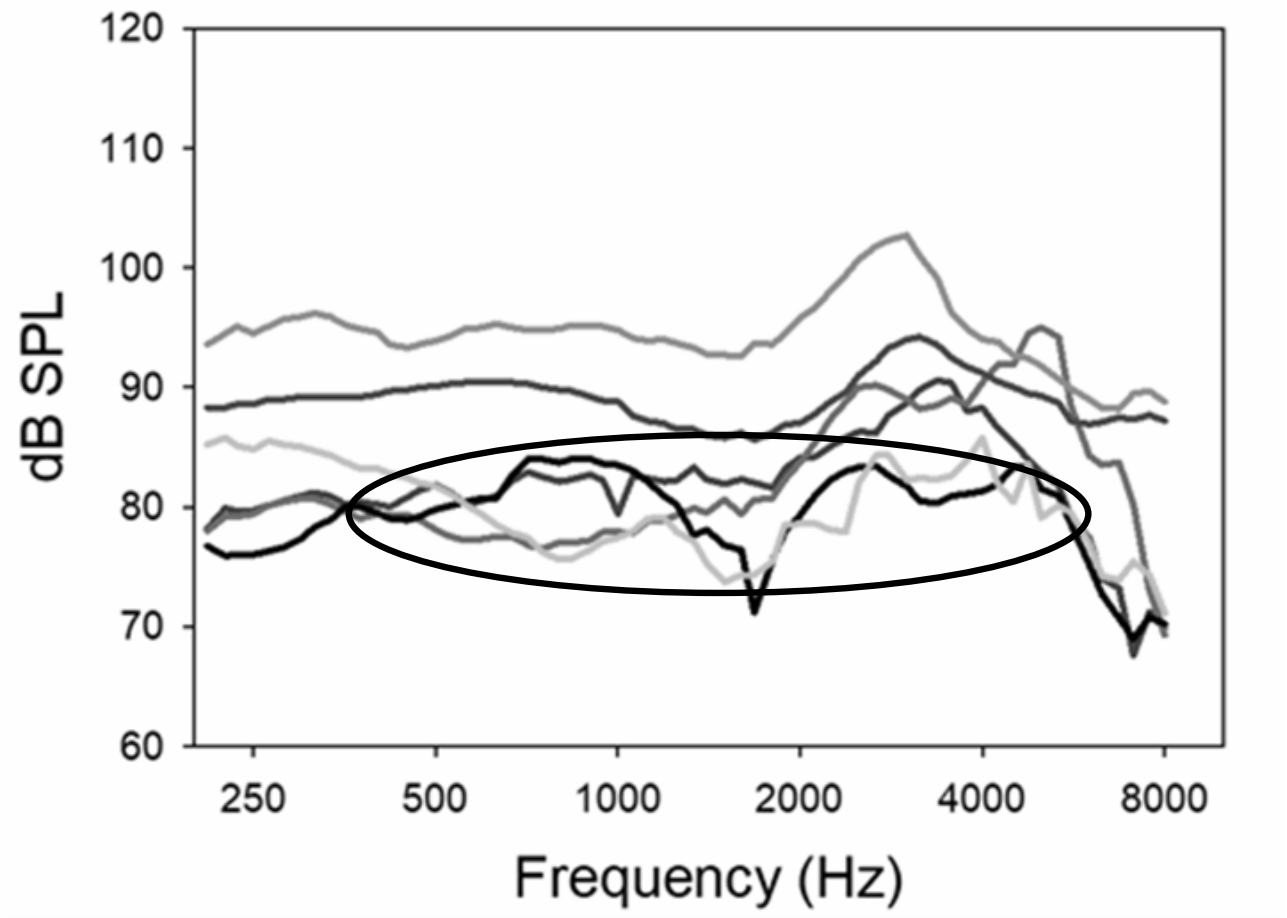
Resulting MPOs for the six instruments



Noisy restaurant outing: Background noise is ~75 dB SPL (not uncommon)

She raises her voice to ~80-82 dB SPL to overcome background noise (as people will do)

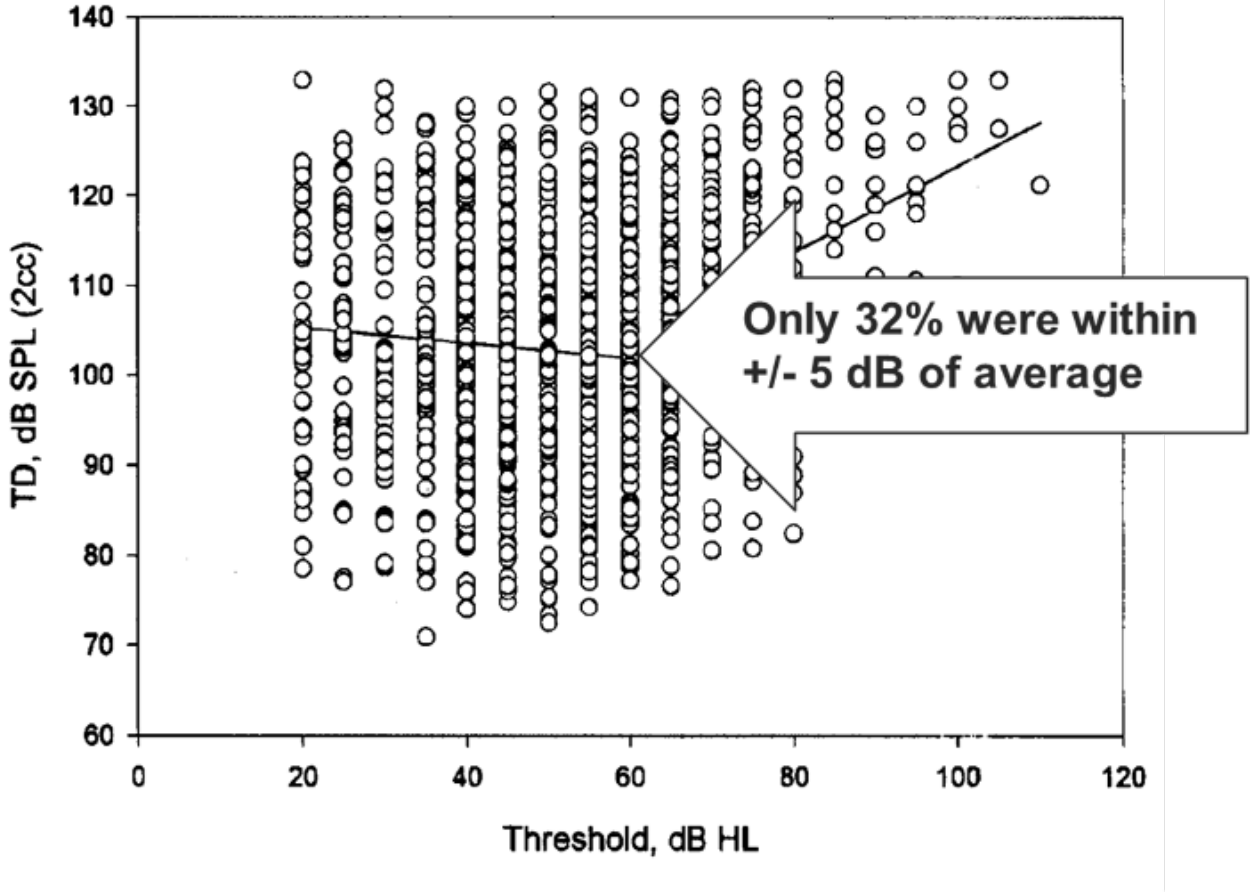
Wearing hearing aids with the max output set to ~75-78 dB SPL

When the patient walks into your office with this problem on Monday morning, how many of your would raise the MPO?

~~Option 1: Let the manufacturer do it for you~~

Option 2: Use average values based on degree of hearing loss

Results from 508 ears with confirmed cochlear hearing loss



~~Option 1: Let the manufacturer do it for you~~

~~Option 2: Use average values based on degree of hearing loss~~

Option 3: Measure and apply (a DIY project)

Step 1: Measuring the frequency-specific LDLs

- It usually is most efficient to conduct LDL testing at the same time that the patient receives the pre-fitting audiogram.
- Testing is conducted under earphones using pulsed pure tones, for each ear independently.
- For a typical audiogram, it usually is adequate to only test two frequencies/ear (e.g., even with hearing losses that might have 50 dB differences between the low and high frequencies, because of the nature of loudness growth functions, LDLs may only differ by 5-10 dB).
- The two frequencies selected should be at the lower and higher boundaries of the key frequencies that are being amplified; the frequencies selected should be regions where applying gain is desired (not too normal, not too severe).
- An ascending method is used, either 2- or 5-dB steps. It is critical that the patient is provided a chart of loudness anchors, which they will then use for their responses. Starting around the expected MCL of the patient, the test signal is increased until a #7 response is given, which is the LDL. Conduct two runs to ensure reliability.
- The instructions are very important, and should be read to the patient .

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Loudness Anchors

#7 Uncomfortably Loud

#6 Loud, But Okay

#5 Comforable, But Slightly Loud

#4 Comfortable

#3 Comfortable, But Slightly Soft

#2 Soft

#1 Very Soft

INSTRUCTIONS FOR LOUDNESS TEST

THE PURPOSE OF THIS TEST IS TO FIND YOUR JUDGMENTS OF THE LOUDNESS OF DIFFERENT SOUNDS.

YOU WILL HEAR SOUNDS THAT INCREASE AND DECREASE IN VOLUME. YOU MUST MAKE A JUDGMENT ABOUT HOW LOUD THE SOUNDS ARE. PRETEND YOU ARE LISTENING TO THE RADIO AT THAT VOLUME. HOW LOUD WOULD IT BE?

AFTER EACH SOUND, TELL ME WHICH OF THESE CATEGORIES BEST DESCRIBES THE LOUDNESS.

KEEP IN MIND THAT AN UNCOMFORTABLY LOUD SOUND IS LOUDER THAN YOU WOULD EVER CHOOSE ON YOUR RADIO NO MATTER WHAT MOOD YOU ARE IN.

HARL
Hearing Aid Research Lab

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	R				FREQUENCY				L							
	500 Hz				3000 Hz				1000 Hz				3000 Hz			
HL	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
120																
115														7		
110													7	6		
105					7	7			7				6	6		
100		7			6	6			6	7			6	5		
95		6	7		6	6			6	6			5	5		
90	7	6	6		6	5			6	6			5	5		
85	6	6	6		5	5			5	5			5	5		
80	6	5	5		5	5			5	5			4	4		
75	5	5	5		5	4			5	5			4	4		
70	5	5	5		4	4			4	4			4			
65	4	4			4	4			4	4			3			
60	4	4			4				4							
55																
50																
45																
40																
35																
30																
25																
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15																
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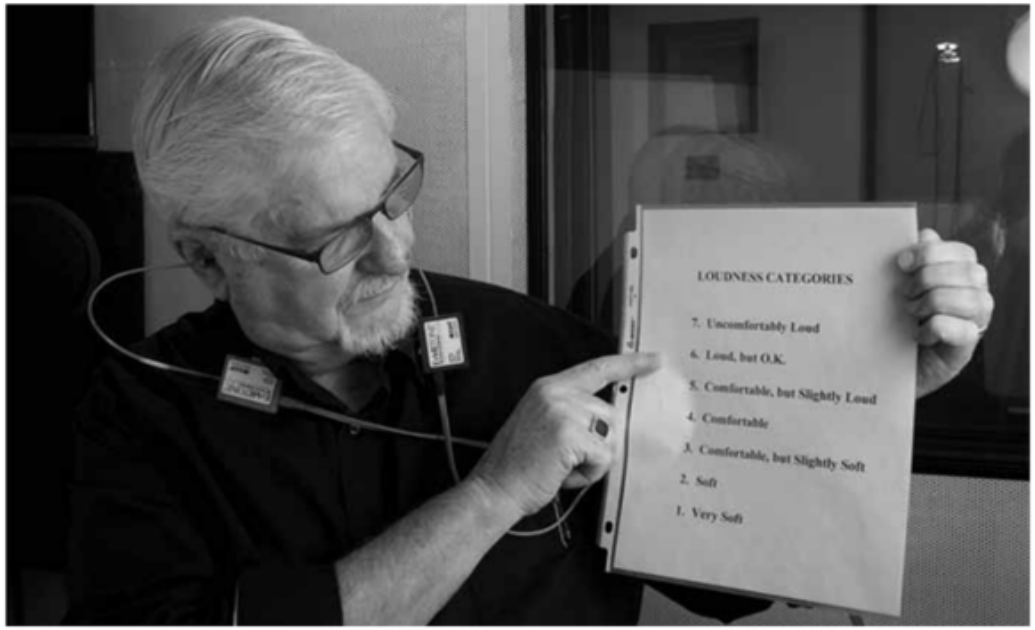

Step 2: Converting the measured LDLs from HL to 2-cc coupler SPL.

- This is accomplished using the reference equivalent threshold sound pressure levels, which go by the acronym RETSPLs (pronounced Rhet-Spulls). These are the same values that are used when insert your earphones are calibrated.
- RETSPLs tend to vary a little from study to study, but here are some average values (insert earphones) that work well (which will be added to the HL LDL values): 500 Hz=8 dB, 1000 Hz=3 dB, 2000 Hz=5 dB, 3000 Hz=3 dB, and 4000 Hz=7 dB.
- For practice, we'll take a patient, with a typical downward sloping loss, whose LDLs are 92 dB at 1000 Hz, and 104 dB at 3000 Hz. So, for 1000 Hz, we'll add the RETSPL of 3 dB and obtain a 2-cc coupler value of 95 dB SPL. For 3000 Hz, which also has a 3 dB RETSPL, we'll add this to the HL LDL of 104 dB, and obtain the 2-cc coupler value of 107 dB SPL.
- Armed with these 2-cc coupler values, we then go to "MPO Programming" in the software, and adjust the frequency-specific handles so that we obtain our desired 2-cc coupler output levels

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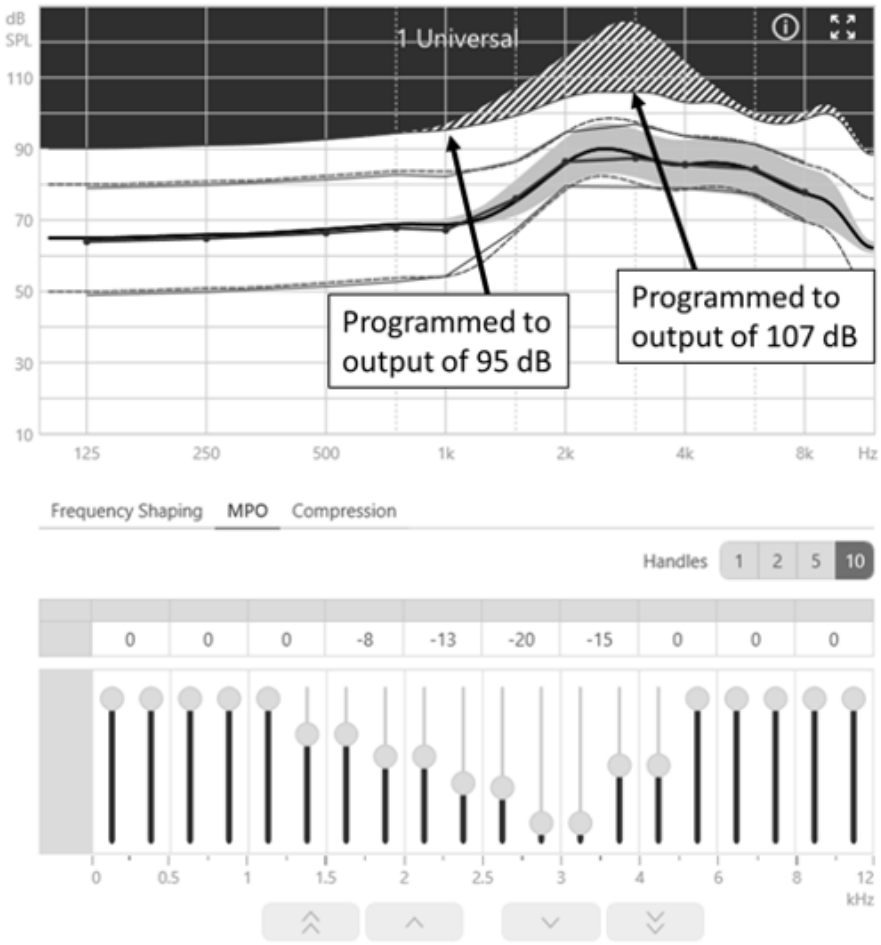
Step 3: Going to manufacturer's software and applying the correct MPO settings.

- Open the fitting software for the patient, and go to the screen where it's possible to set the MPO. Apply the newly calculated 2-cc coupler output values.
- With some manufactures, you simply can scroll through output values until the desired value is obtained. With other systems, such as Signia, it's a matter of reducing the output on the screen to the desired levels.
- Adjust the setting appropriately for the measured LDLs. Once this is accomplished, interpolate and adjust the surrounding frequencies accordingly to obtain a smooth output curve.
- Conduct this for both ears, assuming it's a bilateral fitting.



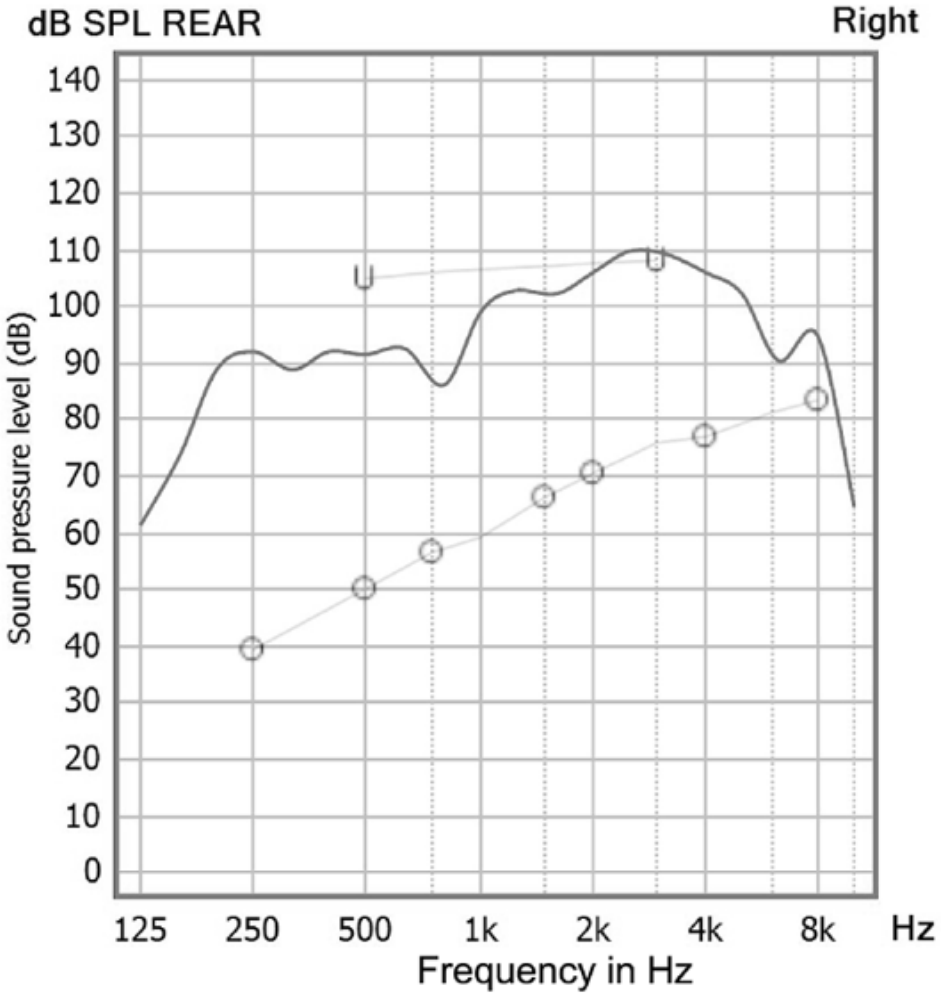
Application of the 2-cc values that were derived earlier (95 and 107 dB) by adding the RETSPL to the HL LDL

For this software, the sliders on the bottom simply are adjusted to obtain the correct values.

For all frequencies other than the measured LDLs, sliders were adjusted to give a smooth output following the predicted pattern

Step 4: Real-ear verification using REAR85 measure.

- The hearing aids should be programmed to the NAL-NL2 or DSL fitting algorithm. If this is a new user, and it has been determined to initially fit the patient under target, for this REAR85 measure, adjust to the true target.
- A swept tone is delivered at 85 dB SPL and the output is displayed on the fitting screen.
- The output of this measure is compared to the earcanal SPL LDLs displayed on the screen.
- If a good match is not obtained, go to the MPO programming and adjust frequency specific output so that it falls just below the LDL for all frequencies.
- It is possible that if it is an open fitting, and the patient still has significant residual earcanal resonance (e.g., 15 dB or more), the observed curve may be the REOR (directly input) rather than the REAR85 (hearing aid output). In this case, of course, changing the programmed MPO will not alter the observed curve. It is helpful to conduct an REOR just before the REAR85 (same input but with the hearing aid muted), as this output will then be stored on the screen for comparison.



The MPO in the 3000 Hz region is a little too high. We would move the AGCo kneepoiont down ~5 dB for this region.

It appears that the MPO is limiting too much in the lows—it's probable however that this is simply because there is little gain for high inputs in this area, due to the patient's hearing loss

Step 5: Behavioral verification

- Once the REAR85 measure and programming (if necessary) is complete, the patient remains seated in front of the probe-mic equipment with the probe assembly still attached.
- The patient is given the Loudness Anchors chart and the instructions are repeated.
- Select a noise signal. For this measure we typically use both speech babble and vacuum cleaner noise. For both, we would expect a rating of #6. A rating of #5 is okay. In nearly all cases, this will be the finding.
- If the patient gives a rating of #7, repeat the measure a few times—often the patient is initially startled by the noise, and ranks it higher than it really is. If the patient consistently rates the noise #7, then go to the programming software and reduce the MPO in the region where the peak appears. Repeat until a #6 rating is obtained.

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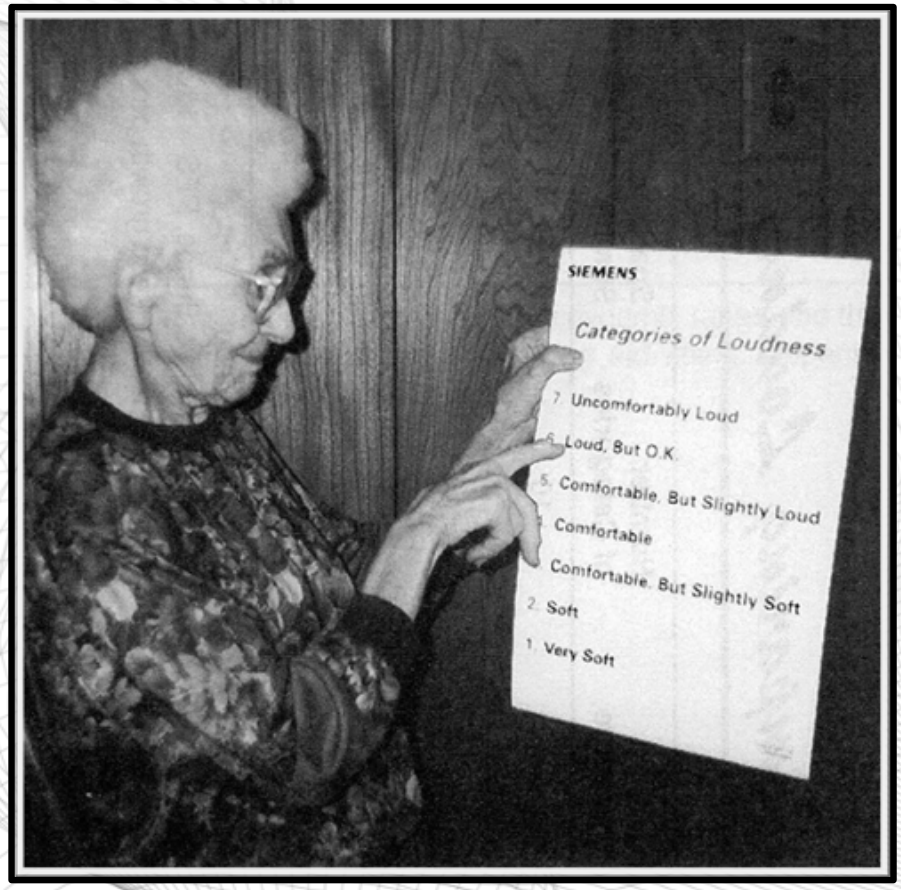
Bernice Mueller verifies hearing aids were set “just right” by her son!



RESEARCH QUICK TAKES

6.4: Hearing Aid Fitting Toolbox: Pre-fitting needs assessment

Brian Taylor & Gus Mueller

Reasons to use pre-fitting self-assessment scales

- Assist in determining if a patient is a candidate for hearing aids. A pre-fitting test such as the Hearing Handicap Inventory for the Elderly/Adult (HHIE/A) is as useful as the pure-tone audiogram for determining who will use and benefit from hearing aids.

- Determine the need for pre-fitting counseling. The pre-fitting assessment that shows scores that are very inconsistent with other audiometric findings can signal denial of the hearing problem.

- Assist in establishing realistic expectations. When the pre-fitting Client Oriented Scale of Improvement (COSI) is constructed, it's important to note the situations selected by the patient, and their expected outcomes. Are they realistic?

Reasons to use pre-fitting self-assessment scales

- Establishing a baseline. Many pre-fitting self-assessment inventories also can be used as an outcome measure. Did the hearing aids provide the expected improvement in benefit and satisfaction? Did they reduce the hearing handicap?

- Assist in establishing goals to select and prioritize technology. Does the patient report difficulties in background noise that warrant assistive listening devices?

- Quality Assurance Management. The pre-fitting scores for a scale such as the HHIE/A can be analyzed over time for groups of patients, and then compared to norms, or previous clinical encounters.

Considerations when selecting pre-fitting self-assessment scales

- Researched for reliability and validity
- Clinical norms available
- Addresses unique domains
- Easy to administer and score
- Can be used as baseline for measuring benefit
- Results relatable to the patient

Hearing Handicap Inventory for the Elderly/Adult (HHIE/A)

- Perhaps the oldest and most well-known self-assessment scale related to the pre-fitting of hearing aids is the HHIE. As the name suggests, this scale assesses handicap—specifically related to the emotional and social aspects of having a hearing loss.

- The adult version (HHIA) is very similar to the elderly version (HHIE)—the usual cut-off is 65 years of age, but someone over 65 who is still active and/or employed would be given the adult version.

- The original versions of both are 25 questions, however, research has shown the shortened versions (10-items) have comparable reliability and validity. We recommend the 10-item versions. They were designed to have questions that fall into two general areas: emotional and social/situational. Normally, the two categories are combined for one single test score for the ten items.

Administration and scoring of HHIE/A

- The HHIE could be completed in the waiting room prior to testing, or mailed to the patient to complete before the clinic visit. It is recommended, however, that HHIE items be read to the patients face-to-face.

- For each of the 10 questions of the HHIE/A, the patient has the choice of three answers: Yes (scored 4 points), Sometimes (scored 2 points), and No (scored 0 points).

- Once completed, the scores for the 10 items simply are added, with 40 representing the highest (worse) score, a very significant handicap.

- The general guidelines for interpreting the results are: 0–8: No significant perception of a hearing handicap, 10–22: Mild to moderate perception of a hearing handicap, >22: Perception of a severe handicap.

Hearing Handicap Inventory Screening Version (HHIE-S)

The purpose of this scale is to identify the problems your hearing loss may be causing you. Please select YES, SOMETIMES, or NO for each question. Do not skip a question if you avoid a situation because of your hearing problem. If you use a hearing aid, please answer the way you hear with the hearing aid.

E-1. Does a hearing problem cause you to feel embarrassed when meeting new people?	YES ☐	SOMETIMES ☐	NO X
E-2. Does a hearing problem cause you to feel frustrated when talking to members of your family?	YES ☐	SOMETIMES X	NO ☐
S-3. Do you have difficulty hearing when someone speaks in a whisper?	YES X	SOMETIMES ☐	NO ☐
E-4. Do you feel handicapped by a hearing problem?	YES ☐	SOMETIMES ☐	NO X
S-5. Does a hearing problem cause you difficulty when visiting friends, relatives, or neighbors?	YES ☐	SOMETIMES X	NO ☐
S-6. Does a hearing problem cause you to attend religious services less often than you would like?	YES ☐	SOMETIMES ☐	NO X
E-7. Does a hearing problem cause you to have arguments with family members?	YES ☐	SOMETIMES ☐	NO X
S-8. Does a hearing problem cause you difficulty when listening to TV or radio?	YES ☐	SOMETIMES X	NO ☐
E-9. Do you feel that any difficulty with your hearing limits or hampers your personal or social life?	YES ☐	SOMETIMES ☐	NO X
S-10. Does a hearing problem cause you difficulty when in a restaurant with relatives or friends?	YES X	SOMETIMES ☐	NO ☐

Total Score: **14 (equivalent to 35 on full HHIE)**

General Interpretation of Scores:

- 0–8: No significant perception of a hearing handicap
- 10–22: Mild to moderate perception of a hearing handicap
- >22: Perception of a severe handicap.

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Abbreviated Profile Hearing Aid Benefit (APHAB)

- We would guess that the second most popular self-assessment scale is the APHAB, a scale developed by Robyn Cox and colleagues at the University of Memphis.

- Although normally thought of as an outcome measure, the APHAB also is a popular pre-fitting tool for one main reason: to calculate benefit with hearing aids, we need an unaided baseline.

- Cox states the following reasons for using the APHAB: Predict success from unaided scores, use the unaided scores for patient counseling, compare results with different hearing aids, measure benefit from the fitting, compare group outcomes over time or for different clinics

The APHAB is composed of 24 items that are scored in four subscales (six questions each):

Ease of Communication (EC): The strain of communicating under relatively favorable conditions. “I have difficulty hearing a conversation when I’m with one of my family at home.”

Reverberation (RV): Communication in reverberant rooms such as classrooms. “When I am talking with someone across a large empty room, I understand the words.”

Background Noise (BN): Communication in settings with high background noise levels. “When I am listening to the news on the car radio and family members are talking, I have trouble hearing the news.”

Aversiveness (AV): The unpleasantness of environmental sounds. “The sounds of running water, such as a toilet flushing or a shower, are Uncomfortably Loud.”

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Administration and Scoring

- The APHAB can be administered as a paper and pencil test, or using the computer software version (NOAH module). Computer scoring is highly recommended so that the information can quickly and efficiently be used to aid in selection.
- The 24 items of the APHAB are scored on a seven-point scale. A percent value, shown on the form, is designated for each letter answer: A: Always (99%); B: Almost Always (87%); C: Generally (75%); D: Half-the-time (50%); E: Occasionally (25%); F: Seldom (12%); G: Never (1%).
- The questions are specifically designed so that someone with normal hearing and no hearing problems would mark A or B for some questions, but F or G or others.
- The instructions for completing the APHAB are as follows:

  "Please circle the answers that come closest to your everyday experience. Notice that each choice includes a percentage. You can use this to help you decide on your answer. If you have not experienced the situation we describe, try to think of a s imilar situation that you have been in and respond for that situation. If you have no I dea, leave that item blank."

APHAB sample questions

	Without My Hearing Aid	With My Hearing Aid
1. When I am in a crowded grocery store, talking with the cashier, I can follow the conversation	A B C D E F G	A B C D E F G
2. I miss a lot of information when I'm listening to a lecture	A B C D E F G	A B C D E F G
3. Unexpected sounds, like a smoke detector or alarm bell are uncomfortable	A B C D E F G	A B C D E F G
4. I have difficulty hearing a conversation when I'm with one of my family at home	A B C D E F G	A B C D E F G
5. I have trouble understanding dialogue in a movie or at the theater	A B C D E F **(G)**	A B C D E F G
6. When I am listening to the news on the car radio, and family members are talking, I have trouble hearing the news	A B C D E F G	A B C D E F G
7. When I am at the dinner table with several people, and am trying to have a conversation with one person, understanding speech is difficult	A B C D E F G	A B C D E F G
8. Traffic noises are too loud	A B C D E F G	A B C D E F G
9. When I am talking with someone across a large empty room, I understand the words	A B C D E F **(G)**	A B C D E F G
10. When I am in a small office, interviewing or answering questions, I have difficulty following the conversation	A B C D E F G	A B C D E F G
11. When I am in a theater watching a movie or play, and the people around me are whispering and rustling paper wrappers, I can still make out the dialogue	A B C D E F G	A B C D E F G
12. When I am having a quiet conversation with a friend, I have difficulty understanding	A B C D E F G	A B C D E F G
13. The sounds of running water, such as a toilet or shower, are uncomfortably loud	A B C D E F G	A B C D E F G

Reminder:
A=Always
G=Never

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APHAB norms for unaided and aided for individuals fitted with hearing aids

2005 APHAB Norms for WDRC-capable hearing aids

Users of WDRC capable hearing aids- Unaided				
Percentile	**EC**	**RV**	**BN**	**AV**
95	99	99	99	70
80	83	87	89	35
65	75	81	81	21
50	63	71	75	14
35	56	65	67	9
20	46	58	58	3
5	26	47	41	1

Users of WDRC capable hearing aids- Aided				
Percentile	**EC**	**RV**	**BN**	**AV**
95	86	79	82	82
80	39	57	58	64
65	29	46	49	53
50	23	37	40	38
35	17	29	32	23
20	12	21	22	14
5	5	12	14	2

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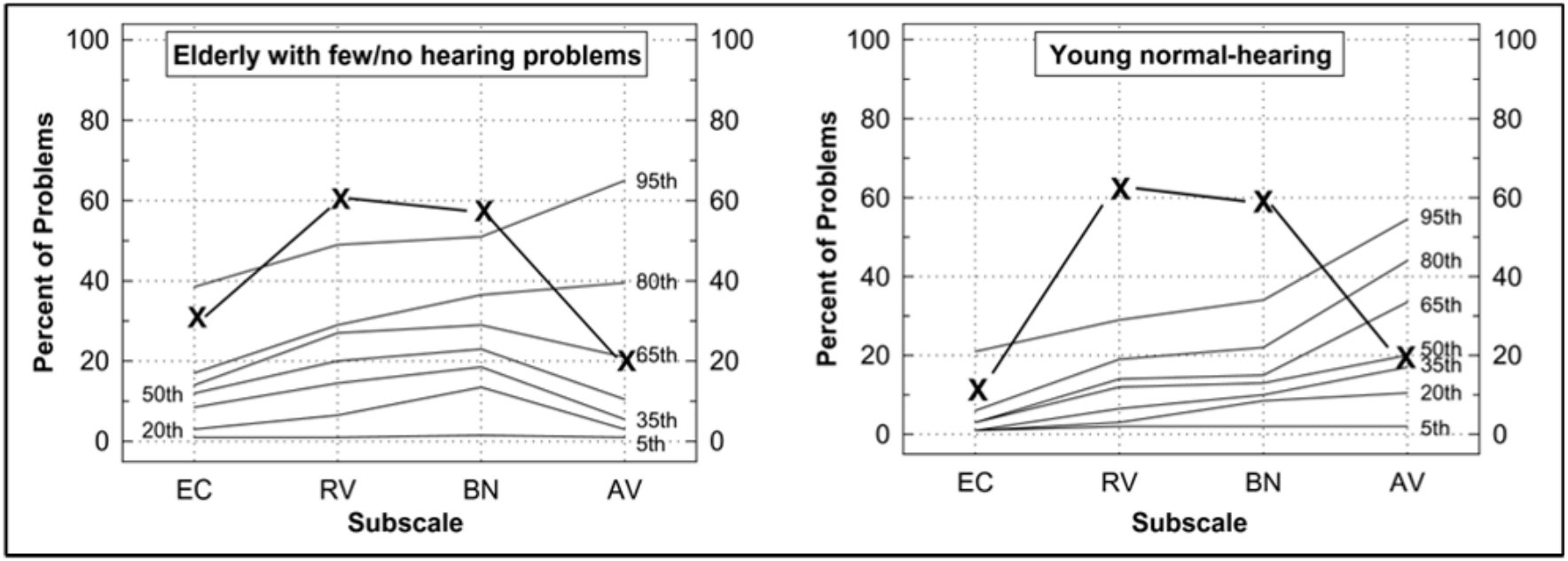
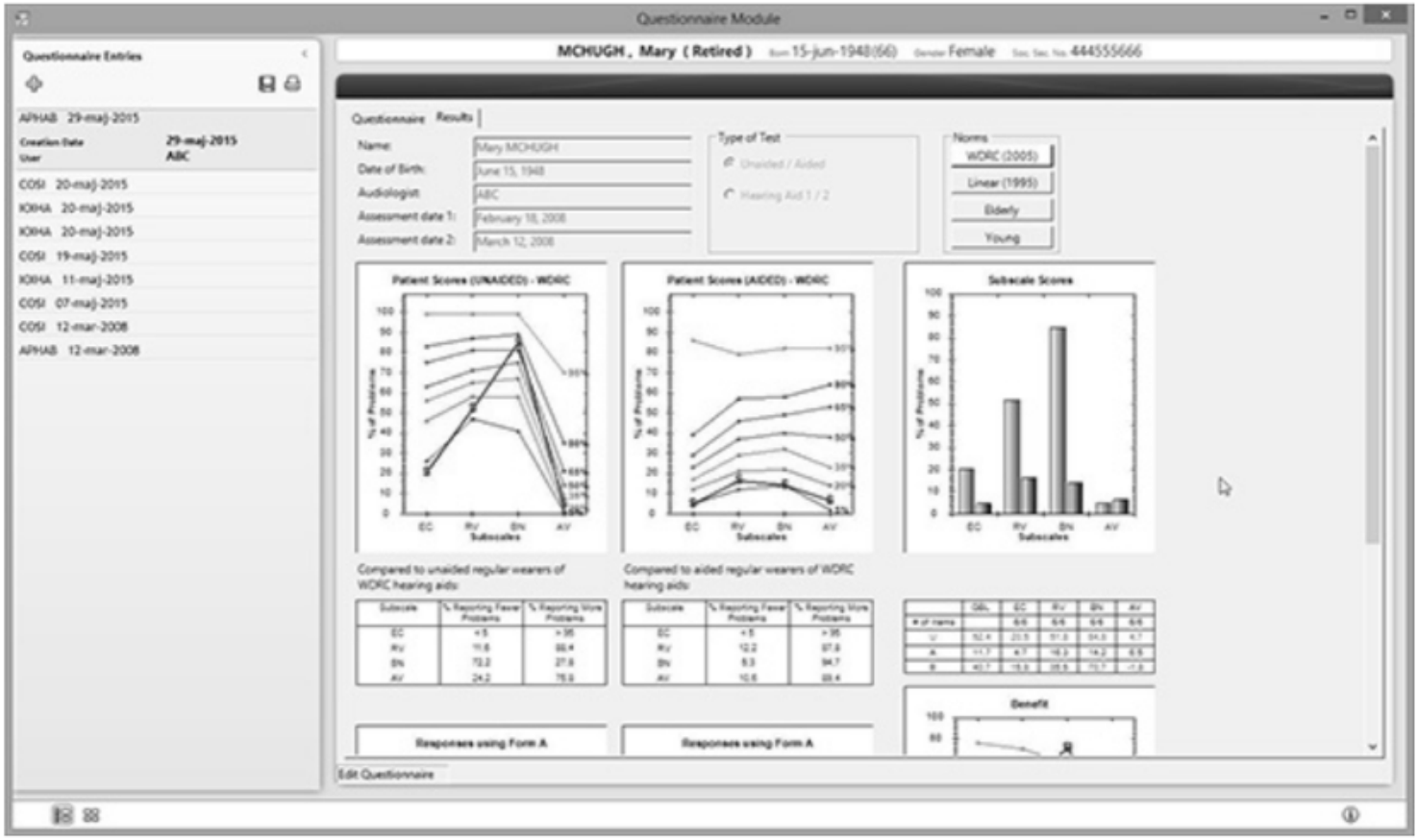
Useful charts for patient counseling



APHAB in Noah Questionnaire Module (13 languages)



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Client Oriented Scale of Improvement (COSI)

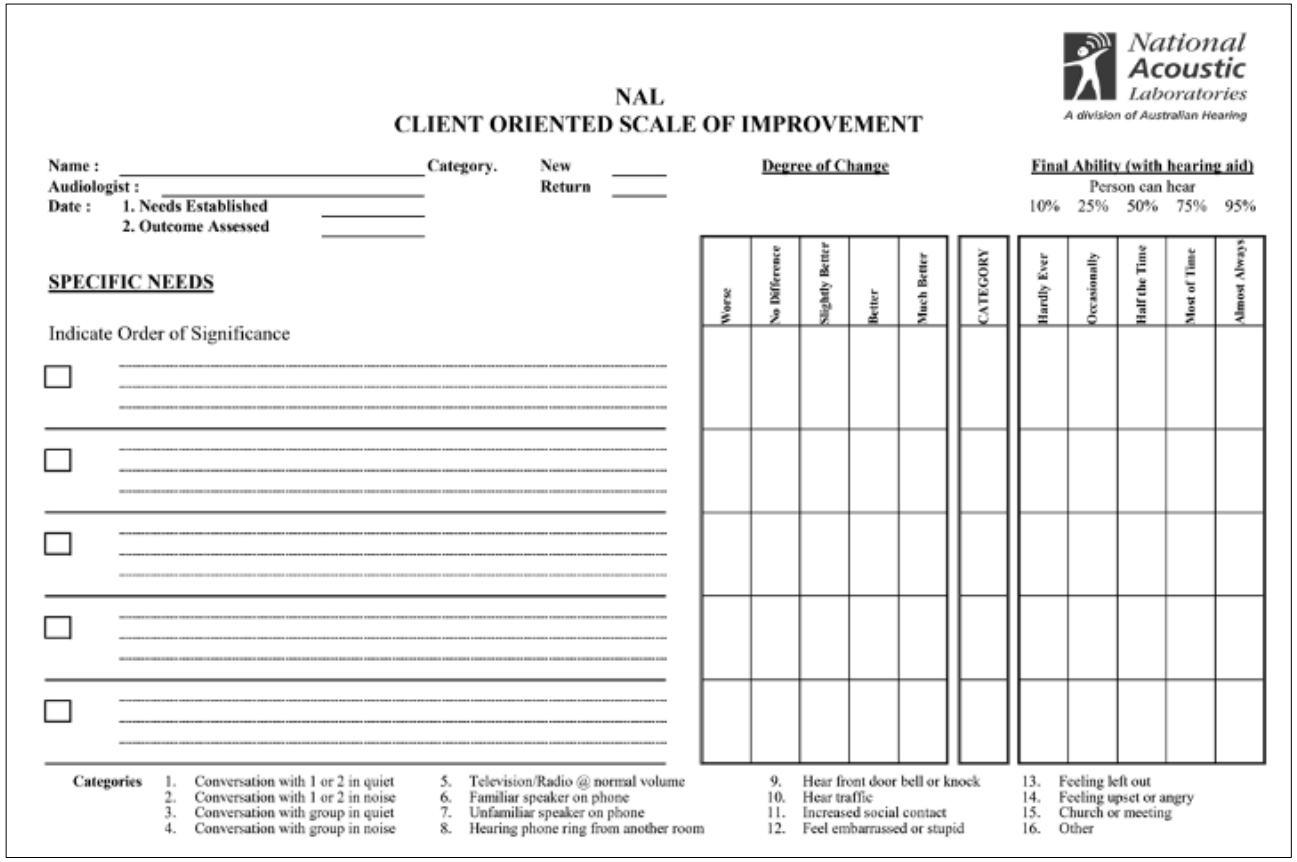
The COSI is probably the most commonly used *outcome* measure, but it is also very useful as a pre-fitting measure, for formalizing the specific listening goals a patient has regarding the benefit from hearing aids.

One issue related to most all standardized self-assessment scales is that the items must be relevant for the hearing aid user. The COSI was designed to accomplish these goals, as well as eliminate irrelevancy.

The COSI allows patients to identify and rank order listening goals that are most important to them as an individual. No two COSIs are the same.

In short, the COSI starts off as a blank page, then allows patients, with the help of the HCP, to design their own questionnaires.

The COSI form



National Acoustic Laboratories
A division of Australian Hearing

NAL
CLIENT ORIENTED SCALE OF IMPROVEMENT

Name : _____ **Category.** **New** _____
Audiologist : _____ **Return** _____
Date : **1. Needs Established** _____
2. Outcome Assessed _____

SPECIFIC NEEDS

Indicate Order of Significance

☐ _____
☐ _____
☐ _____
☐ _____
☐ _____

Degree of Change

Worse	No Difference	Slightly Better	Better	Much Better	CATEGORY

Final Ability (with hearing aid)
Person can hear

10%	25%	50%	75%	95%
Hardly Ever	Occasionally	Half the Time	Most of Time	Almost Always

Categories
1. Conversation with 1 or 2 in quiet
2. Conversation with 1 or 2 in noise
3. Conversation with group in quiet
4. Conversation with group in noise
5. Television/Radio @ normal volume
6. Familiar speaker on phone
7. Unfamiliar speaker on phone
8. Hearing phone ring from another room
9. Hear front door bell or knock
10. Hear traffic
11. Increased social contact
12. Feel embarrassed or stupid
13. Feeling left out
14. Feeling upset or angry
15. Church or meeting
16. Other

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Administration and Scoring

- The process begins by having the patient identify up to five specific listening situations in which he or she would like to hear better. It is important to stress these are *listening situations* and not necessarily just communication. We suggest having at least three items whenever possible. It is important to make each item as specific as possible.

- Encourage to have the patient select goals that are encountered frequently.

- After all situations have been identified, it is then helpful to go back, review all situations, and have the patient rank order them. Simply place a 1 for most important, 2 for the second most important, and so on in the box to the left of the item.

- Once the items have been prioritized, we then have the patient select their expectations for each one of the items.

- After several weeks of hearing aid use the patient then completes the COSI again, this time ranking benefit for each item.

Interesting research findings related to the COSI from Elaine Mormer and Catherine Palmer

For individuals who had used their hearing aids for three weeks:

- 96% nominated two of the same items
- 64% nominated three of the same items
- No one nominated four of the same items

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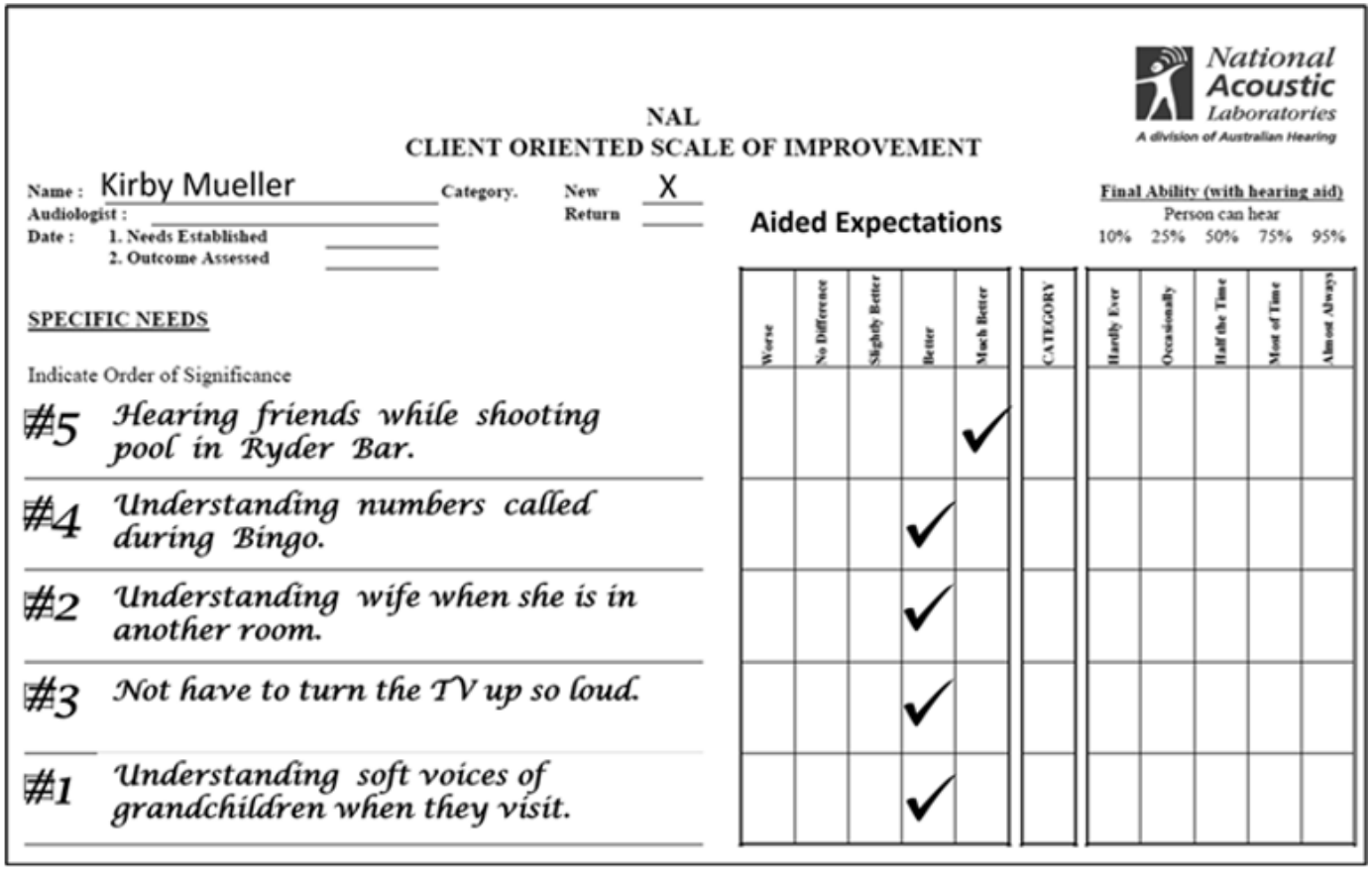
Sample pre-ftting completed COSI with rated “expectations”



National Acoustic Laboratories
A division of Australian Hearing

NAL
CLIENT ORIENTED SCALE OF IMPROVEMENT

Name : Kirby Mueller Category. New X
Audiologist : Return
Date : 1. Needs Established
2. Outcome Assessed

SPECIFIC NEEDS

Indicate Order of Significance

Aided Expectations

Final Ability (with hearing aid)
Person can hear

		Worse	No Difference	Slightly Better	Better	Much Better	CATEGORY	10% Hardly Ever	25% Occasionally	50% Half the Time	75% Most of Time	95% Almost Always
#5	Hearing friends while shooting pool in Ryder Bar.					✓						
#4	Understanding numbers called during Bingo.				✓							
#2	Understanding wife when she is in another room.				✓							
#3	Not have to turn the TV up so loud.				✓							
#1	Understanding soft voices of grandchildren when they visit.				✓							

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In summary, we've recommended three easy to administrer and score pre-fitting self-assessment inventories:

- HHIE/A: Determines degree of perceived handicap for both social and emotional situatioins
- APHAB: Provides detailed disasbility information for listeing in quiet, noise and reverberation, and provides guideance regarding loudness issues.
- COSI: Provides patient-derived fitting goals, and the patient's expectations regarding achievement of these targets.

RESEARCH QUICK TAKES

6.5: Hearing Aid Fitting Toolbox: Real-ear probe-microphone verification

Brian Taylor & Gus Mueller

Starting with a gold standard . . .

- Several factors enter into making a fitting successful: audibility, speech understanding, loudness restoration, good sound quality, and acceptance for the patient, just to name a few.

- Smart people have examined the best balance of all these factors and have developed prescriptive fitting approaches. Considerable research has shown that these approaches will provide the best opportunity for an optimum fitting for the average hearing aid user.

- Today, we have both the DSL5.0 and the NAL-NL2. For our discussion here, we'll refer to the NAL-NL2, as it is the most popular in the U.S.

Why simply clicking on NAL-NL2 in the fitting software doesn't work #1

- Once a hearing aid company has licensed the NAL-NL2, they are allowed to make alternations, and can still call the algorithm "NAL-NL2."

- What has been common practice over the years, therefore, is for most if not all manufacturers to alter the NAL algorithm to more closely resemble their proprietary fitting—that is, significant gain reduction in the higher frequencies, especially for soft inputs, beginning ~2000 Hz. It's common that this reduction is 10 dB or more.

- Hence, while the fitting screen may show a "fit-to-NAL" it is *not* a fit to the *real* NAL, and the patient will not experience the same degree of benefit.

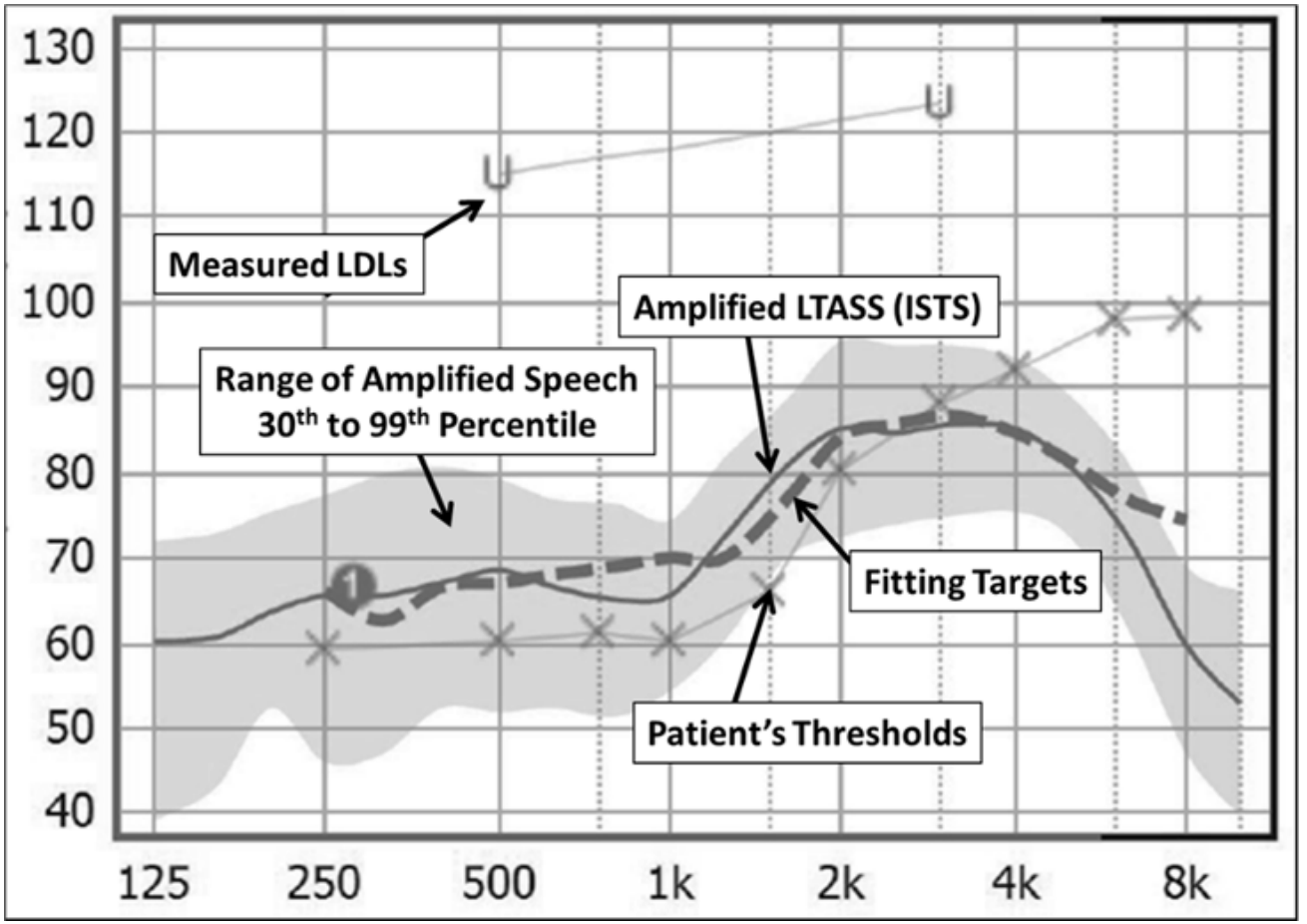
Why simply clicking on NAL-NL2 in the fitting software doesn't work #2

- Even if the manufacturer's NAL was the true NAL, the software programming is for the *average* person, with the *average* coupling.
- The actual output in the real ear, however, will vary based on microphone location, the residual earcanal resonance and the residual volume in the ear canal (real ear coupler difference; RECD).
- The venting and openness/tightness of the coupling also will have a significant effect on the fitting.
- The only alternative, therefore, to verify that the fitting is to the NAL standard, is to conduct real-ear probe-microphone verification.

Probe-Mic verification—background

- Today's validated prescriptive fitting methods provide research-based earcanal SPL targets—we rarely think in terms of "gain," which was common decades ago.
- The goal of the fitting simply is to obtain a real-ear output that is reasonably close (+/- 5 dB) to that prescribed by these targets across frequencies.
- This is accomplished with probe-microphone measures, using a real-speech input and earcanal SPL as the definitive measure, sometimes referred to as "speech mapping."
- Hearing thresholds and LDL are entered in HL, and then coverted to earcanal SPL by the probe-mic software, and displayed on the fitting screen.
- The input signal is shapted real-speech, calibrated to desired levels.

Sample of typical fitting screen



Probe-Mic Verification Procedures: Step-by-step

- Enter patient's audiogram and LDLs into software.
- Calibrate probe tube.
- Position the patient appropriately; should be seated 2-3 feet from loudspeaker at 0 degree horizontal and vertical azimuth.
- Place probe assembly on ear; probe tube should be inserted so that probe tip is within 5-mm of eardrum. Use probe fitting guide for correct placement, or if this is not available, place marker 30 mm from tip, insert probe, and then align marker with inter-tragal notch.

Probe-Mic Verification Procedures: Step-by-step

- If possible, conduct real-ear coupler difference (RECD) test. Enter the patient's RECDs into the fitting software.
- Note in the *probe-mic* software if this is an experienced or new user, a unilateral or bilateral fitting. Also select type of coupling (e.g., open vs. vented vs. closed).
- Place hearing aids on ear and pre-program to the manufacturer's NAL-NL2 fitting. With most modern equipment, testing can be conducted bilaterally if desired.
- Select the appropriate calibrated speech-signal input. The most commonly used, available on all probe-mic equipment, is the international speech test signal (ISTS), which is what we recommend.

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Probe-Mic Verification Procedures: Step-by-step

- With most modern equipment, testing can be conducted bilaterally if desired.

- Conduct verification by starting with the presentation of the 55 dB input signal. Make programming adjustments until a satisfactory match to target is obtained.

- Following the programming for 55 dB input, present the 75-dB input signal. Continue programming until the output is at least within 5 dB at each frequency and has a general contour consistent with the targets.

Probe-Mic Verification Procedures: Step-by-step

- After the programming for the 75 dB SPL input, present the 65 dB input signal. Given that this input is mid-way between 55 and 75, a close match to target is expected. Make minor adjustments as necessary, but keep in mind that these adjustments for 65 could impact the output for the 75 dB signal.

- Most probe-systems will calculate both SII values and rms error. Check these for each presentation level to ensure that they are within appropriate range.

- The final step is to conduct the REAR85 verification (the patient's measured LDLs serve as the guidelines for this programing). A step-by-step for this real-ear verification was detailed in QuickTakes 6.3.

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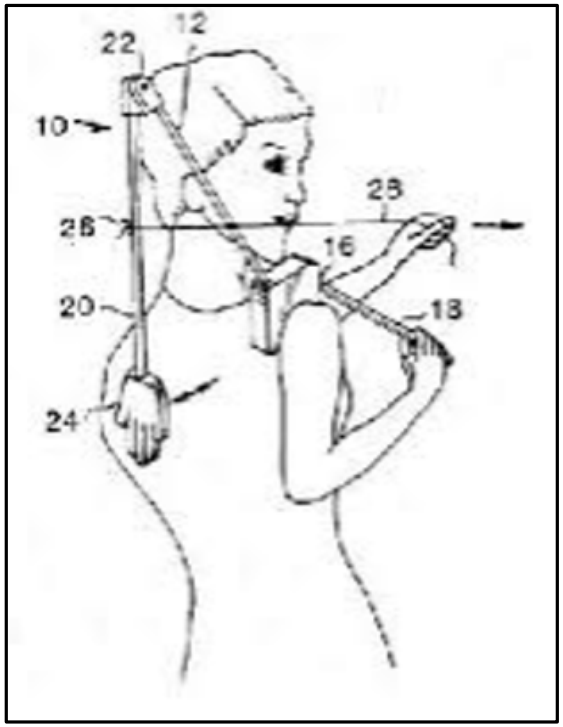

Pat yourself on the back for
following Best Practice Guidelines!

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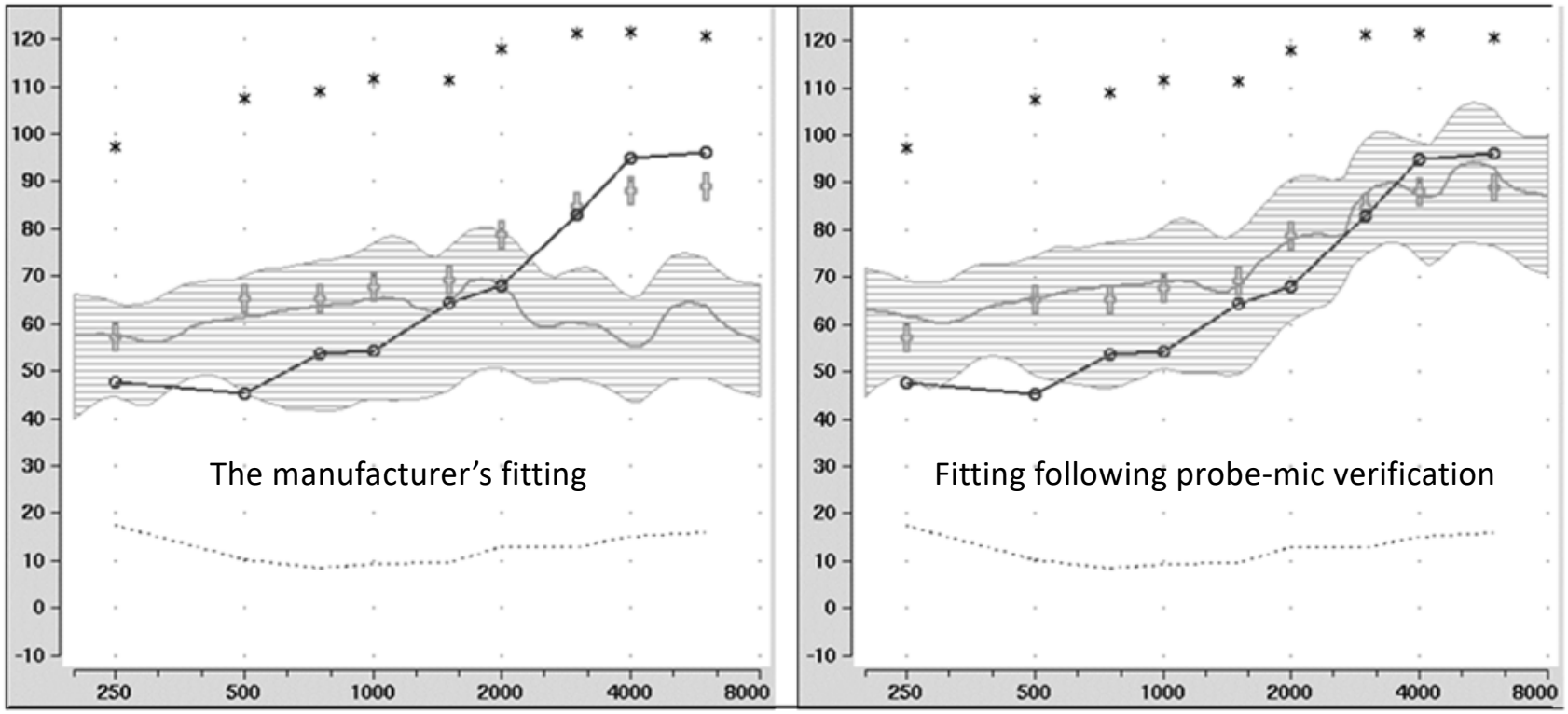
Why the effort makes a difference!



A little about “goodness-of-fit” calculations

The SII.

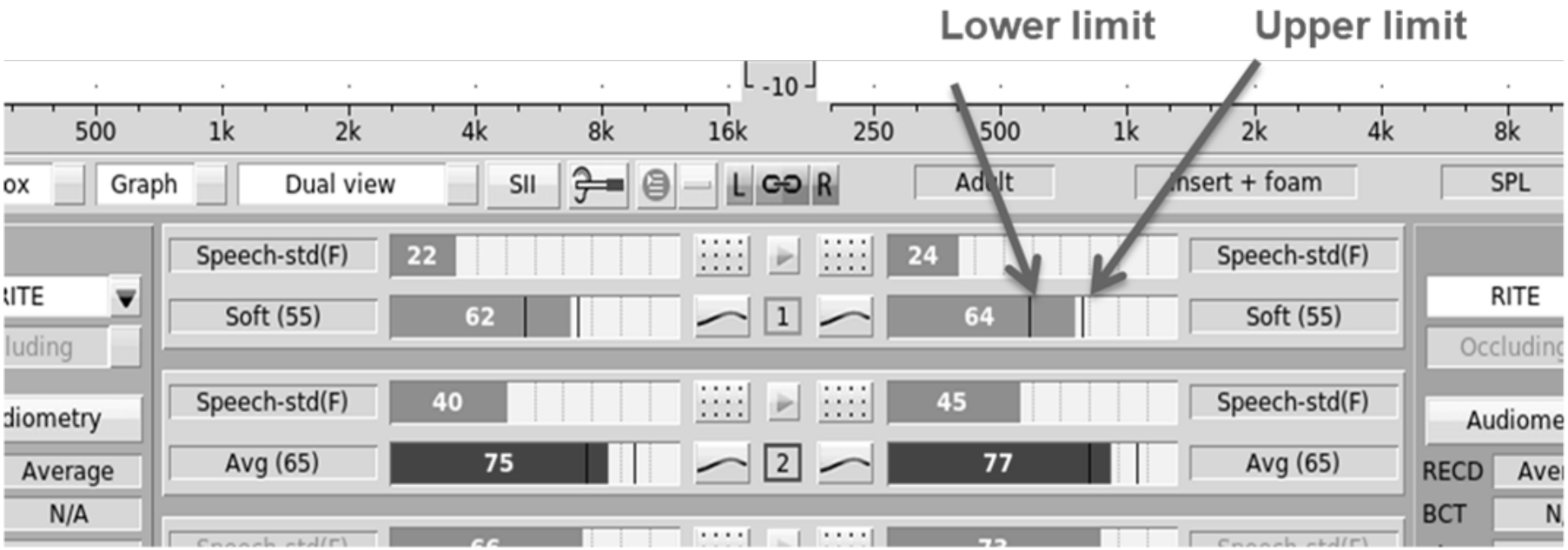
- Methods to calculate the audibility of speech have been available since the 1940s—most notably the Articulation Index (AI), which in recent years has become the Speech Intelligibility Index (SII).

- Importantly, it is not the goal of the fitting to obtain an SII of 100% (i.e., 1.00), as this isn’t needed for good speech understanding. In general, for adults with a typical downward sloping mild-to-moderate hearing loss, for a 65 dB SPL input, we would be looking for an SII around .65 to .75.

- As you would expect, as the input becomes softer, the “acceptable” SII becomes smaller. Also, the “acceptable” SII will become smaller as the degree of the hearing loss becomes larger, simply because of the limits of amplification.

- The rules are somewhat different for children.

Example from probe-mic manufacturer



A little about “goodness-of-fit” calcuations

Root Mean Square error (RMSe)

$$RMSE = \sqrt{\sum_{i=1}^{n} \frac{(\hat{y}_i - y_i)^2}{n}}$$

A little about “goodness-of-fit” calcuations

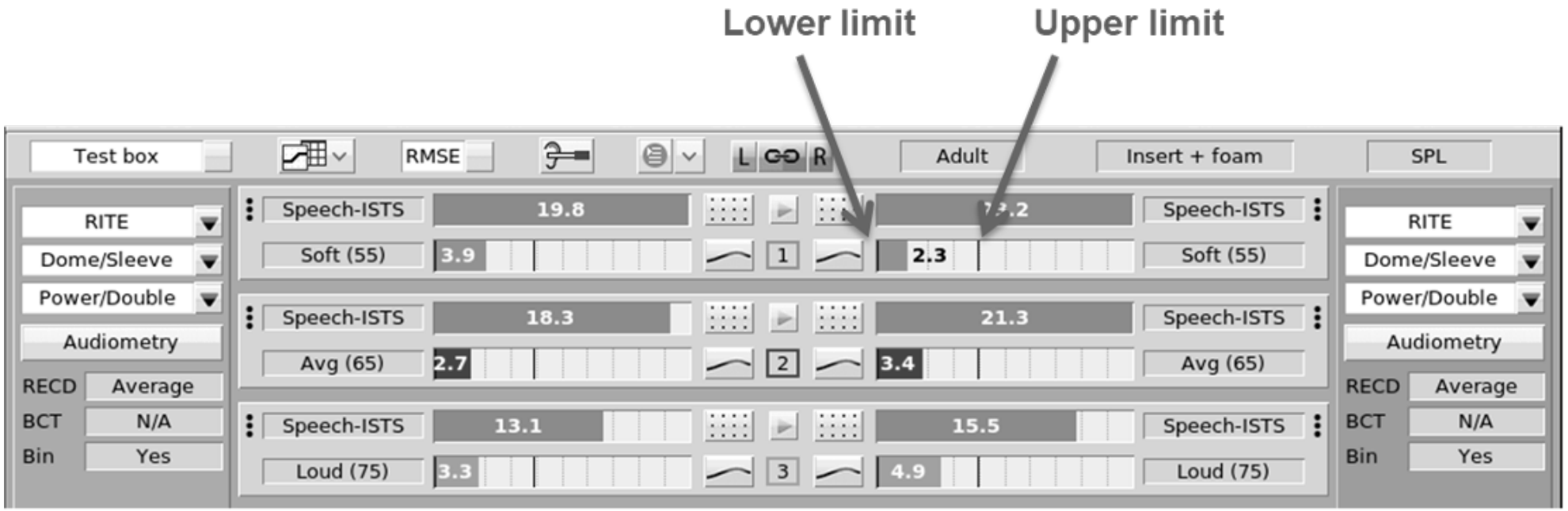
Root Mean Square error (RMSe)

- You can more or less think of the RMSe as the “average absolute dB error,” although the math will give you slight differences.

- If indeed you were within 5 dB at each key frequency, then your RMS error would be 5 dB. Using the fitting goal of having an RMS error of 5 dB or smaller, however, does provide some forgiveness for missing target by more than 5 dB.

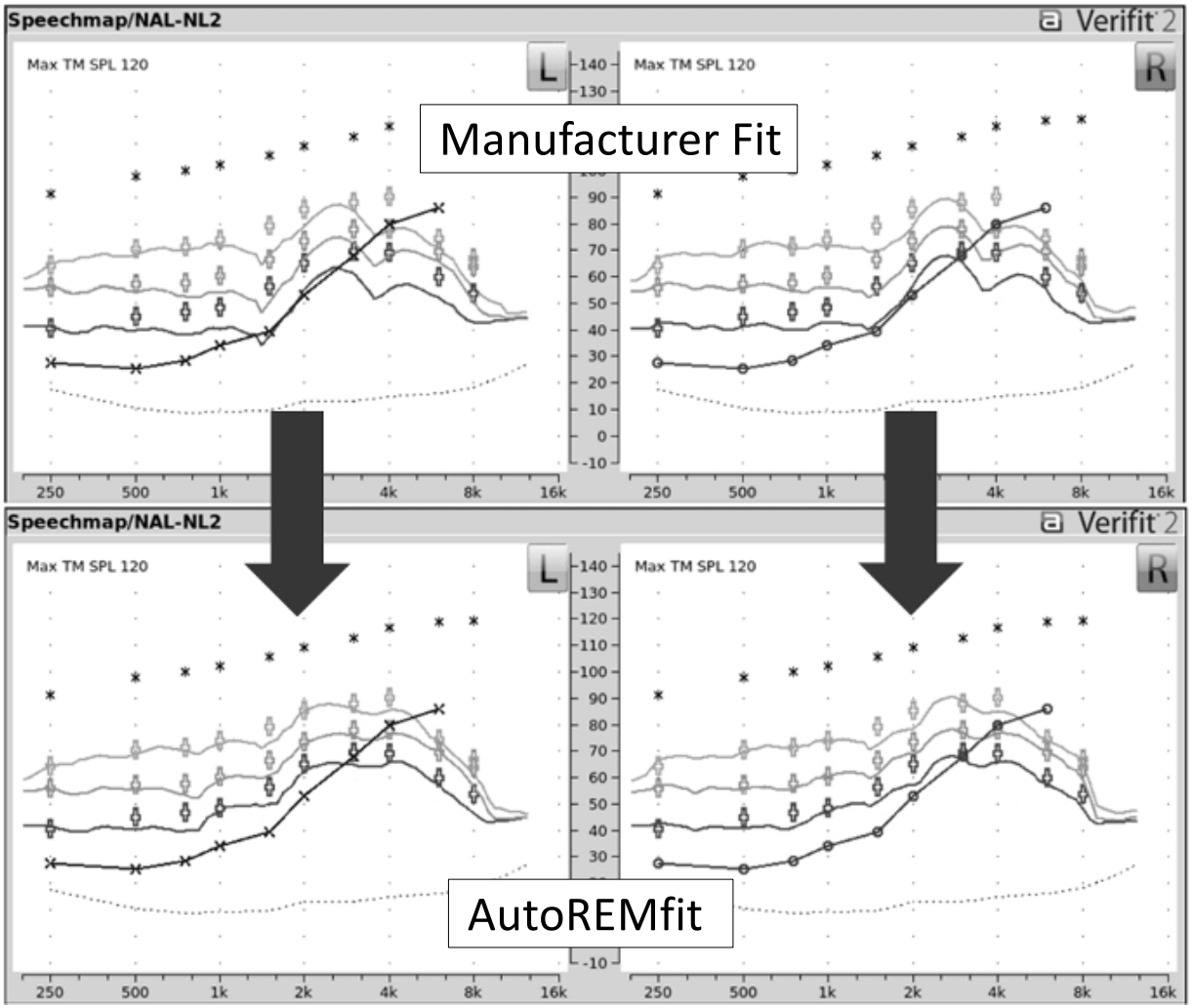
- For example, if your fitting error was 3 dB at 500 Hz, 1000 Hz, and 2000 Hz, but 8 dB at 4000 Hz, the RMS error would still be below 5.0 (4.7 dB). One, therefore, must still use some clinical reason, consider that a fitting that had errors of 0 dB at 500 Hz, 1 dB at 1000 Hz, 2 dB at 2000 Hz, *10 dB at 3000 Hz*, and 2 dB of 4000 Hz, would have a passing RMS error of 4.7, but most of us would not consider it a “passing fitting.”

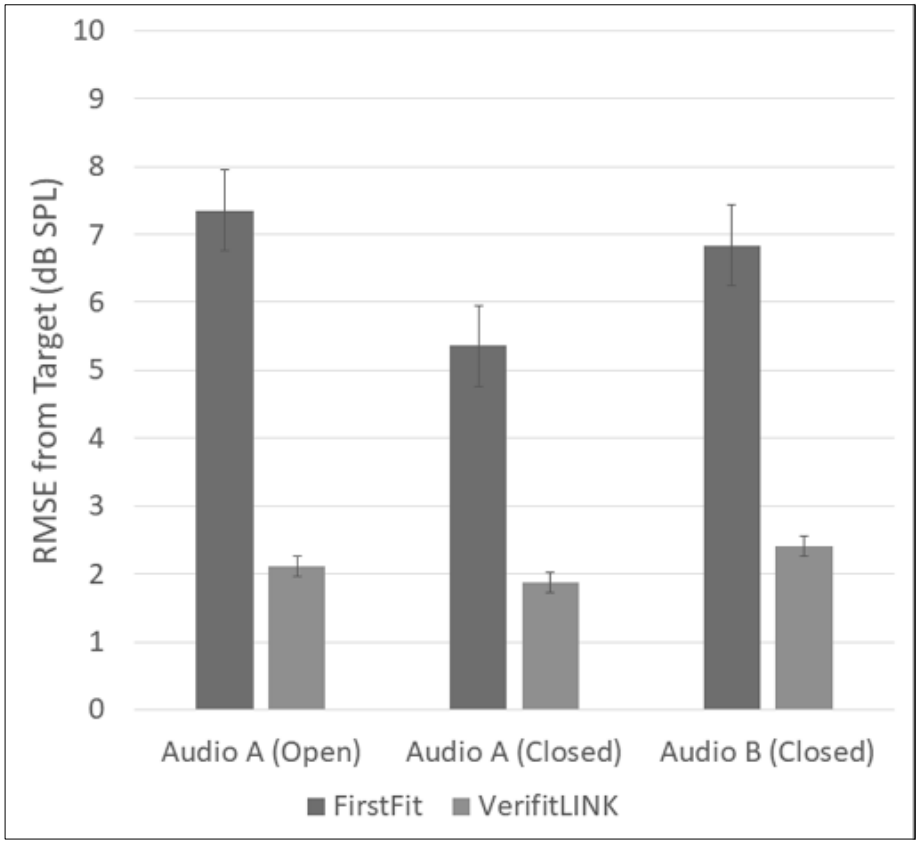
Example from probe-mic manufacturer



AutoREMfit (which goes by many other names)

- Today, most all major manufacturers have an arrangement with one or more probe-microphone manufacturer, where the software of the two systems talk to one another. Much of the fitting then becomes “automatic.”
- This is not new, and has been used for over 20 years, but it only recently has been adopted by a large number of manufacturers.
- The purported advantage is that it makes the fitting more efficient (faster), and while not advertised, it also tends to allow someone less skilled the ability to do the fitting.
- Research has shown that when compared to an experienced clinician, the fitting indeed is slightly faster, and the fit to target, is almost as good.


Speechmap/NAL-NL2
Verifit 2
Max TM SPL 120
L
R
Manufacturer Fit
AutoREMfit
250
500
1k
2k
4k
8k
16k



- Recent data from Pumford and Mueller (2021) for autoREMfit for Signia AX using Verifit equipment.
- Comparison of RMSe for initial fitting (65 dB input) vs results after autoREMfit
- AutoREMfit errors of ~2 dB are as good or better than commonly obtained by experienced clinician.

All sounding “too good to be true?”

- If the autoREMfit only fits to the 65-dB-SPL input, our observations have been that soft inputs will be under-fit. The HCP will then need to manually increase gain for soft, which will cause a mismatch to target for 65-dB-SPL, and the entire fitting will then need to be programmed manually.

- As we discussed earlier, it is common that the manufacturer’s implementation of the NAL-NL2 is not the true NAL-NL2. If the hearing aid software is controlling the fitting, the targets displayed on the probe-mic equipment will not be correct, and what would appear to be a fit-to-target, could be off by 10 dB or more. If the probe system is in control (as is the case with the Verifit), then we can be assured that “a fit really is a fit.”

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RESEARCH QUICK TAKES

6.6: Hearing Aid Fitting Toolbox: Soundfield threshold measures

Brian Taylor & Gus Mueller

A little history . . .

- Up until the mid-1970s the "preferred way" to select the best hearing aid for a given patient was to do aided repeated speech testing for several different product. Research began to show, however, that this process was not reliable or valid. Moreover, audiologists were going into private practice and selling hearing aids, and needed a more efficient method.

- The popularity of gain-based prescriptive fitting began in the 1970s, fueled by the original NAL, the Prescription Of Gain and Output method (POGO) and the work of Ken Berger (who traveled the U.S. conducting workshops on his method).

- Given that all these methods prescribed "gain," soundfield functional gain measures were the logical verification strategy, and were commonly used for ~10 years.

- By the mid-1980s, however, probe-microphone insertion gain measures were common, and were then used to replace functional gain.

So why . . . 40 years later, would we conduct soundfield testing today?

- Current fitting of systems that deliver sound through bone conduction present a challenge to verification. The same challenge is present for cochlear and middle ear implants.

- There are cases when there is excessive cerumen in the earcanal that plugs the probe tip (preventing probe-mic measures), but does not occlude the canal, so threshold measures are valid. Best clinical practice would have this patient return for the probe-mic verification after an ear cleaning, but sometimes this isn't possible.

- Some middle-ear pathologies and conditions cause probe-mic measures to be invalid, or not possible (e.g., large perforations, mastoid cavities, etc.). Functional gain may be the only alternative.

- Some federal government, state agencies and third party payers will not accept probe-microphone data, and still require aided soundfield documentation.

Conducting functional gain measures

- The patient is first seated in an audiometric test booth, positioned at a calibrated location, away from reflective surfaces, usually one meter from a loudspeaker located at 0 degree azimuth.

- The patients are instructed to not lean forward or back, or turn their head (although they nearly always do anyway).

- Masking is applied via earphone to the non-test ear. Simply putting an earplug in the non-test ear is not satisfactory.

- Using pulsed pure tones, thresholds are obtained for the key test frequencies (e.g., usually 250 Hz through 6000 Hz) using a conventional threshold determination procedure. The earphone thresholds *cannot* be used in place of the unaided threshold measures.

Conducting functional gain measures

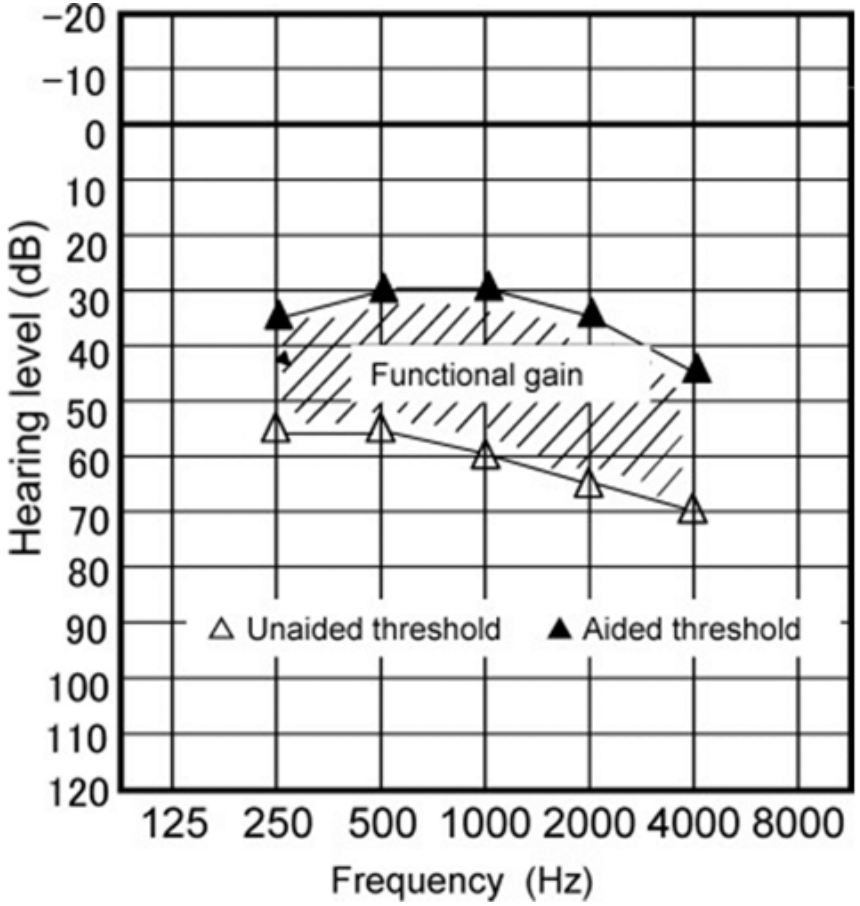
- Following this testing, the hearing aid is placed on the ear, presumably programmed to gain that approximates validated prescriptive targets. Threshold testing is repeated.

- The aided thresholds are subtracted from the unaided, and this value is the frequency-specific functional gain.

- These gain values are then compared to the prescribed gain values of the NAL-NL2 to determine if there is a match, and what programming changes are needed.

- Following the re-programming, the aided testing is repeated to determine if the desired gain has been obtained. This may need to repeated for select frequencies several times.

One method to chart final findings



The (many) pitfalls of conducting functional gain measures

- **Eliminating the non-test ear:** Most people being fitting with hearing aids have fairly symmetrical hearing loss, and therefore, whenever soundfield testing is conducted it is important to ensure that the non-test ear is eliminated.

- **Room masking effects:** Most of today's hearing aids use low threshold compression, and provide the most gain for low-level inputs. One of these inputs, of course is the ambient noise of audiometric test rooms. This seemingly low-level background noise will be amplified by 30 to 40 dB in some cases.

- **Low-level expansion:** Nearly all hearing aids have low-level expansion, a circuit designed to reduce gain for low-level signals. If the patient only has a mild hearing loss, and aided thresholds are expected to be in the 20 dB HL range, the expansion circuit may reduce the input of these signals.

The (many) pitfalls of conducting functional gain measures

- **Input compression:** Most of today's hearing aids have WDRC with low kneepoints. Once the signal if above this kneepoint, it will be compressed. Hence, what is a 60 dB HL value on the audiometer dial, will be less than this value after signal processing—this will make thresholds appear worse than they really are.

- **Gain information provided:** With WDRC instruments, it is important to verify gain for a variety of inputs ranging from soft to loud. Functional gain (even when all contaminating variables are eliminated) only provides information for low-level inputs, as threshold measures are used. It is very difficult to interpolate gain for higher input levels with only this information.

The (many) pitfalls of conducting functional gain measures

- **Frequency information provided:** Only key frequencies are tested. Many important aspects of the hearing aid fitting involve peaks and dips in the gain and output, which often are not revealed with functional gain measures at discrete frequencies.

- **Efficiency:** Once the patient is set up, a probe-microphone assessment of gain can be accomplished in 5-10 seconds. During the hearing aid fitting process, it often is necessary to repeat this measure 10 or more times as the frequency response and compression is tweaked to obtain the best fitting, an different intput signals are used. It's unlikely that either the hearing care provider (HCP) or the patient would have the endurance for 10 or more repeats of functional gain measures.

- **Test-retest reliability:** For probe-mic measures is ~2 dB. Reliability is considerably worse for functional gain—10 to 15 dB!

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Only conducting aided soundfield thresholds

There are times when functioinal gain is not needed, and only soundfield thresholds are necessary. Three things to remember:

- All the pitfalls of functional gain testing are in play.
- It is very critical that the loudspeakers are calibrated (more so than for functional gain, when a difference measure is used).
- There is no value in attempting to obtain aided thesholds better than 20 dB HL. In real world envrionments, amplied ambient noise masks out hearing sounds at a lower level than this.

For those of you who do pediatric fittings—a statement from the AAA Pediatric Amplification Guidelines

6.2.3 Aided Thresholds in the Sound Field Recommendations for measurement of aided thresholds in the sound field

1. Measurement of aided sound field thresholds should not be used as a method of hearing aid verification. A commonly used measurement is the "aided audiogram" or "functional gain". These two terms are not synonymous, but are related: "aided audiogram" simply implies that thresholds are determined in soundfield while the child is wearing their hearing aids. The aided audiogram may be obtained in each ear separately (with the contralateral ear masked if necessary), or obtained binaurally. "Functional gain" implies a comparison of the unaided thresholds (soundfield, either bilaterally or each ear separately with appropriate contralateral masking) with the aided thresholds in the comparable condition. This permits, theoretically, a determination of the insertion gain provided by the hearing aid(s). Both measures, while having appealing face validity, are fraught with potential error sources.

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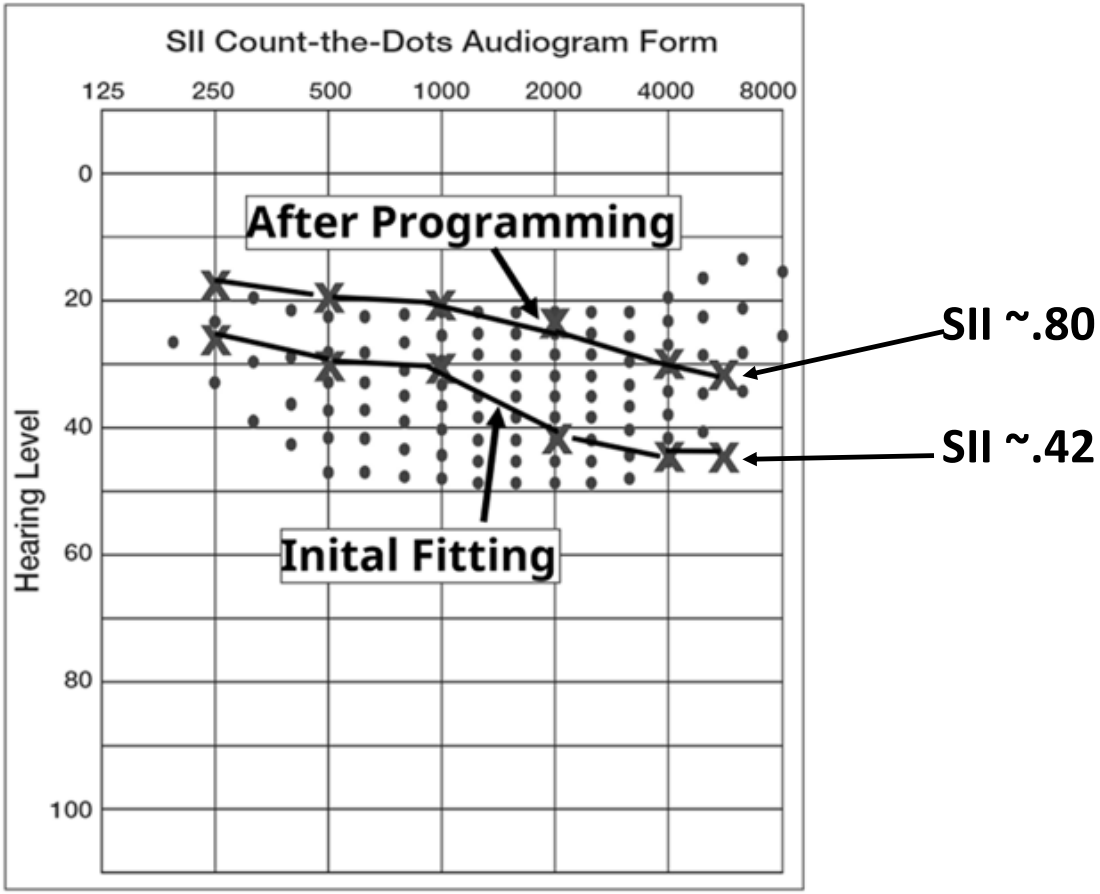
Plotting aided thresholds on SII audiogram can be helpful



Alternative approach when aided thresholds are needed

- Conduct traditional probe-mic measures—fit to target for soft inputs
- Switch to “insertion gain” mode. Use average REUG.
- Run repeat REAR for soft input inputs—50 dB SPL if possible
- Take calculated insertion gain values and apply to HL audiogram—simply add the gain to earphone values to show predicted aided thresholds. Some probe-mic equipment will do this automatically for you.
- While this is not “true” aided thresholds, because of the errors associated with aided soundfield measures, may actually be more accurate.

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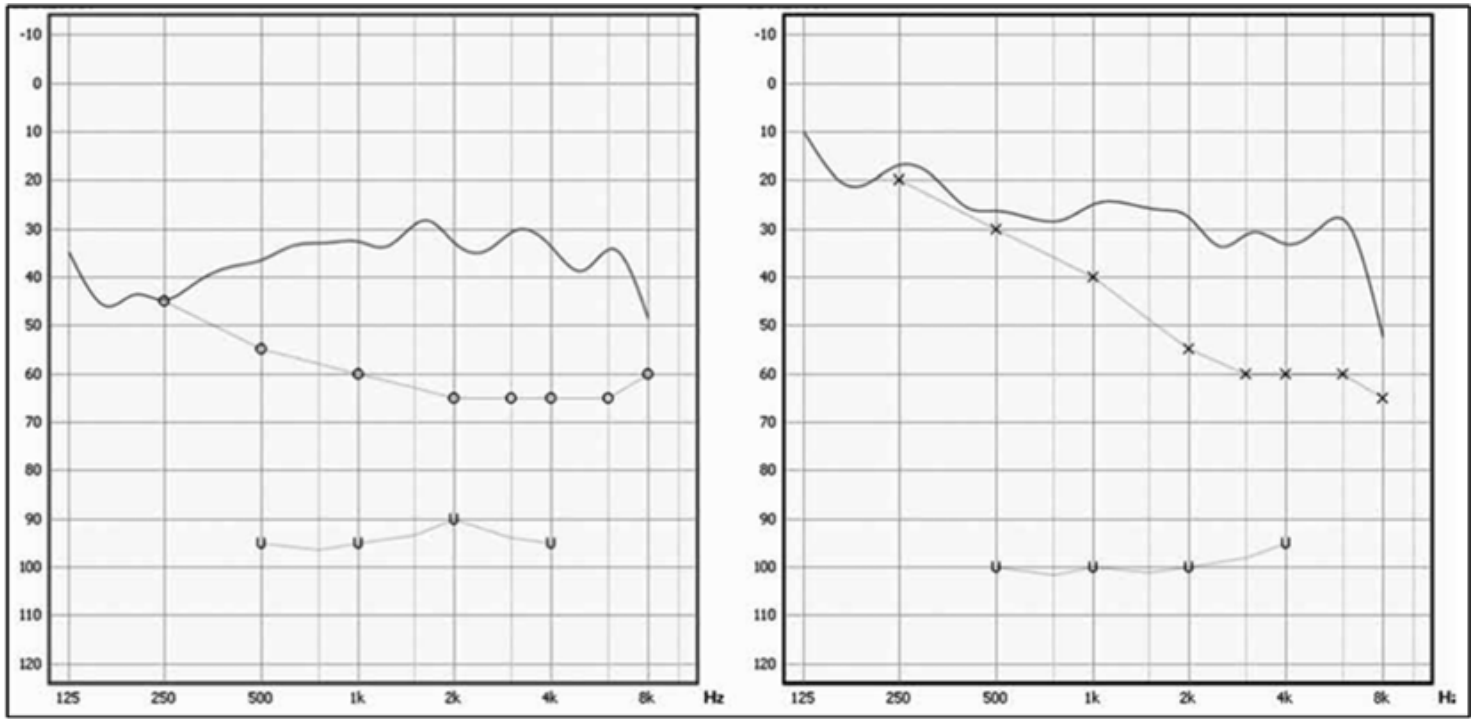
Alternative approach when aided thresholds are needed



In closing—Functional gain and aided soundfield testing: The bottom line . . .

"The measure of who we are is what we do with what we have."

These tests are unreliable, inefficient, and not very valid, but sometimes, you just might have to do them. Remember all the pitfalls!

RESEARCH QUICK TAKES

6.6: Hearing Aid Fitting Toolbox: Soundfield threshold measures

Brian Taylor & Gus Mueller

RESEARCH QUICK TAKES

6.7: Hearing Aid Fitting Toolbox: Identification and treatment of the hearing aid occlusion effect

Brian Taylor & Gus Mueller

The hearing aid occlusion effect

- The hearing aid occusion effect can be highly annoying and it is more likely to be annoying for patients having better than 30-40 dB HL thresholds in the lower frequencies.
- Some patients will report only using one hearing aid rather than two to minimize the annoyance, or simply discontinuing hearing aid use in general.
- The most common report from patients is that their voice sounds “booming,” “hollow” or “echoing” “distorted” when they talk.

Note: You might hear all these same complaints from someone who doesn't have a large OE, but rather is experiencing unwanted hearing aid gain in the low frequencies—an important differentiation that needs to be made.

What causes the hearing aid occlusion effect?

- When we talk, certain sounds, especially vowels, reach 120–130 dB SPL or more in the back of the throat.
- The high intensity sounds travel via the mandible (bone conduction) to the condyle, which is adjacent to the ear canal.
- This bone-conducted signal (typically below 750 Hz) then becomes an air-conducted signal by vibrating the cartilaginous portion of the ear canal (in general, the lateral 2/3).
- In normal situations, when the ear is open, this low-frequency energy escapes out the ear canal and does not contribute significantly to our perception of our own voice.

What causes the hearing aid occlusion effect?

- If the lateral portion of the ear canal is plugged with a hearing aid or ear mold, this signal cannot escape, and the resulting trapped energy in the residual ear canal volume is reflected back to the eardrum and transmitted to the cochlea in the typical air-conducted manner.

- These sounds will then change the perception of our own voice and can also increase the sounds of chewing (particularly crunchy foods), and even vascular noise and breathing.

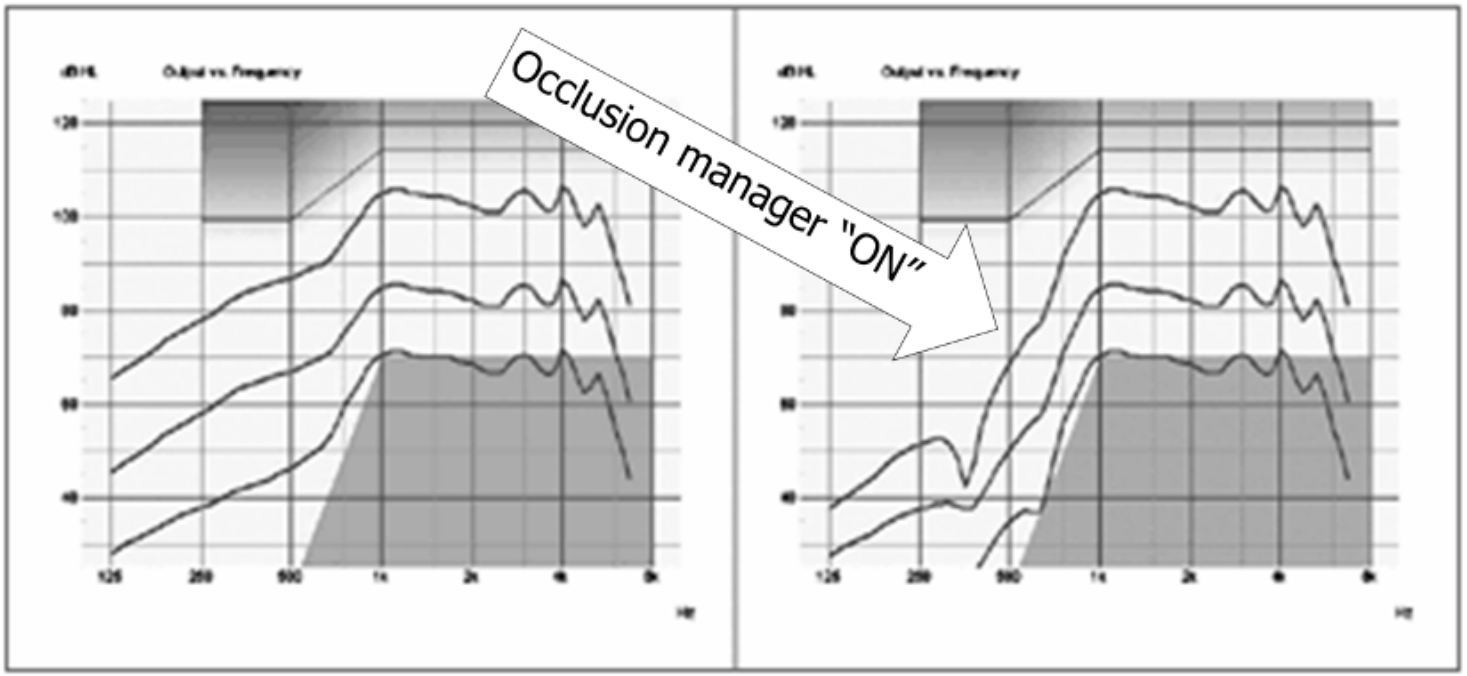
- The OE affects different speech sounds in different ways, boosting some vowels as much as 20 dB, and other vowels very little, and hence, it's not just a matter of our voice sounding louder, but also "different."

Important to remember . . .

The occlusion effect IS NOT related to sound delivered by the hearing aid

For this reason, a quick test to determine if hearing aid occlusion is the problem, is to have the patient read a passage with the hearing aid on, and with it muted. If the problem is the occlusion effect, it will still be present when the hearing aid is “off.”

One manufacturer has/had an "Occlusion Manager" in their software



The hearing aid occlusion effect: What determines bothersome?

- Overall level of effect
- Peak of effect
- Patient's hearing loss
- Amplification characteristics of hearing aid
- Patient's general view on life

Probe-mic assessment of the occlusion effect

- Position the patient appropriately; should be seated 2-3 feet from loudspeaker at 0 degree horizontal and vertical azimuth.

- Place probe assembly on ear; probe tube should be inserted so that probe tip is within 5-mm of eardrum. Use probe fitting guide for correct placement, or if this is not available, place marker 30-mm from tip, insert probe, and then align marker with inter-tragal notch.

- Configure the probe-microphone system so that the selected input is live voice. The terminology and set-up vary among manufacturers.

- With the ear open, have the patient vocalize an “ee” at 75 dB SPL. Some probe systems will have an SPL gauge for this. It also easily works to use a cell phone sound level recording app. Place the phone ~one foot in front of the patient.

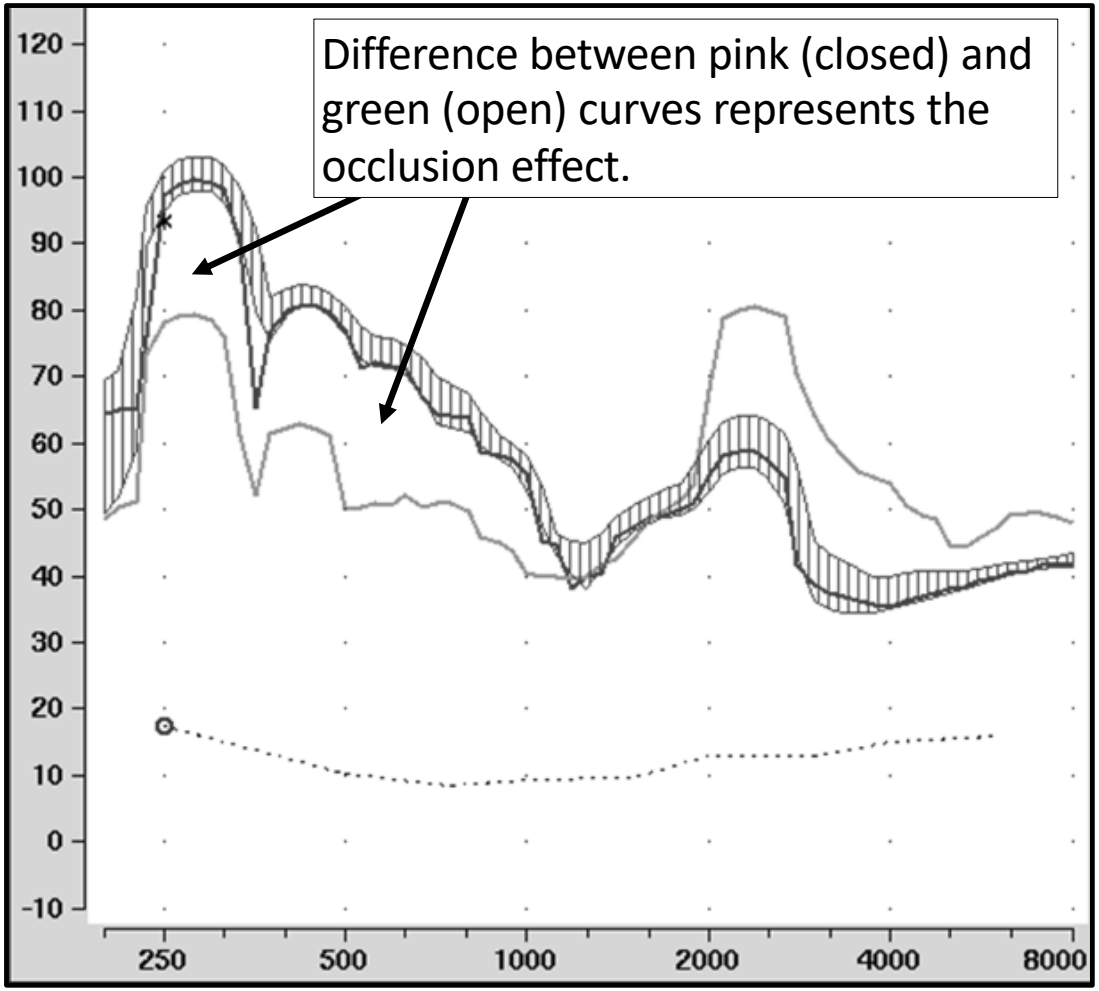
Probe-mic assessment of the occlusion effect

- Analyze the spectrum of the signal (as you would for speech mapping), and save.

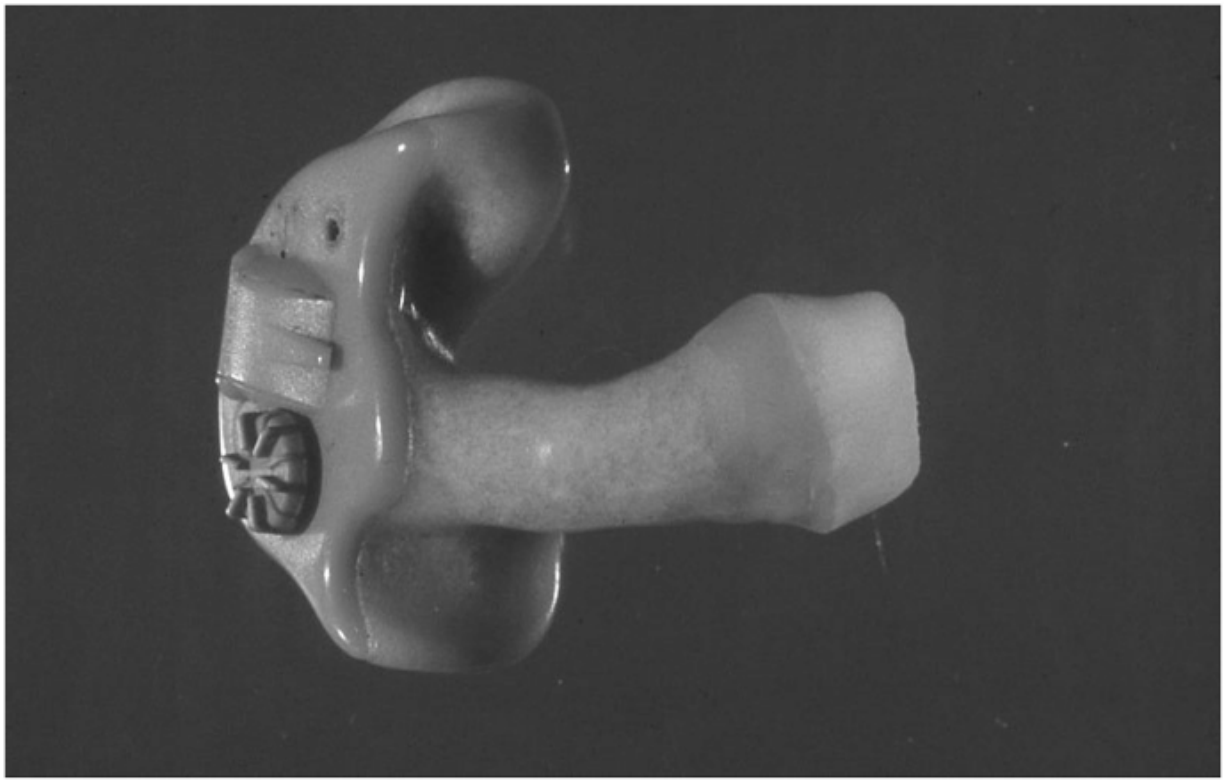
- Place the earmold/eartip/hearing aid in the ear, but do not turn on.

- Again, have the patient vocalize at 75 dB SPL, analyze, and store the measure. Importantly, ensure that vocalizations for the two measures have the same input SPL. If the patient could not strongly vocalize at 75 dB, switch to 70 dB. What we are concerned with is the difference measure.

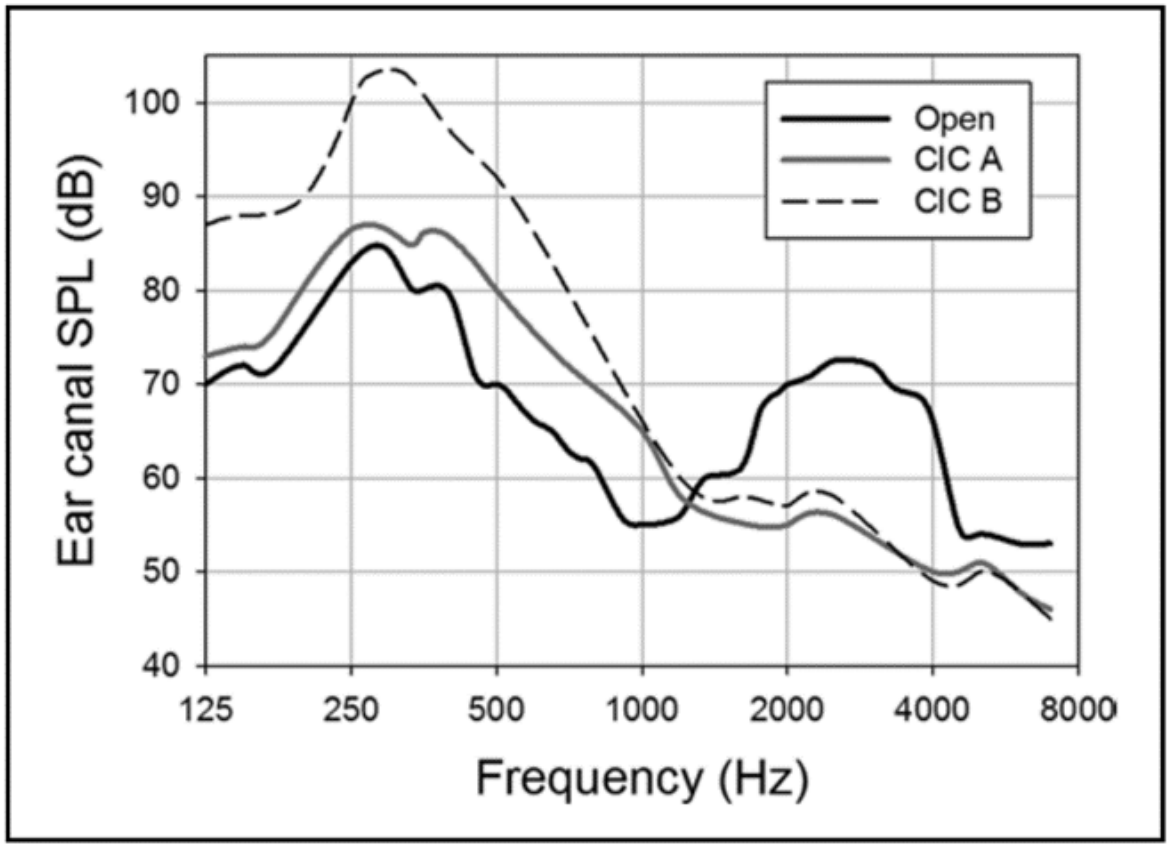
- Compare the differences between the two curves. If similar, no occlusion effect is present. If the closed ear finding is significantly higher than the open ear results, the difference is the occlusion effect (recall that the hearing aid was turned off, so it can't be hearing aid gain).


Difference between pink (closed) and green (open) curves represents the occlusion effect.
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
250
500
1000
2000
4000
8000

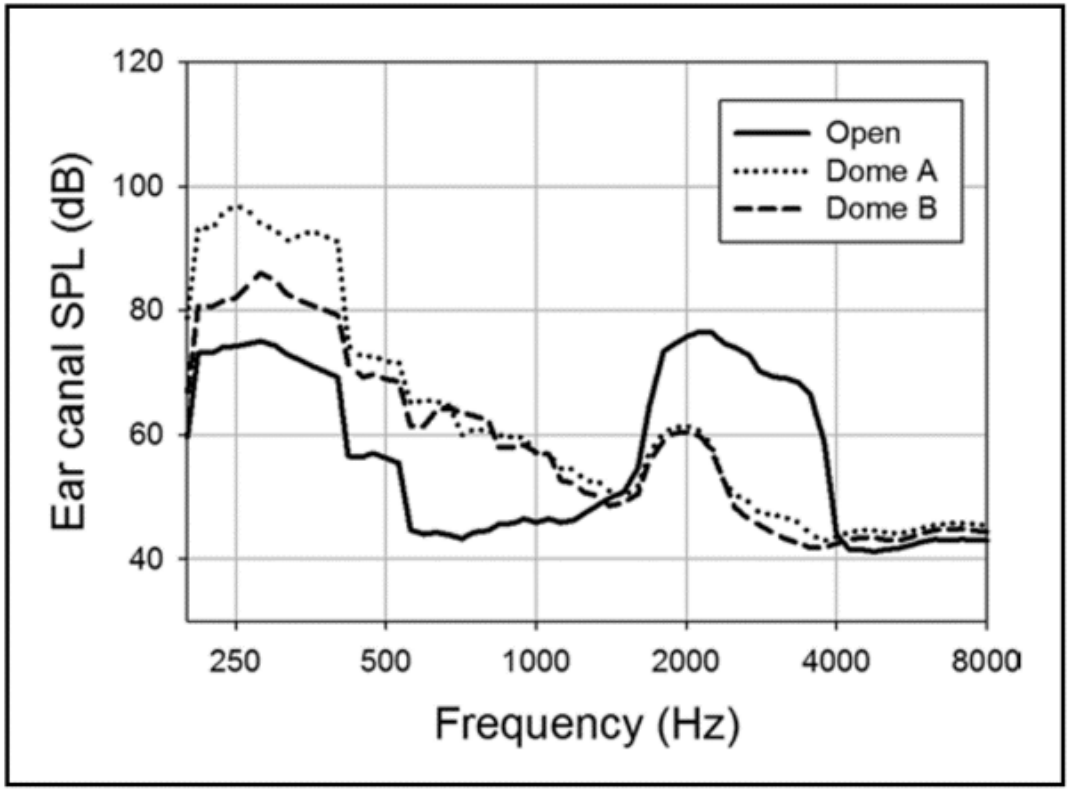
The Treatment: A “deep fitting” will reduce the occlusion effect . . . but, comfort will be a major concern.



The Treatment: A “deep fitting” will reduce the occlusion effect . . . but, comfort will be a major concern.



The Treatment: Fitting a vented dome reduced the occlusion effect enough that it was no longer bothersome.



Step-by-step treatment process

- Determine that indeed the patient is reporting the occlusion effect, and not a general dissatisfaction of too much low frequency amplification.

- Using our earlier guidelines, measure the magnitude of the occlusion effect using probe microphone techniques.

- If the occlusion effect is less than 5 dB or so, the complaint may be related to low frequency gain not the occlusion effect. Most patients do not find the occlusion effect to be particularly bothersome until it reaches 8-10 dB or greater.

- For fittings using an “open ear-tip,” determine if the fitting is open through the use of REOG measures or direct measurement of the occlusion effect. If the REOG shows the fitting to be open (or nearly open; REOG is similar to the REUG), or the occlusion effect is near zero, reconsider if the complaint is truly the occlusion effect.

Step-by-step treatment process

- If a significant occlusion effect is observed, fit with more open coupling, or increase vent size. Repeat probe-mic occlusion measures to ensure that improvement was made. Do not rely on patient comments, which tend to be unreliable.

- If the fitting has been made more open, before the patient leaves the clinic ensure that:

  1) You have not created a feedback problem, and

  2) The increased venting did not remove necessary low-frequency information needed for speech understanding (e.g. you still have adequately matched your desired low frequency gain targets—reprogramming usually is necessary).

A final word about the term “Ampclusion”

- We did some checking, and it seems the term was coined by Steve Painton in a JAAA araticle. According to Painton, ampclusion is “the combination of occlusion and low-frequency amplification that results in the ‘hollowness’ or ‘head in the barrel’ complaints.”

- So first, if we’re understanding this correctly, if you know that the patient's problem is caused by the OE, then the patient would not have ampclusion, as there is no “combined” effect.

- For effective treatment and management, we need to determine which of the two factors is the prime contributor to the problem. Additionally, we need to think about “adding dB.” If the occlusion effect was 15 dB, and the hearing aid gain was 15 dB, the “combined effect” is not 30 dB, it’s 18 dB! We doubt that 18 dB vs 15 is dB is going to change the patient’s complaint.

Talking in barrels certainly is fun, but not the audio experience we want for our hearing aid patients

The occlusion effect is easy to detect and quantify, and different treatment strategies are available.

RESEARCH QUICK TAKES

6.8: Hearing Aid Fitting Toolbox: Self-assessment outcome measures

Brian Taylor & Gus Mueller

Verification vs. Validation

Did we build the system right (verification)? vs.
Did we build the right system (validation)?

Over-arching reasons for using self-assessment outcome inventories

- Health care is becoming more consumer-driven. The major index of quality of service is self-report outcome and satisfaction.

- Many real-world experiences simply cannot be measured effectively in laboratory conditions. The effectiveness of automatic features and signal classification depend heavily on the lifestyle and listening environments of the individual patient.

- There are several Best Practice documents available, all based on an evidence-based practice paradigm. Validation is a cross-check and monitoring of these practices.

Practical reasons for using self-assessment outcome inventories

- Comparison of different dispensing sites or personnel
- Comparison of different fitting procedures across groups of patients
- Comparison of different circuitry or products across groups of patients
- Post-fitting counseling effectiveness across groups of patients—does extra effort result in improved real world satisfaction and benefit?
- Documentation of service/practice effectiveness—You know you do a good job, but do you have data to prove it?

Important factors when deciding what outcomes measures to use.

- Clinician burden: Easy to administer, score and interpret the test?
- Patient burden: This refers to the difficulty encountered by the patient in reading, understanding, and completing the items of the questionnaire.
- Scoring: Convenient, quick, objective and easy to score?
- Utility: Extent to which the data from the scale can be readily applied for treatment, planning or counseling.

And also: Important to consider norms, reliability, validity and sensitivity.

The APHAB is composed of 24 items that are scored in four subscales (six questions each):

Ease of Communication (EC): The strain of communicating under relatively favorable conditions. “I have difficulty hearing a conversation when I’m with one of my family at home.”

Reverberation (RV): Communication in reverberant rooms such as classrooms. “When I am talking with someone across a large empty room, I understand the words.”

Background Noise (BN): Communication in settings with high background noise levels. “When I am listening to the news on the car radio and family members are talking, I have trouble hearing the news.”

Aversiveness (AV): The unpleasantness of environmental sounds. “The sounds of running water, such as a toilet flushing or a shower, are Uncomfortably Loud.”

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Administering and scoring the APHAB

- Have patient complete the 24-item scale, either on a laptop/iPad, using paper and pencil, or in response to HCP reading the statements to the patient (ideal).
- The patient must answer at least three questions in each category for the test to be valid. If several statements are skipped, the HCP can create similar scenarios to elicit response.
- If the patient previously completed the APHAB for unaided, it is okay to let them see their answers. If pre-testing was not conducted, have the patient answer the statements for both unaided and aided.
- Following automated scoring, compare the patients results to the norms for unaided, aided and degree of benefit.
- Conduct counseling relative to the findings. If the aided results, or the benefit fall below expectations (e.g., >75th percentile), consideration should be given to hearing aid programming changes.

APHAB norms for unaided and aided for individuals fitted with hearing aids

2005 APHAB Norms for WDRC-capable hearing aids

Users of WDRC capable hearing aids- Unaided				
Percentile	**EC**	**RV**	**BN**	**AV**
95	99	99	99	70
80	83	87	89	35
65	75	81	81	21
50	63	71	75	14
35	56	65	67	9
20	46	58	58	3
5	26	47	41	1

Users of WDRC capable hearing aids- Aided				
Percentile	**EC**	**RV**	**BN**	**AV**
95	86	79	82	82
80	39	57	58	64
65	29	46	49	53
50	23	37	40	38
35	17	29	32	23
20	12	21	22	14
5	5	12	14	2

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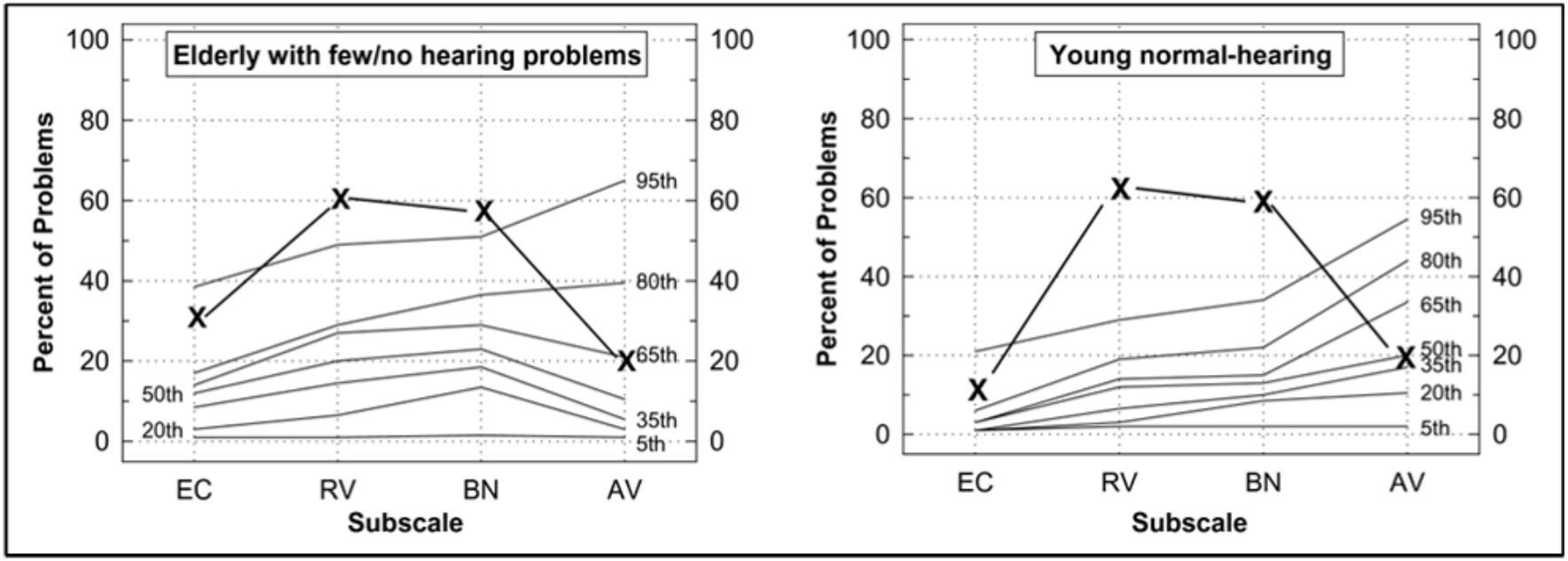
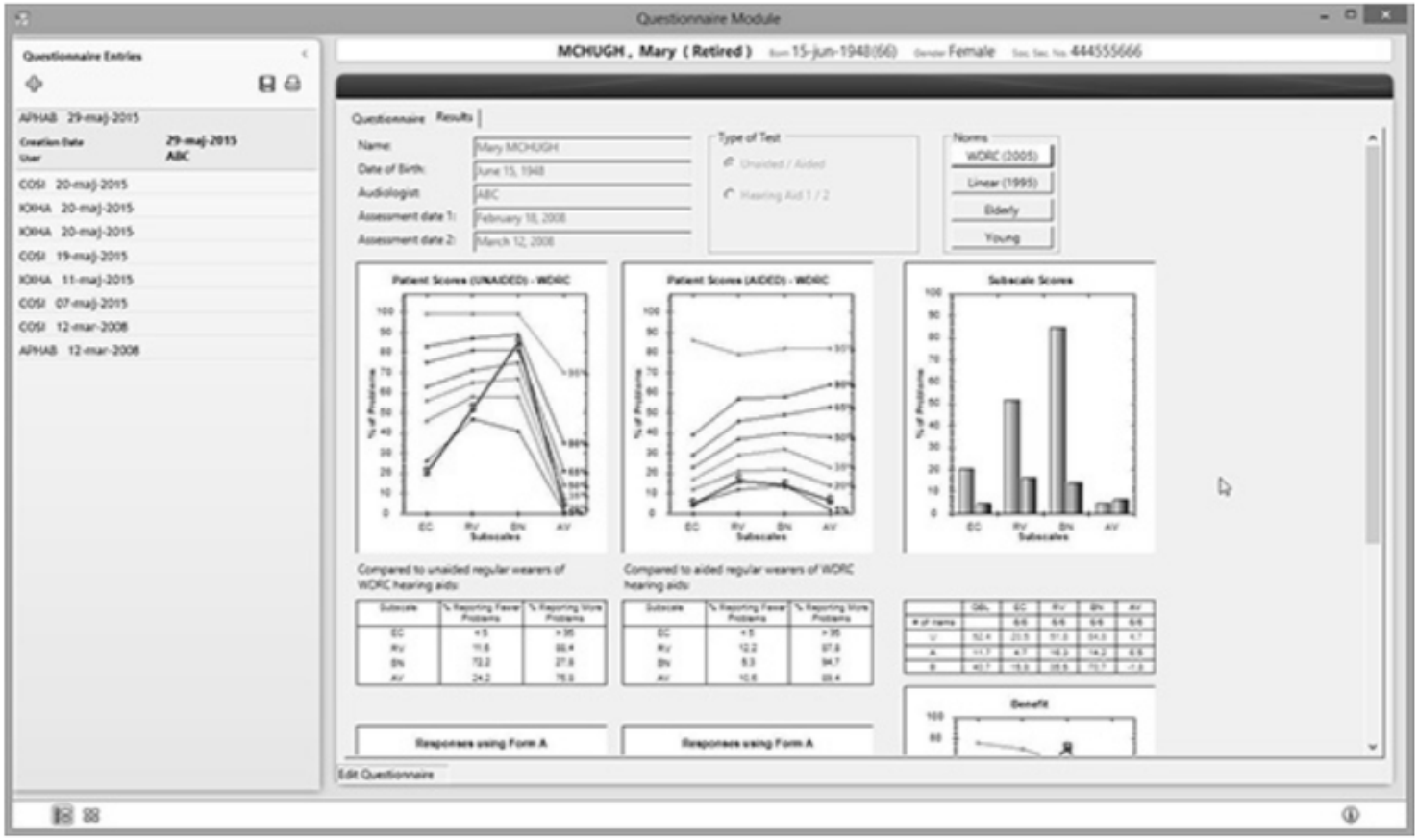
Useful charts for patient counseling



APHAB in Noah Questionnaire Module (13 languages)



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The International Outcome Inventory for Hearing Aids (IOI-HA)

- The IOI-HA is a short inventory used to quantify the effectiveness of hearing aid treatment.

- This inventory is unique in that it addresses several domains related to hearing aid use, and is the outcome measure that is available in the greatest number of different languages (~28), allowing for hearing aid outcome comparisons around the world.

- It can be useful for clinical comparisons across groups based on differences in clinical setting, treatment option, or even evaluation of the performance of individual HCPs.


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Hearing Aid Fitting Applications
RSIN
SIR
CST
VIOLA
Contour
AFAAF

INTERNATIONAL OUTCOME INVENTORY – HEARING AIDS (IOI-HA)

1. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the hearing aid(s)?

none	less than 1 hours a day	1 to 4 hours a day	4 to 8 hours a day	more than 8 hours a day
❑	❑	❑	❑	❑

2. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in that situation?

helped not at all	helped slightly	helped moderately	helped quite a lot	helped very much
❑	❑	❑	❑	❑

3. Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation?

very much difficulty	quite a lot of difficulty	moderate difficulty	slight difficulty	no difficulty
❑	❑	❑	❑	❑

4. Considering everything, do you think your present hearing aid(s) is worth the trouble?

not at all worth it	slightly worth it	moderately worth it	quite a lot worth it	very much worth it
❑	❑	❑	❑	❑

5. Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do?

affected very much	affected quite a lot	affected moderately	affected slightly	affected not at all
❑	❑	❑	❑	❑

6. Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties?

bothered very much	bothered quite a lot	bothered moderately	bothered slightly	bothered not at all
❑	❑	❑	❑	❑

7. Considering everything, how much has your present hearing aid(s) changed your enjoyment of life?

worse	no change	slightly better	quite a lot better	very much better
❑	❑	❑	❑	❑

Note: Each one of the 7 questions addresses one of the 7 domains

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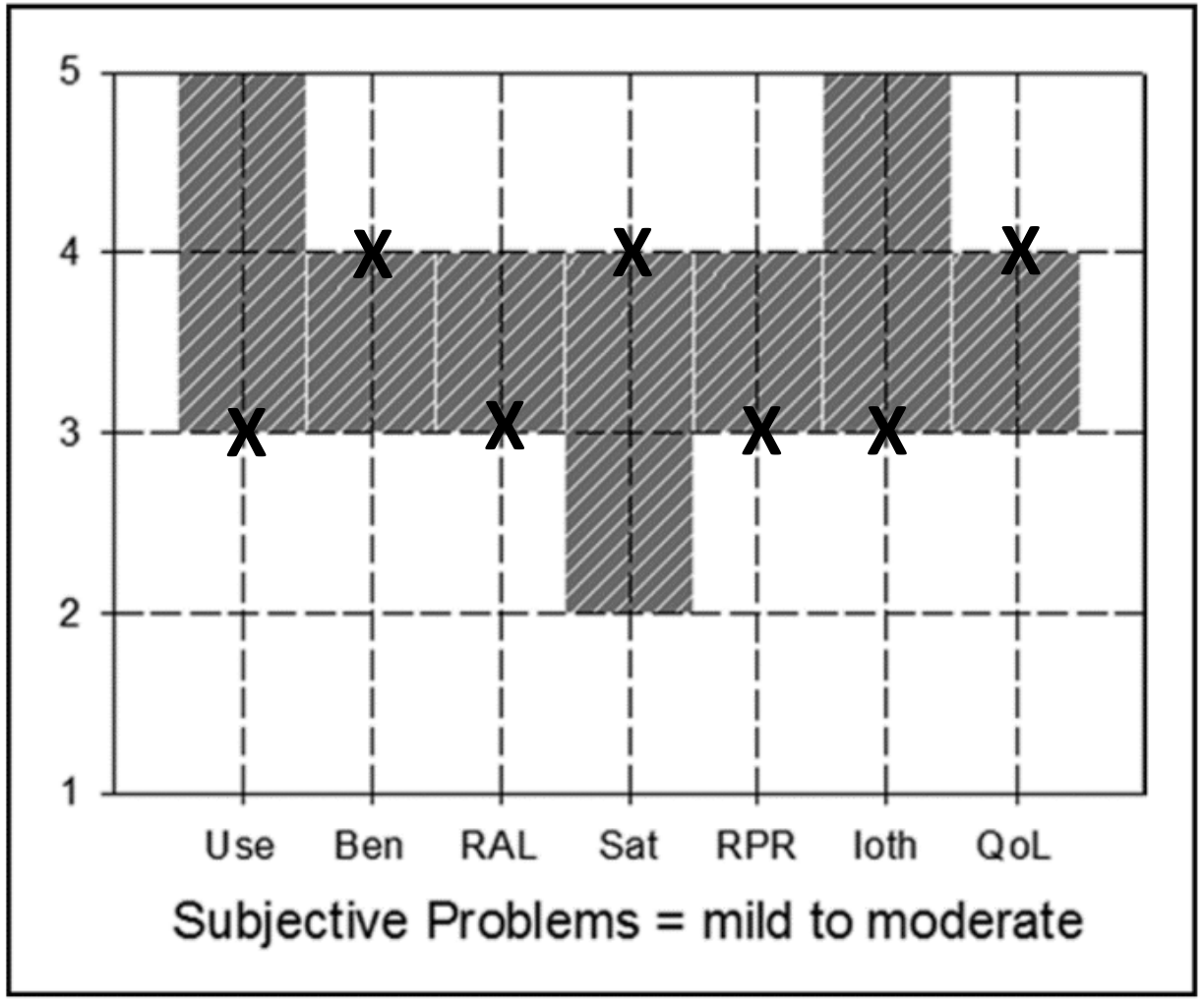
Administration and scoring of the IOI-HA

- The inventory is meant to be given in paper-and-pencil form. It is very self-explanatory, and there are no formal instructions.

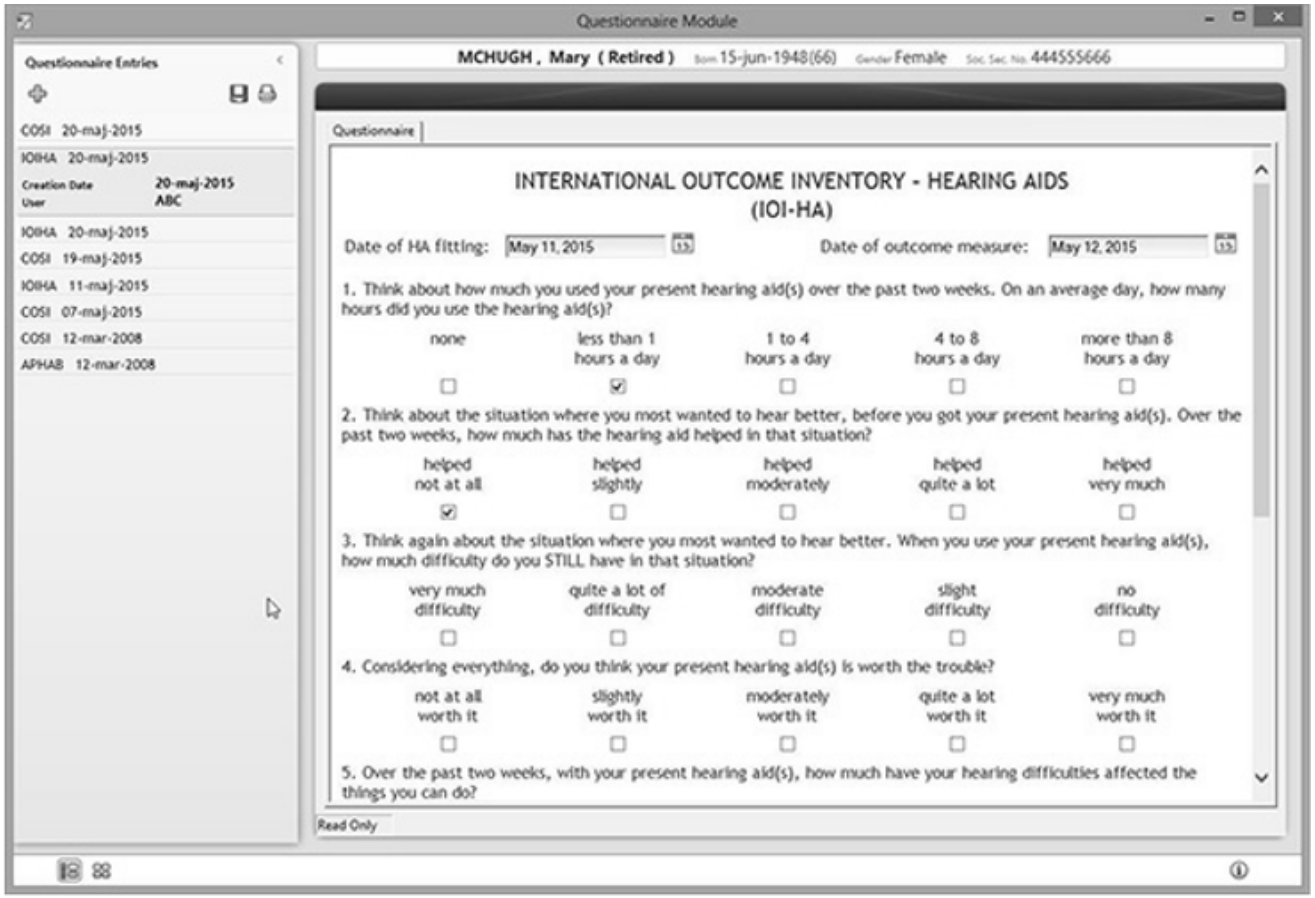
- To score the outcome, each answer is given a number value 1 (worst) through 5 (best). For this measure, a higher score is indicative of a better outcome.

- The general norms are shown on a summary score sheet. The shaded box indicates what would be considered “acceptable”.

- If a patient falls below “acceptable” for one of the categories, further explanation of the problem is warranted, and appropriate counseling applied.


5
4
3
2
1
Use
Ben
RAL
Sat
RPR
Ioth
QoL
Subjective Problems = mild to moderate

Questionnaire module of Noah



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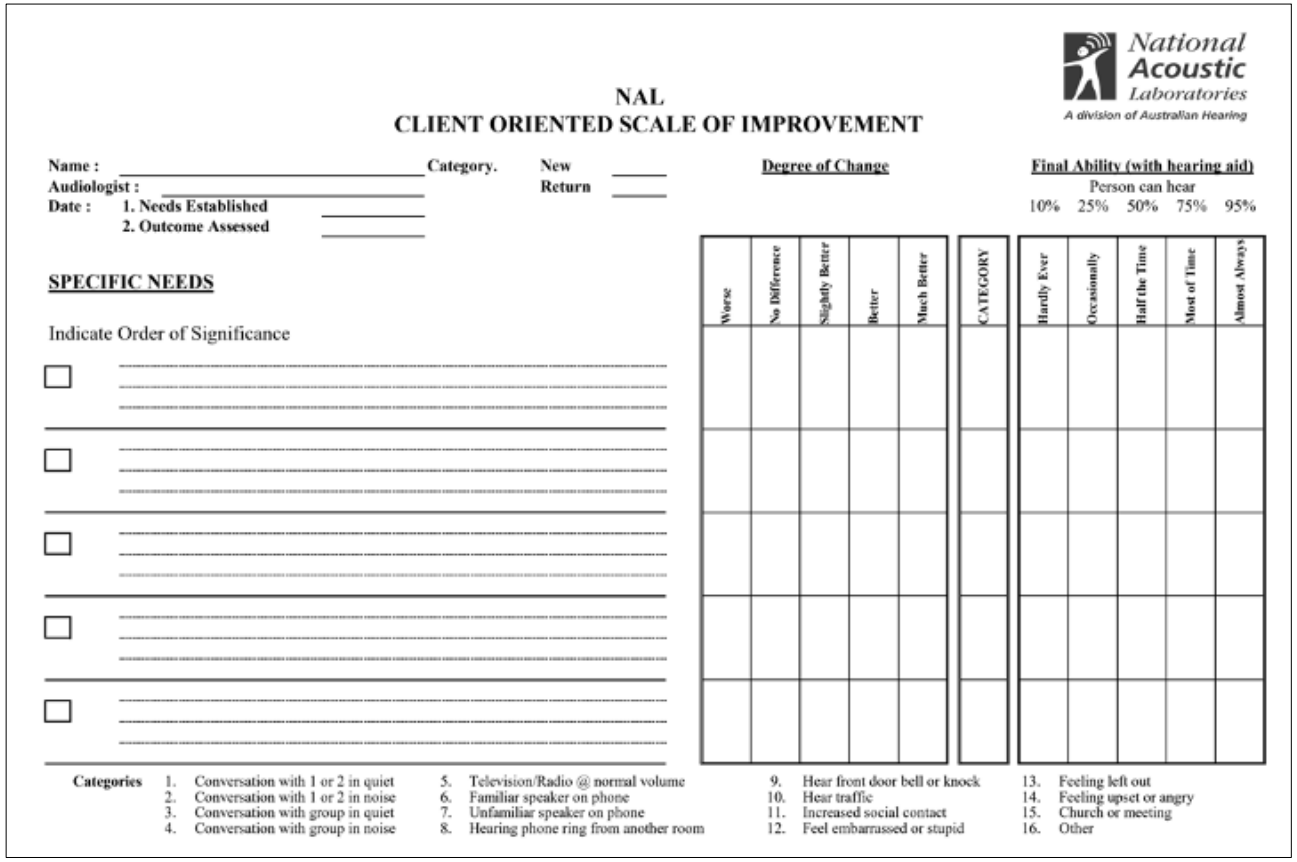
Client Oriented Scale of Improvement (COSI)

- The COSI is probably the most commonly used *outcome* measure.
- The COSI was designed to eliminate irrelevancy in an outcome questionnaire.
- The COSI allows patients to identify and rank order listening goals that are most important to them as an individual. No two COSIs are the same.
- In short, the COSI starts off as a blank page, then allows patients, with the help of the HCP, to design their own questionnaires.

The COSI form



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CLIENT ORIENTED SCALE OF IMPROVEMENT

Name : _____ **Category.** **New** _____
Audiologist : _____ **Return** _____
Date : **1. Needs Established** _____
2. Outcome Assessed _____

SPECIFIC NEEDS

Indicate Order of Significance

☐ _____
☐ _____
☐ _____
☐ _____
☐ _____

Degree of Change

Worse	No Difference	Slightly Better	Better	Much Better	CATEGORY

Final Ability (with hearing aid)
Person can hear

10%	25%	50%	75%	95%
Hardly Ever	Occasionally	Half the Time	Most of Time	Almost Always

Categories

1. Conversation with 1 or 2 in quiet
2. Conversation with 1 or 2 in noise
3. Conversation with group in quiet
4. Conversation with group in noise
5. Television/Radio @ normal volume
6. Familiar speaker on phone
7. Unfamiliar speaker on phone
8. Hearing phone ring from another room
9. Hear front door bell or knock
10. Hear traffic
11. Increased social contact
12. Feel embarrassed or stupid
13. Feeling left out
14. Feeling upset or angry
15. Church or meeting
16. Other

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Administration and Scoring

- The process begins by having the patient identify up to five specific listening situations in which he or she would like to hear better. It is important to stress these are *listening situations* and not necessarily just communication. We suggest having at least three items whenever possible. It is important to make each item as specific as possible.

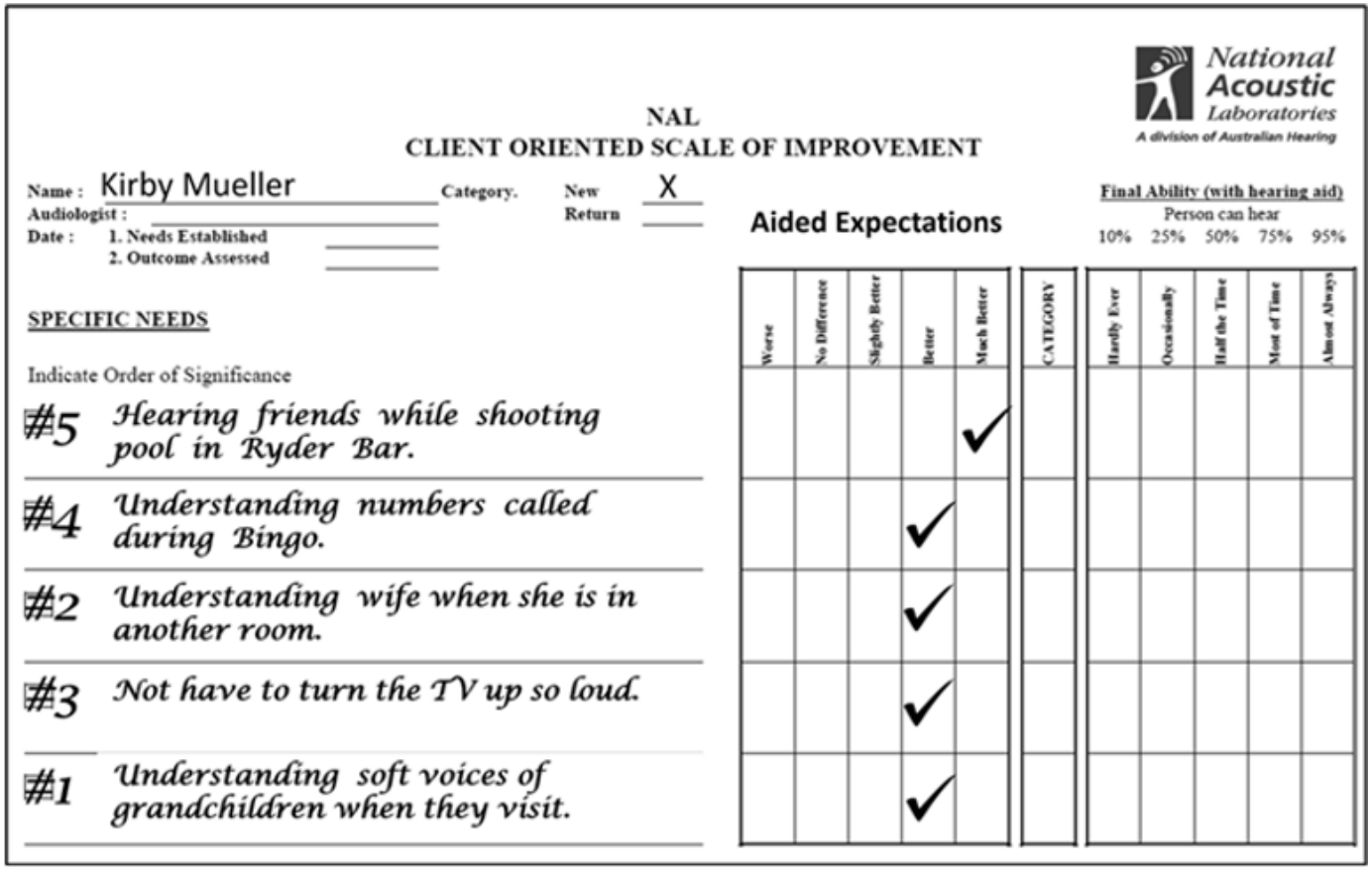
- Encourage to have the patient select goals that are encountered frequently.

- After all situations have been identified, it is then helpful to go back, review all situations, and have the patient rank order them. Simply place a 1 for most important, 2 for the second most important, and so on in the box to the left of the item.

- Once the items have been prioritized, we then have the patient select their expectations for each one of the items.

- After several weeks of hearing aid use the patient completes the COSI again, this time ranking benefit for each item.

Sample pre-ftting completed COSI with rated “expectations”



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NAL
CLIENT ORIENTED SCALE OF IMPROVEMENT

Name : Kirby Mueller Category. New X
Audiologist : Return
Date : 1. Needs Established
2. Outcome Assessed

SPECIFIC NEEDS

Indicate Order of Significance

Aided Expectations

Final Ability (with hearing aid)
Person can hear

		Worse	No Difference	Slightly Better	Better	Much Better	CATEGORY	10% Hardly Ever	25% Occasionally	50% Half the Time	75% Most of Time	95% Almost Always
#5	Hearing friends while shooting pool in Ryder Bar.					✓						
#4	Understanding numbers called during Bingo.				✓							
#2	Understanding wife when she is in another room.				✓							
#3	Not have to turn the TV up so loud.				✓							
#1	Understanding soft voices of grandchildren when they visit.				✓							

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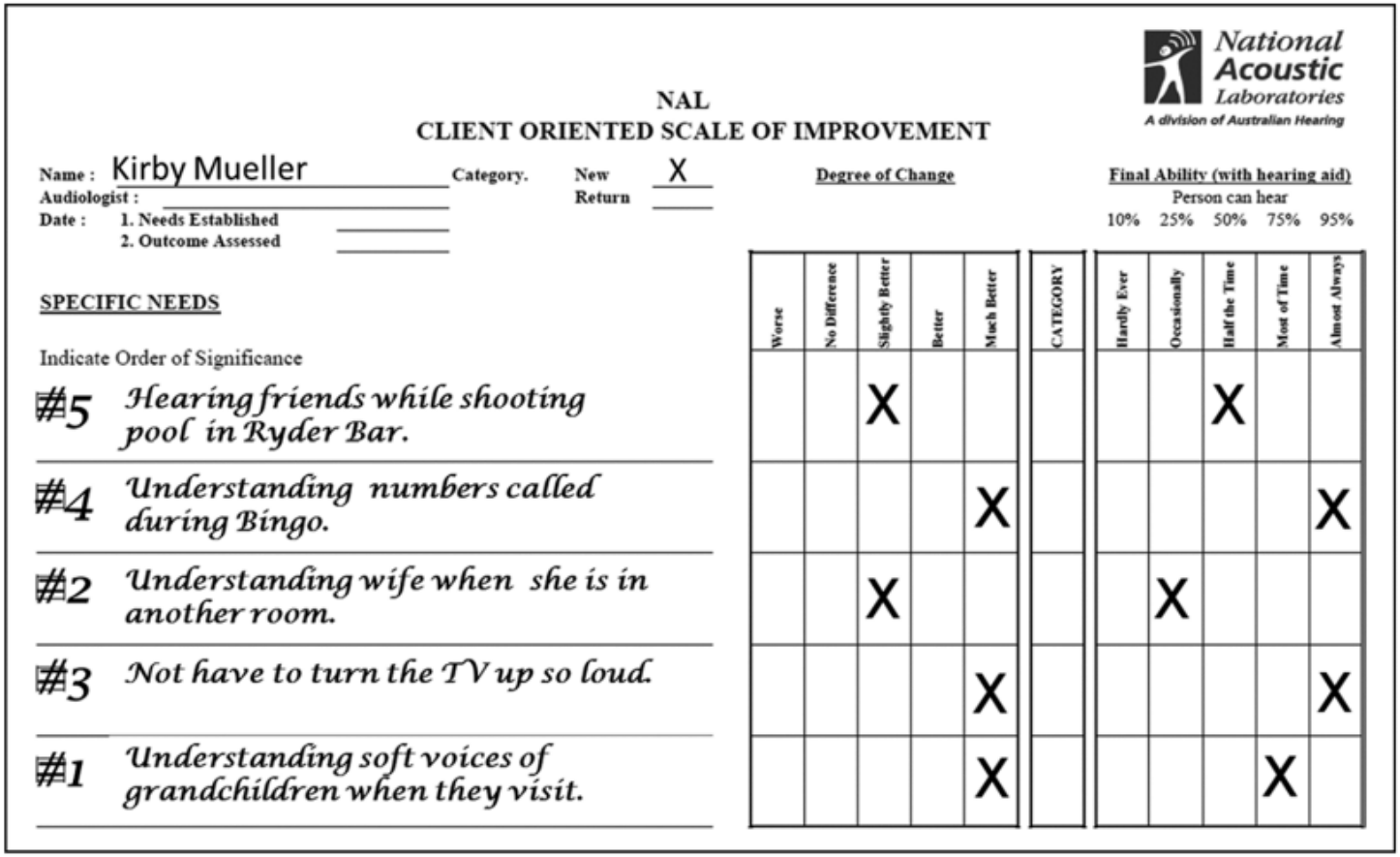

National Acoustic Laboratories
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NAL
CLIENT ORIENTED SCALE OF IMPROVEMENT

Name : Kirby Mueller Category. New X
Audiologist : Return
Date : 1. Needs Established
2. Outcome Assessed

SPECIFIC NEEDS

Indicate Order of Significance

		Degree of Change						Final Ability (with hearing aid) Person can hear				
		Worse	No Difference	Slightly Better	Better	Much Better	CATEGORY	Hardly Ever	Occasionally	Half the Time	Most of Time	Almost Always
								10%	25%	50%	75%	95%
#5	*Hearing friends while shooting pool in Ryder Bar.*			X						X		
#4	*Understanding numbers called during Bingo.*					X						X
#2	*Understanding wife when she is in another room.*			X					X			
#3	*Not have to turn the TV up so loud.*					X						X
#1	*Understanding soft voices of grandchildren when they visit.*					X					X	

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Questionnaire module of Noah

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The APHAB . . THE IOI-HA . . The COSI

- Easy to administer and score
- Easy for the patient to understand
- Provide useful information for several domains related to the use of hearing aids.

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RESEARCH QUICK TAKES

6.8: Hearing Aid Fitting Toolbox: Self-assessment outcome measures

Brian Taylor & Gus Mueller