

Academia CLAYTON FISHER

M.Cl.Sc., Audiologist

Case Studies in Real-Ear Measurement



Wednesday, Nov. 29, 2023

12:00PM EST



About Me



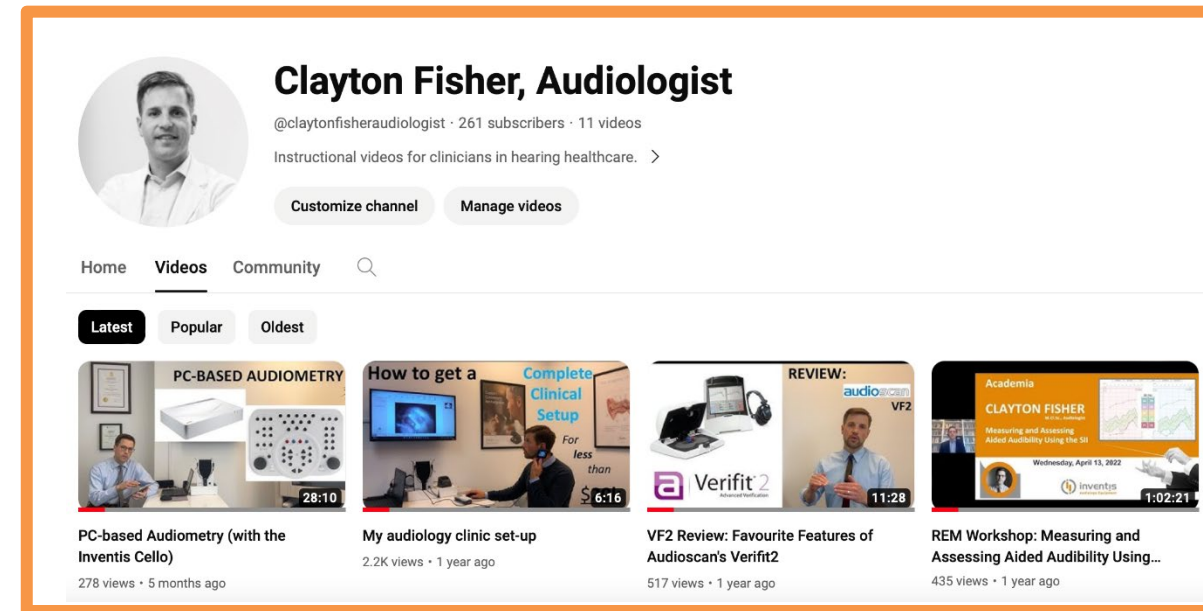
a c a d e m i a

I do not have a PhD, nor do I have an AuD...

But, I have fit thousands of hearing aids;

I do it daily and have a strong background

- Despite my clinical experience, I still find fitting hearing aids challenging
- I like teaching; I have mentored or supervised at least a dozen students and helped dozens more colleagues with REM
- I created a YouTube channel to support clinicians, particularly around HA fittings



<https://www.youtube.com/@claytonfisheraudiologist/videos>

Workshop Goals



a c a d e m i a

Learning Objectives:

- 1) Learn some history around the REAR and hearing aid fitting protocols
- 2) Learn tips and tricks to facilitate workflow and ensure accurate real-ear measurements (REM)
- 3) Learn techniques for fitting “tricky-to-fit” hearing loss, such as slight and mild losses

Workshop Outline



a c a d e m i a

- **Part 1: Why and how I fit hearing aids the way I do**
 - Some history on the REAR
 - Background on my fitting philosophy and protocol
 - Workflow tips and tricks for fast, accurate fittings
- **Part 2: Case Studies**
 - SNHL (various degrees, configurations, symmetries)
 - MHL / CHL (Otosclerosis)
 - Trickier fittings (mild losses, upward sloping, etc.)

Real-Ear Aided Response



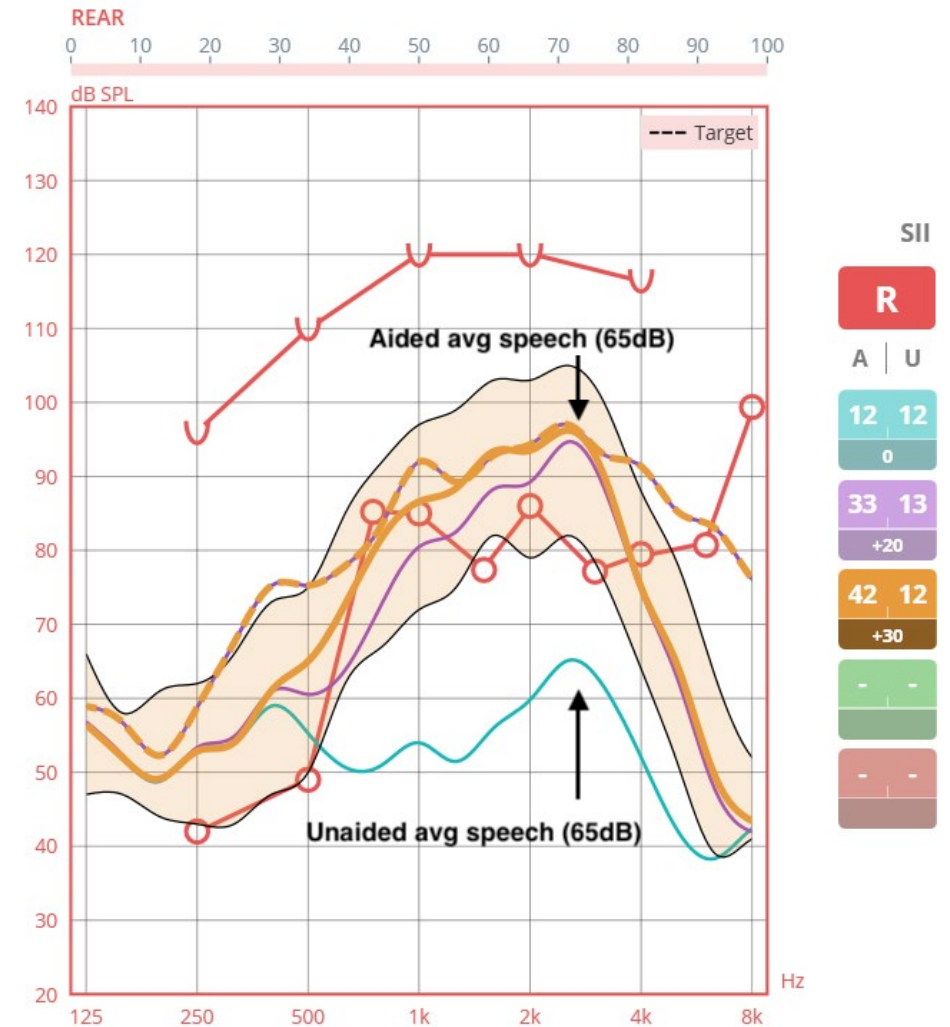
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Today we will be exclusively looking at the “Aided” screen on the Trumpet

- **AKA:**

- “SPLoGRAM”
- “SpeechMapping”

We are looking at the measured frequency response (of the hearing aid) in the ear canal i.e. the dB SPL recorded across frequencies in relation to the patient’s hearing thresholds, prescriptive targets, and LDLs



REAR – Some History



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Our modern fitting process is based on the pioneering work of many others:

28 J.A.R.A.

XX 25-37 1987

Selecting and Verifying Hearing Aid Performance Characteristics for Young Children

Richard C. Seewald
University of Western Ontario

Mark Ross
University of Connecticut

Patricia G. Stelmachowicz
Boys Town National Institute for Communication Disorders in Children

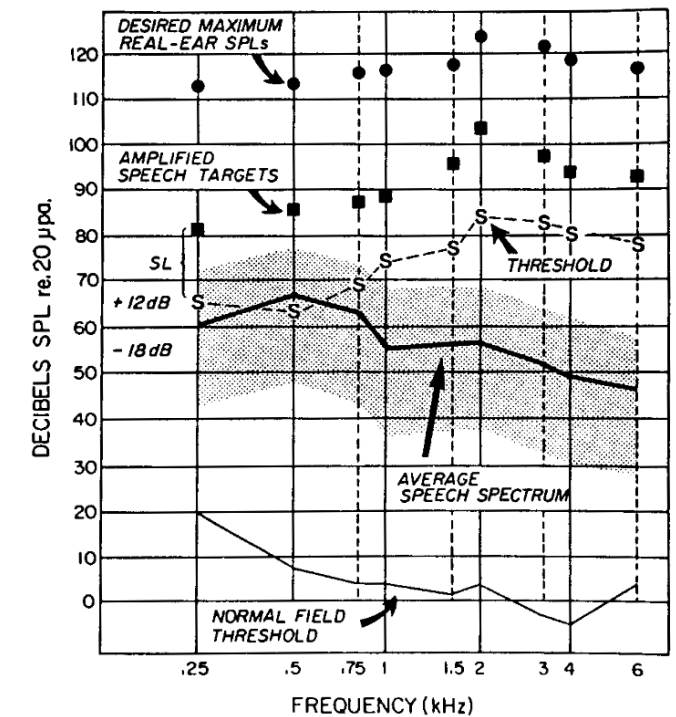


Figure 2. Unaided sound field audiogram in dB SPL (S) for a child with a moderately-severe sensorineural hearing loss. The target sound pressure levels for amplified speech (■) and desired maximum sound pressure levels (●) are shown as a function of frequency. The long-term average speech spectrum (adapted from Cox, 1983) with its associated 30-dB intensity range is also shown.

Note: Desired Sensation Level (DSL) prescribes an ear canal hearing instrument output in dB SPL

Read full article here:

https://www.audrehab.org/files/ugd/cafe823_e9b643e457cd462c91ca5b06d1001d2e.pdf

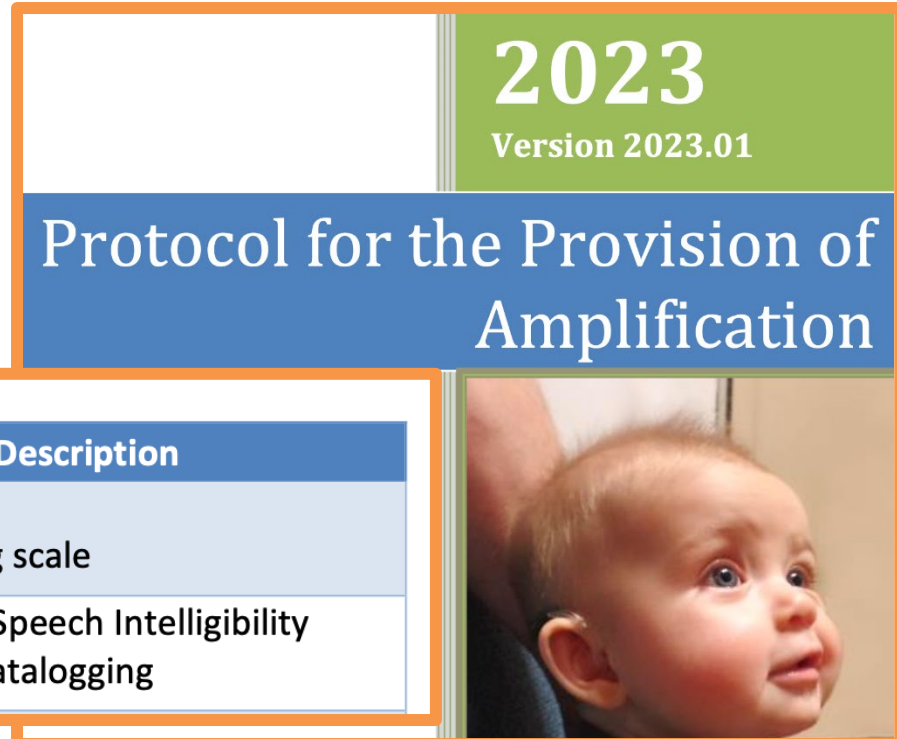
Fitting Protocols



a c a d e m i a

For infants, we have very high fitting standards:

- For example, the Infant Hearing Program in Ontario, Canada defines specific criteria for what is considered a high-quality hearing aid fitting



The IHP Outcome Measurement tools consist of the following:

Tool	Purpose	Description
Amplification Benefit Questionnaire	- Acceptance & use of hearing aids - Satisfaction with services	11 items 5 point rating scale
Hearing Aid Fitting Details	- Quality of hearing aid fitting	RECD, MPO, Speech Intelligibility Index (SII), Datalogging

Complete Protocol Available here:

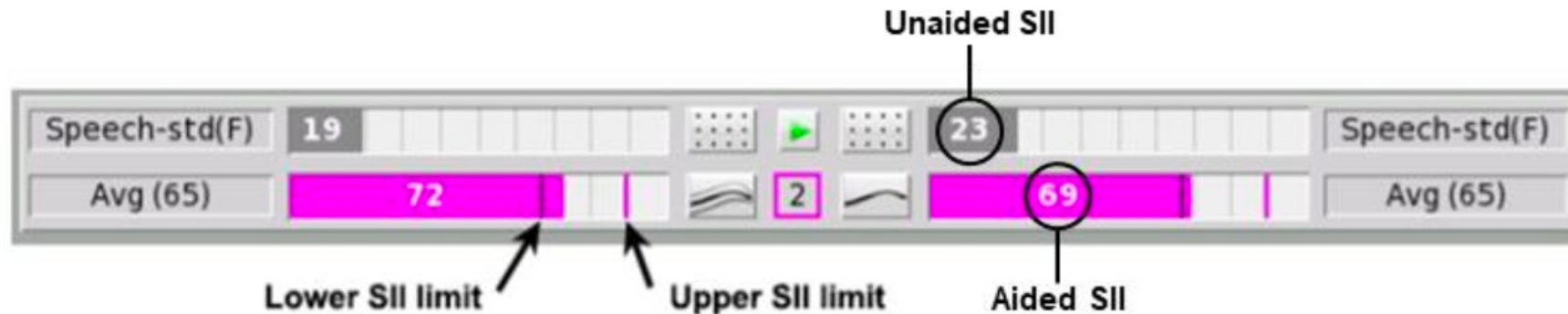
Fitting Protocols



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Aided Speech Intelligibility Index (SII) values should be within expected normative range

SII: the proportion/percentage of speech that is audible to a patient



The norms that were previously only available for children are now known for adults!

Dao A, Folkeard P, Baker S, Pumford J, Scollie S. Fit-to-Targets and Aided Speech Intelligibility Index Values for Hearing Aids Fitted to the DSL v5-Adult Prescription.

J Am Acad Audiol. 2021 Feb;32(2):90-98. doi: 10.1055/s-0040-1718707. Epub 2020 Dec 9. PMID: 33296929.

My Fitting Philosophy



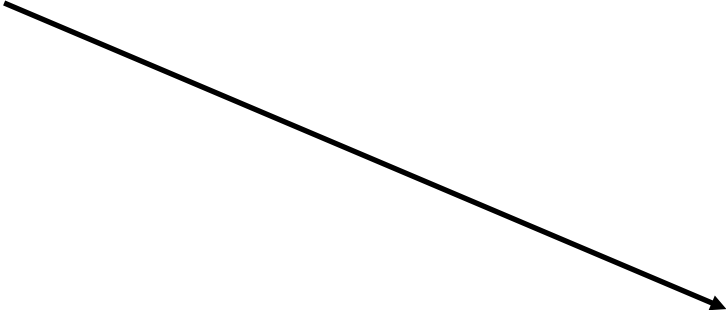
a c a d e m i a

Adults deserve the same level of care as infants and children

- Achieved aided audibility (SII) should be within an expected range, or
- **Improvements in audibility (change in SII) should be as expected**

Outcomes must be documented

- We must validate the success of the fitting
 - Questionnaires on perceived improvement (COSI, etc.)
 - Datalog (hrs/day)



R		L	
A	U	A	U
29	29	43	43
0	0	0	0
50	30	64	44
+20		+20	

My Fitting Goals



a c a d e m i a

1) **Maximize audibility**

- Trying to get the largest **change in SII** (aided-unaided)

2) **Maintaining loudness comfort**

- While having patient feel it is not uncomfortably loud

Since this is also the goal of DSL...

- Prescriptive targets are the blueprint to achieving this

Goal 1: Maximize Audibility



a c a d e m i a

My focus is not the ultimate aided SII, but rather how much change (improvement) is observed (Aided – Unaided)

- The Trumpet not only automatically calculates aided SII values and predicts unaided SII values...
 - It calculates the difference for you!



I have created a tool to help clinicians interpret SII change values for average speech

Rating	Change in SII65 (aided - unaided)	Expected Patient Benefit
Very High	> 25	Excellent Improvement Expected
High	20 - 25	Very Good Improvement Expected
Average	15 - 19	Good Improvement Expected
Fair	10 - 14	Noticeable Improvement Expected
Low	5 - 9	Slight improvement expected (unless loss is mild or precipitously sloping)
Very Low	< 5	Minimal improvement expected: Re-examine fitting (unless loss is slight)
Nil	0 (or negative)	Red Flag - Re-examine fitting

The **Expected Benefits with Amplification** (EBA) tool helps predict a patient's expected benefit with HAs

Goal 2: Loudness Comfort



a c a d e m i a

Patients must rate the loudness of speech with HAs on

- Give the patient the Cox loudness scale to hold
- Have them rate the loudness/volume by pointing to the appropriate rating...
 - ***while the speech is running***
- Average speech (65dB) should be # 5
 - **“Comfortable, but slightly loud”**
 - (new users)
 - or “Comfortable” for experienced users



Robyn M. Cox

7. UNCOMFORTABLY LOUD
6. LOUD, BUT OK
5. COMFORTABLE, BUT SLIGHTLY LOUD
4. COMFORTABLE
3. COMFORTABLE, BUT SLIGHTLY SOFT
2. SOFT
1. VERY SOFT

Figure 5. *Chart of loudness categories.*

My Fitting Protocol



a c a d e m i a

If hearing loss is fairly standard e.g. Mild/mod to mod-severe...

I run AutoREM (if available for manufacturer and REM system)

- This creates a really good starting point, but I always check with
- **Manual measurements** to obtain SII values, run MPO, and make further adjustments (hybrid approach)

Why AutoREM?

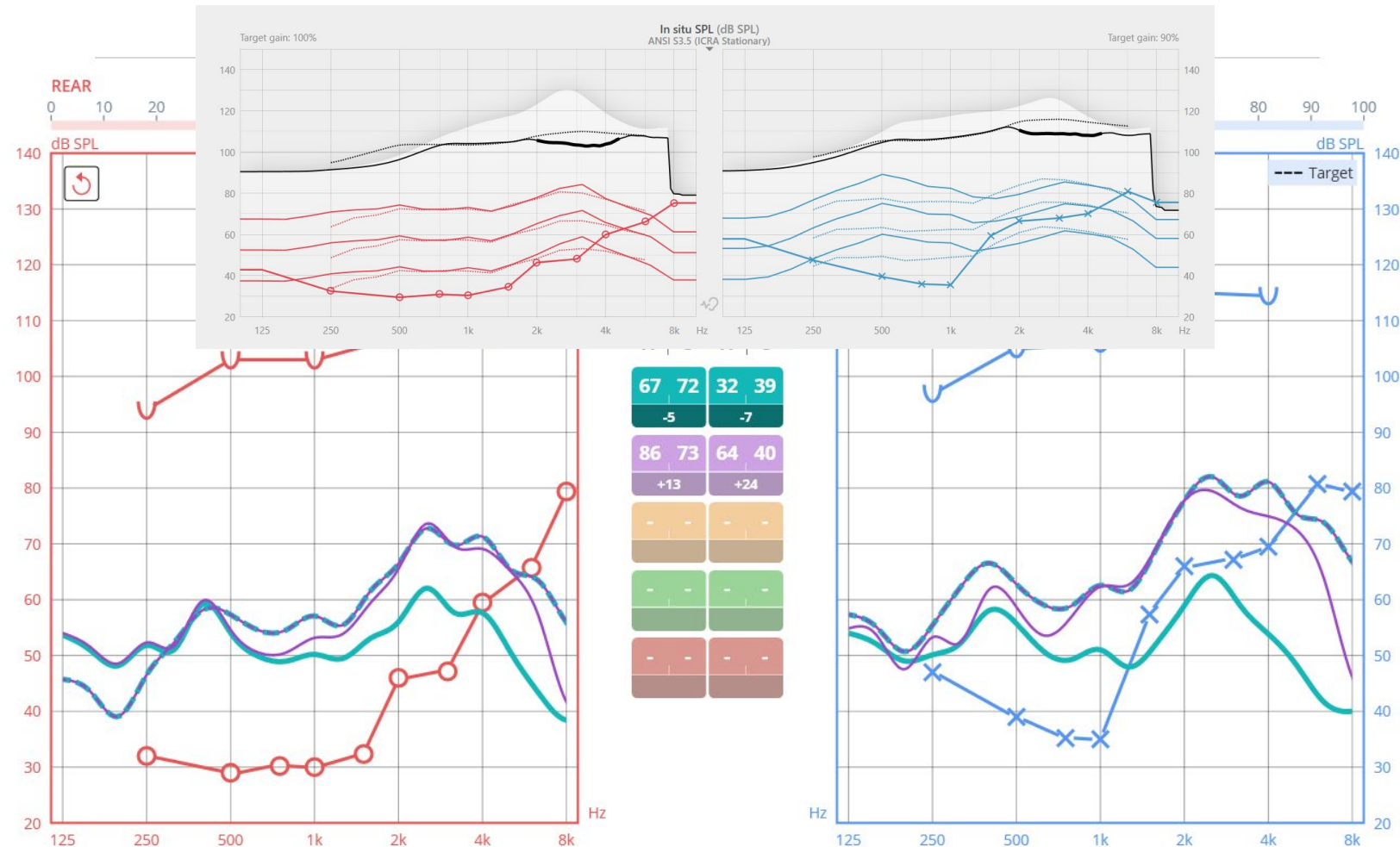
- It is fast and objective
- It is convenient
- However, it is not always appropriate
 - e.g. slight / mild losses, etc.

My Fitting Protocol



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AutoREM example 1

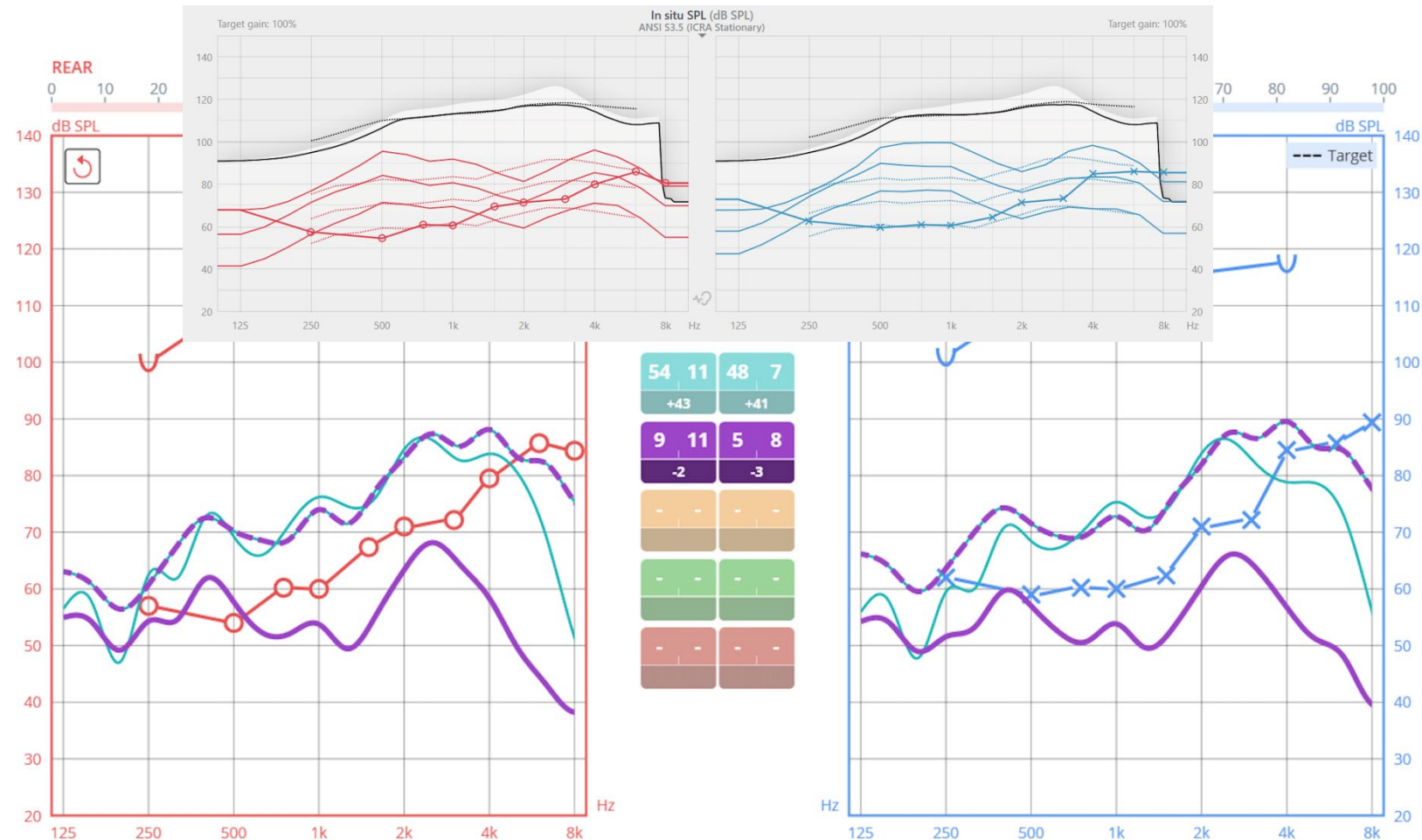


My Fitting Protocol



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AutoREM example 2



If loss is not straight forward, or the patient is an experienced HA user...

I use a fully manual approach:

- Measure REUR with 70 dB Pink Noise (for ear canal resonance characteristics)
- Measure MPO and adjust as needed
- Manually **run unaided speech at 65dB** (or aided with old HAs) in "Aided" screen
- Run aided speech at 65dB and adjust as needed
- Assess loudness and make further adjustments, as needed
- Run additional levels, as needed/desired, e.g. soft (55dB) and loud (75dB)

My Fitting Protocol



a c a d e m i a

- **For all of the upcoming case examples**
 - I am using average RECDs; but measured is better!
 - I am using predicted UCLs; but measured is better!
 - REUR for pink noise (ear canal resonance) is measured
 - Prescriptive targets are DSL v5 Adult

On the assessment side:

- AI = Articulation (Audibility) Index
 - This is essentially the SII based on HL audiogram
 - Note: for 60 dB SPL speech

A screenshot of the 'Fitting Rule' settings window for 'DSL_V5'. The window has a title bar with 'Fitting Rule' and a dropdown menu showing 'DSL_V5'. Below the title bar is a 'SETTINGS' button and an information icon. The main content area is titled 'Traces/curves in use' and contains a table with four rows: 'Associated PTA', 'REUG', 'RECD', and 'UCL'. The values for these rows are '15-Sep-23', 'Measured', 'Predicted', and 'Predicted' respectively.

Traces/curves in use	
Associated PTA	15-Sep-23
REUG	Measured
RECD	Predicted
UCL	Predicted

Case Study #1

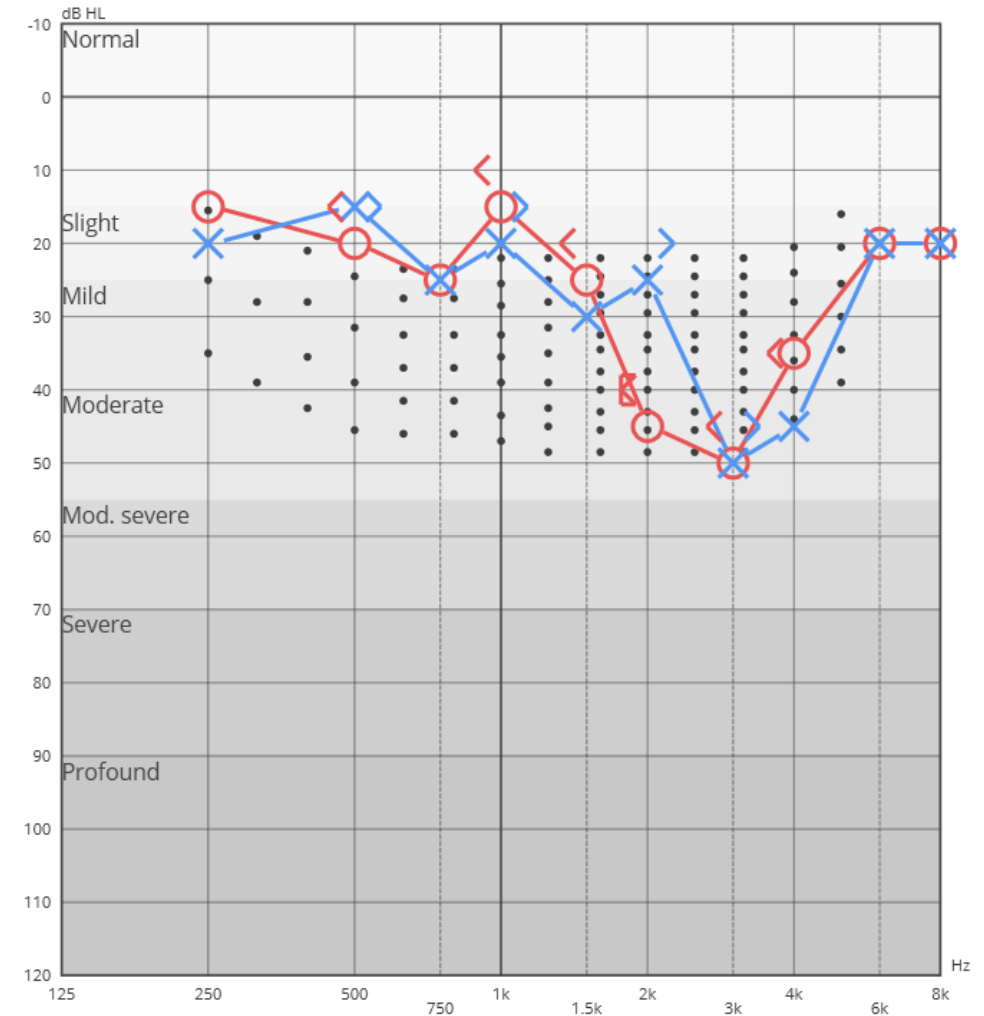


a c a d e m i a

We are going to use the first case to show the workflow process of a manual fitting

33 year old woman, special needs teacher

- **History:** Feeling of “blockage” in ears; came in for wax removal, but no wax!
- **AI** = 61 (R) and 62 (L)
- **Hearing difficulties:**
 - listening effort;
 - low talkers (partner, who is soft-spoken)
 - staff meetings – from a distance



Case Study #1

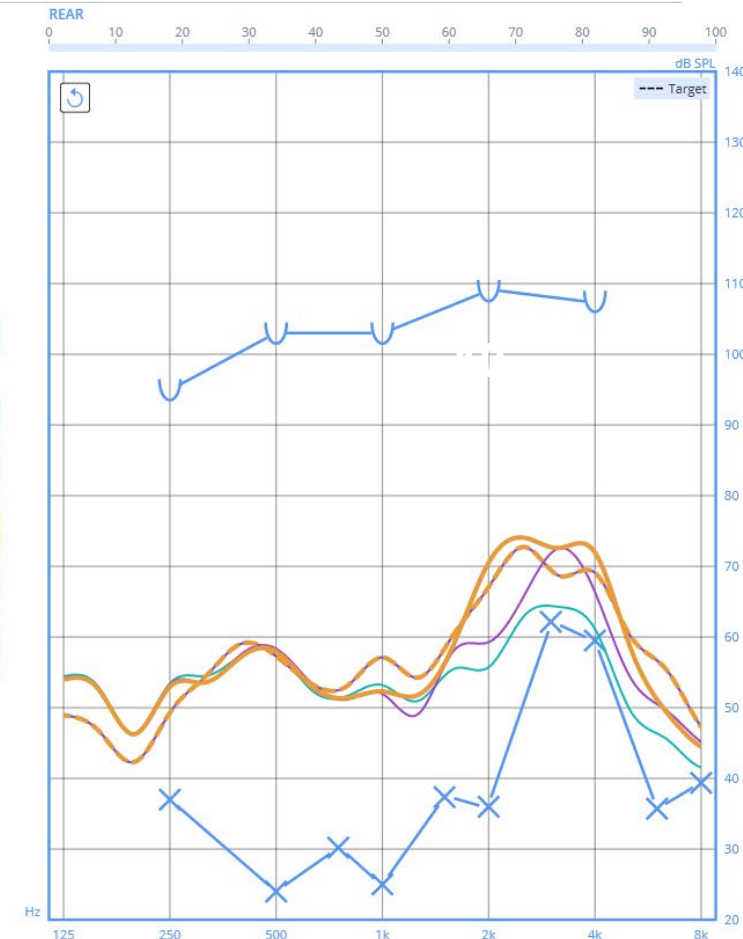
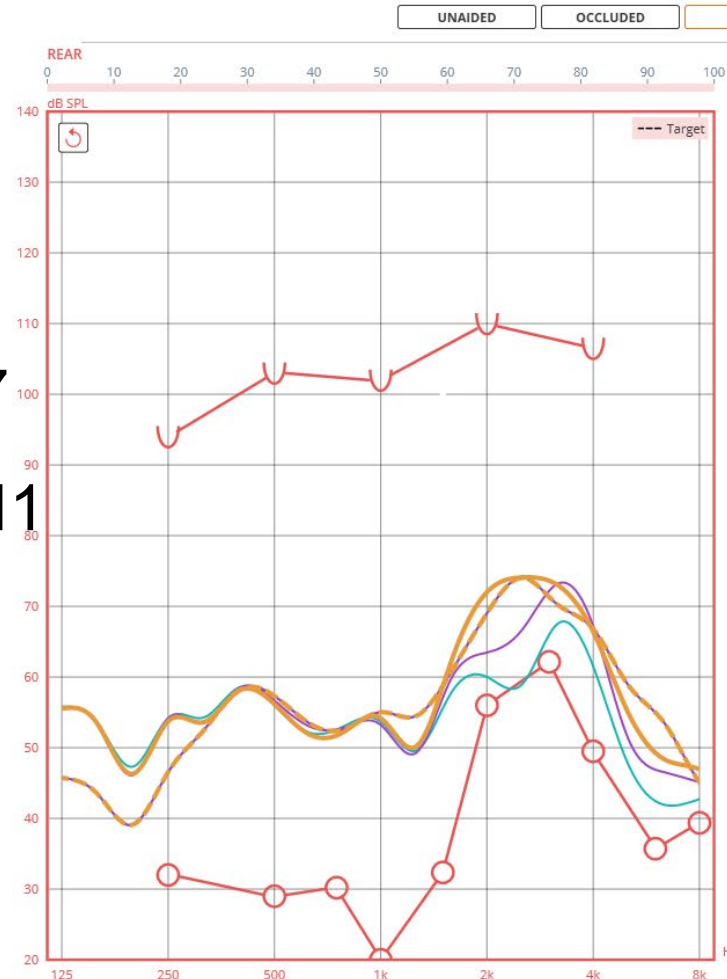


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Hearing aid Fitting

RICs with M receivers and open domes

- **Change in SII:**
 - “Best fit” = R = 6; L = 7
 - Adjusted: R = 11; L = 11
- **Improvement on COSI:**
 - TBD
- **Datalog:** TBD

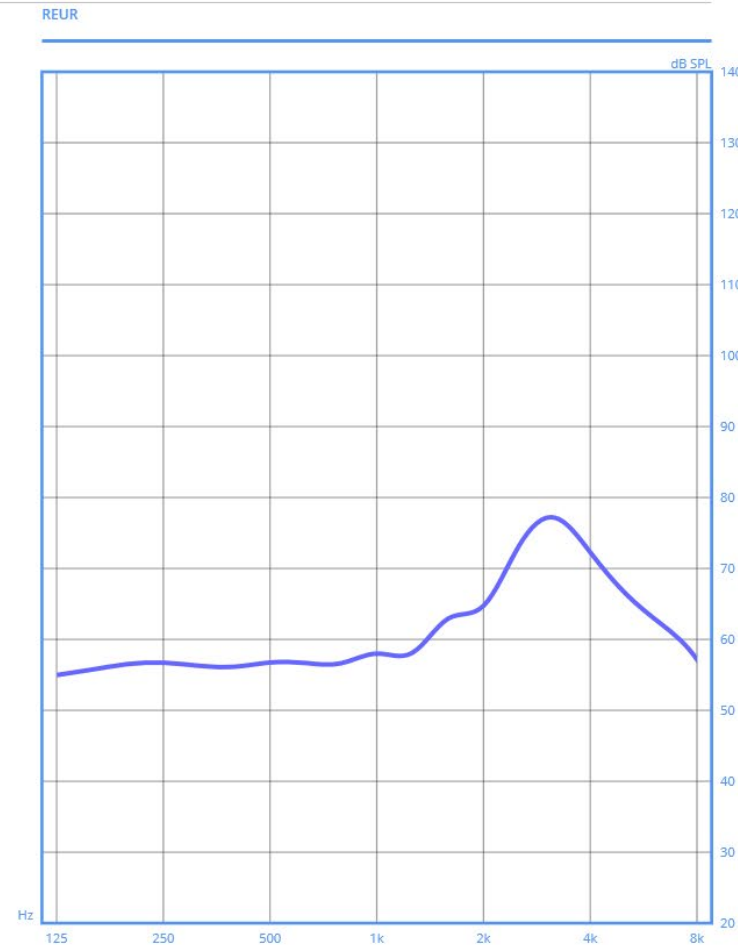
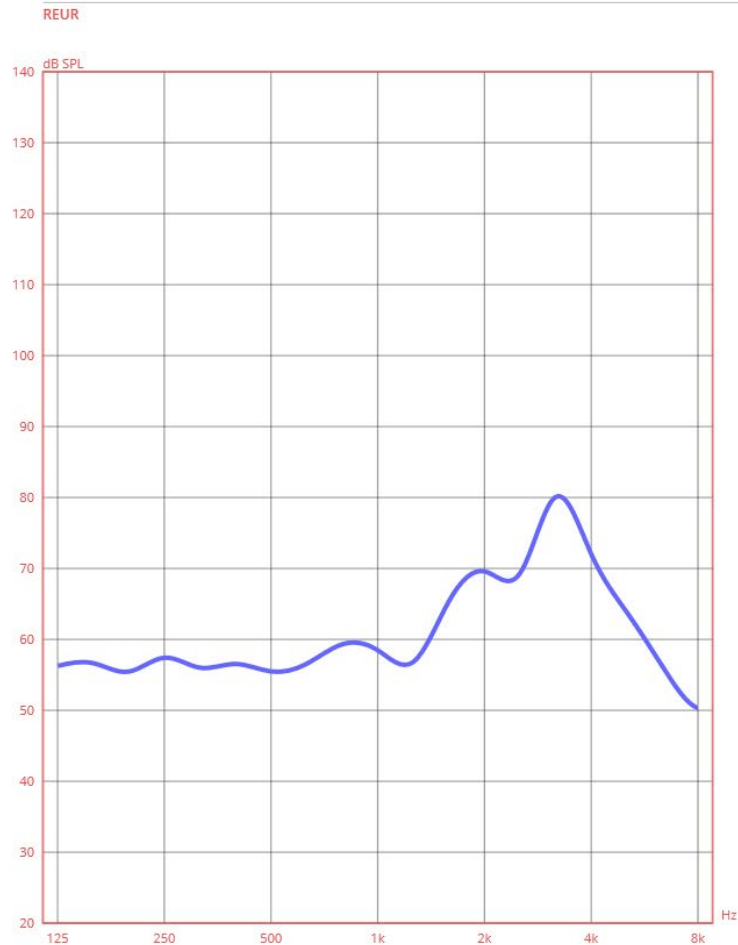


Step By Step



a c a d e m i a

Quickly measure REUR for pink noise; assess ECR

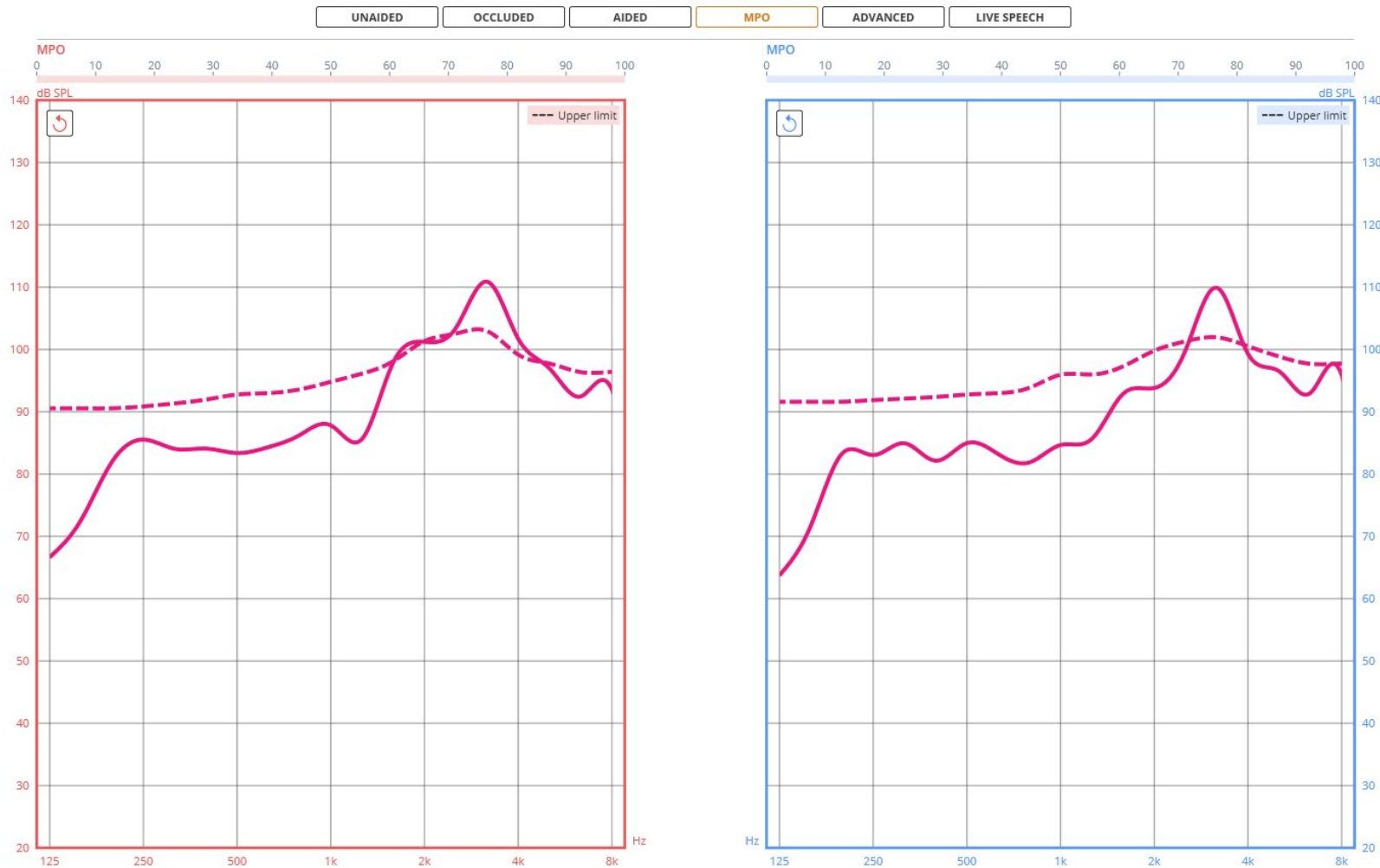


Step By Step



a c a d e m i a

Run MPO and make adjustments



Measure unaided average speech (65db)

REAR

dB SPL

418 Hz
88 dB SPL

--- Target

Hz

BLUE

dB SPL

--- Target

Hz

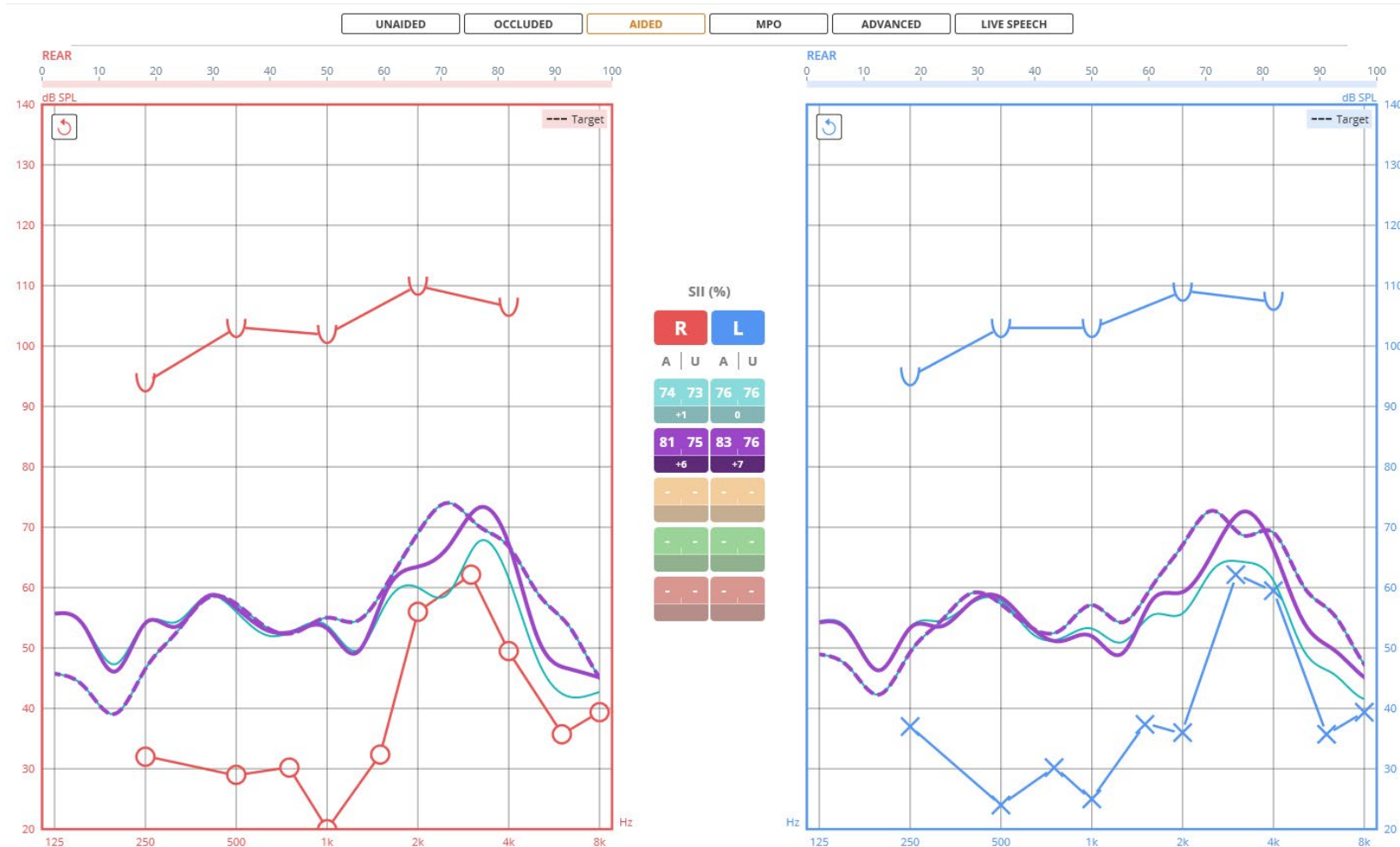
SII (%)	
R	L
A	U
74	73
76	76
+1	0
-	-
-	-
-	-
-	-
-	-

Step By Step

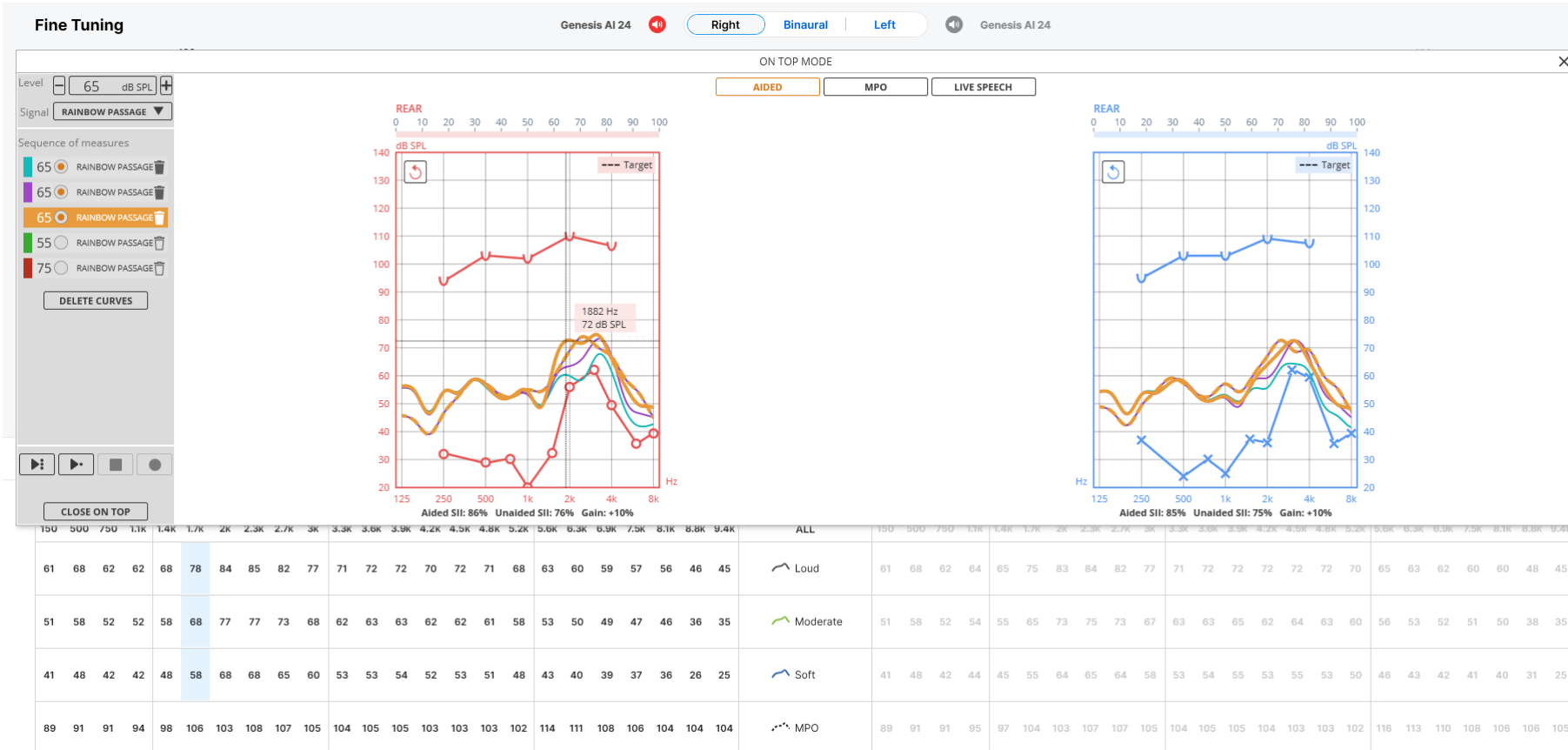


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Measure aided average speech for “best fit”



Manually make adjustments to target in *on-top* mode

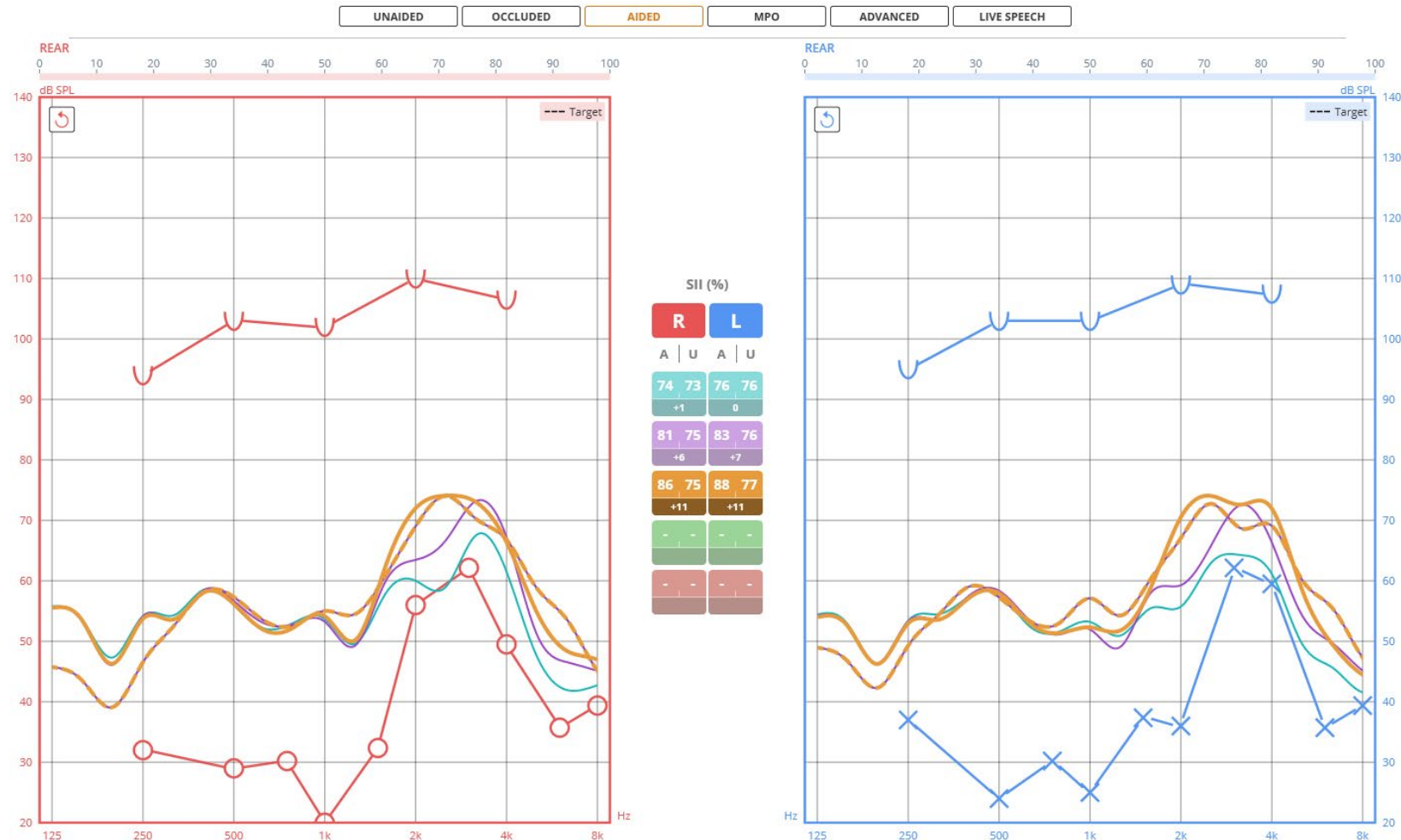


Step By Step



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Re-run average 65dB speech (aided)

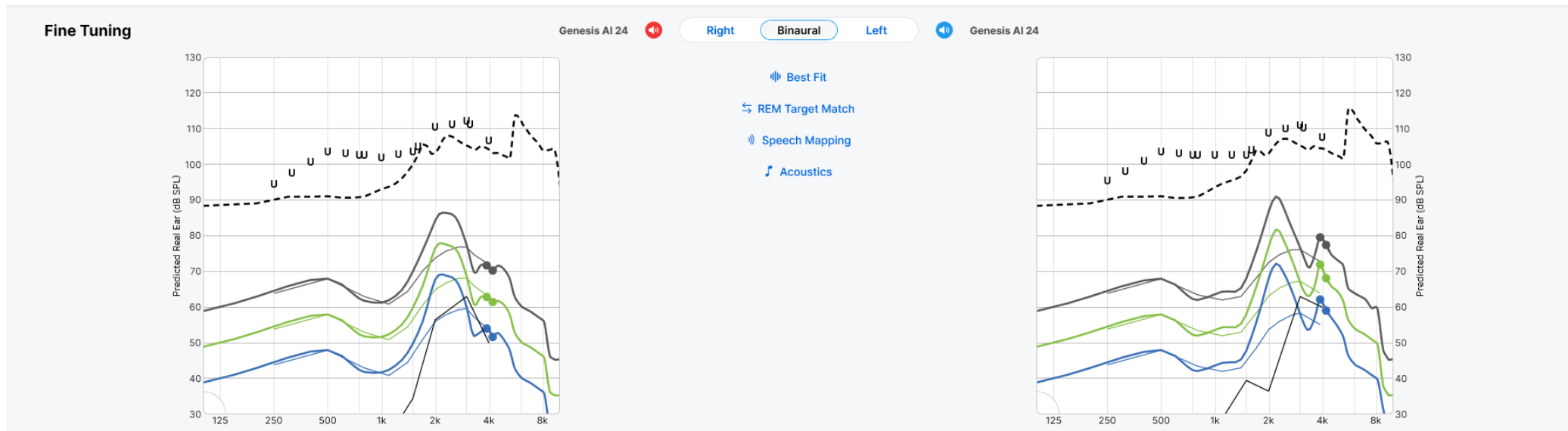


Step By Step



a c a d e m i a

Don't freak out if your simulated curves look wacky!



(everything is going to be OK!)

These tools can make life easier and speed things up:

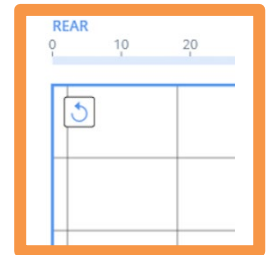
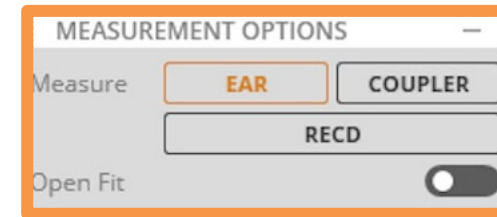
- I use AutoREM, whenever possible
 - Not appropriate for all degrees and configurations
- I use binaural, whenever possible
 - May not make sense with very asymmetrical losses
- I always use the on-top feature
 - Allows single screen adjustment

Tips for Accuracy



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- **You want your measurements to be accurate (obviously)**
 - Calibrate for room every time (Speaker equalization)
 - Leave “open fit” off and mute HAs before every level calibration
 - Even if fitting is open (remember to unmute the aids after!)
 - Re-run curves, as needed (check tube, HA, patient movement)
 - Consider doing sequential, monaural measurements
 - For “binaural”, if the difference between R/L sides on calibration is >5dB, it will not let you run the measurement
 - But, if it is <5dB the difference in output at the ears is averaged



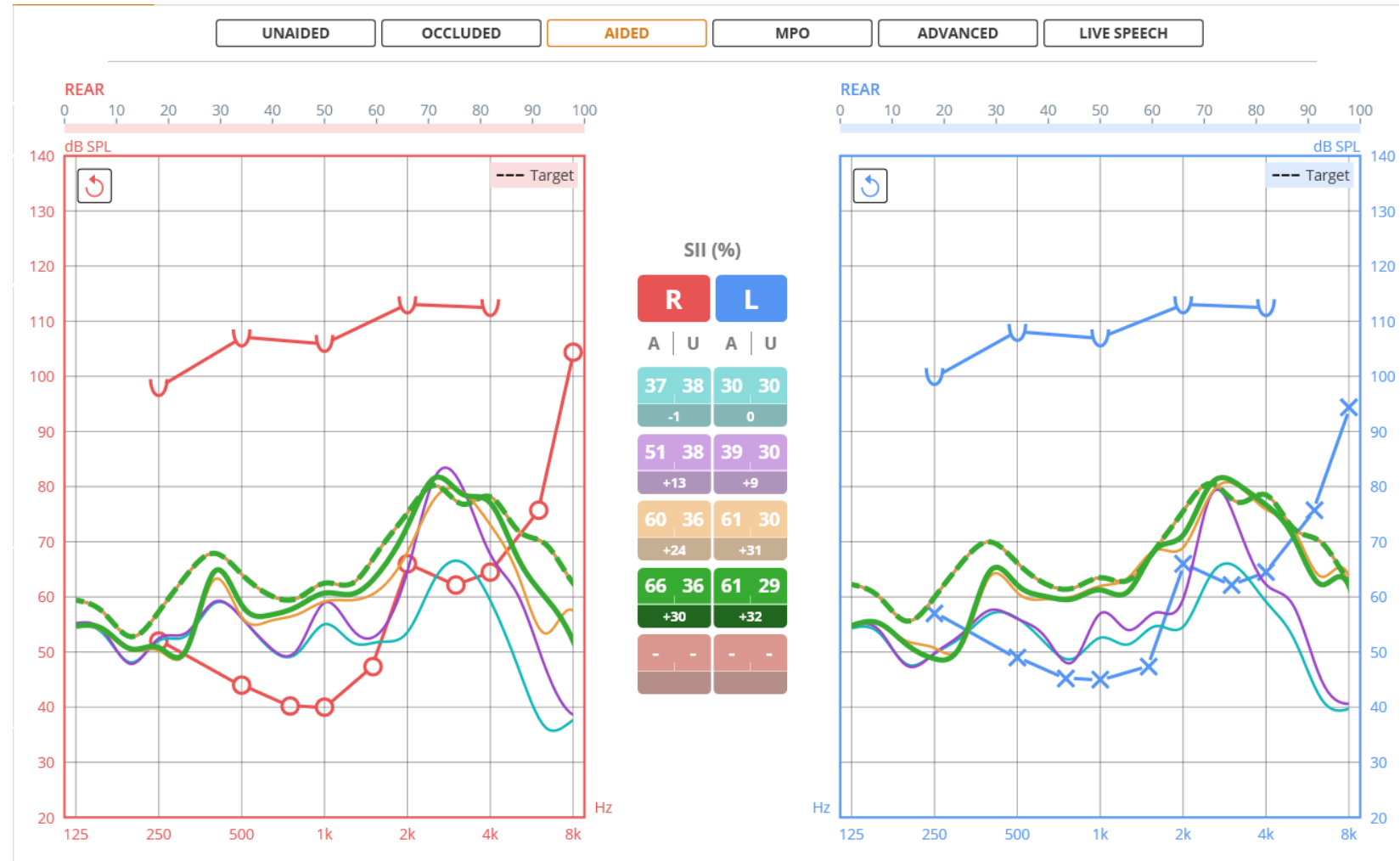
Part 2: More Case Studies!



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“Curve Tour”:

- **Turquoise:** Unaided 65
- **Purple:** Aided 65
 - “BestFit”, Demo
 - (Or in this case, with old hearing aid)
- **Orange:** Aided 65
 - Adjusted
- **Green:** Final Aided 65
 - (or soft (55))



Case Study #2

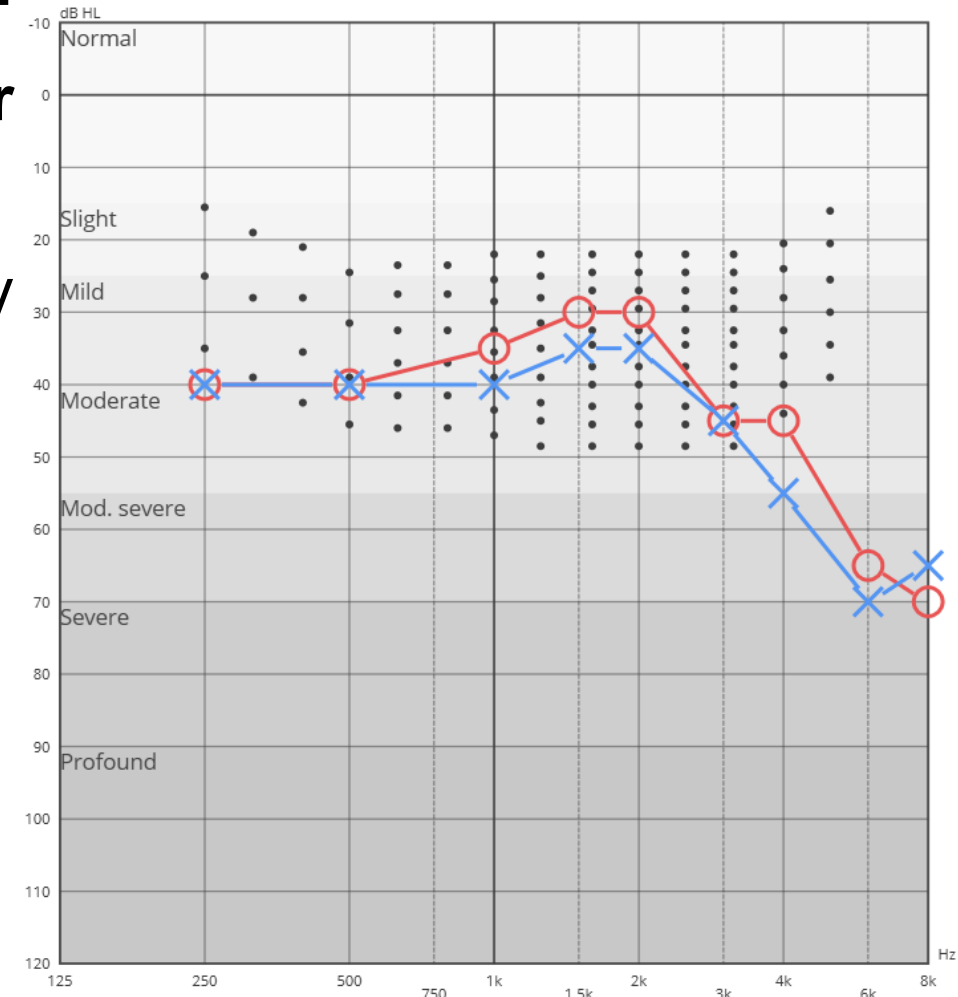


a c a d e m i a

Mild/Moderate sloping to moderately-severe SNHL

71 year old woman, university professor, new user

- **History:** Has known about hearing loss for years and been putting off treating it; now actively ready to do something about it
- **AI:** 36 (R) and 26 (L)
- **Hearing difficulties:**
 - seminar room at university;
 - conferences – questions from audience;
 - women whispering – can't hear;



Case Study #2

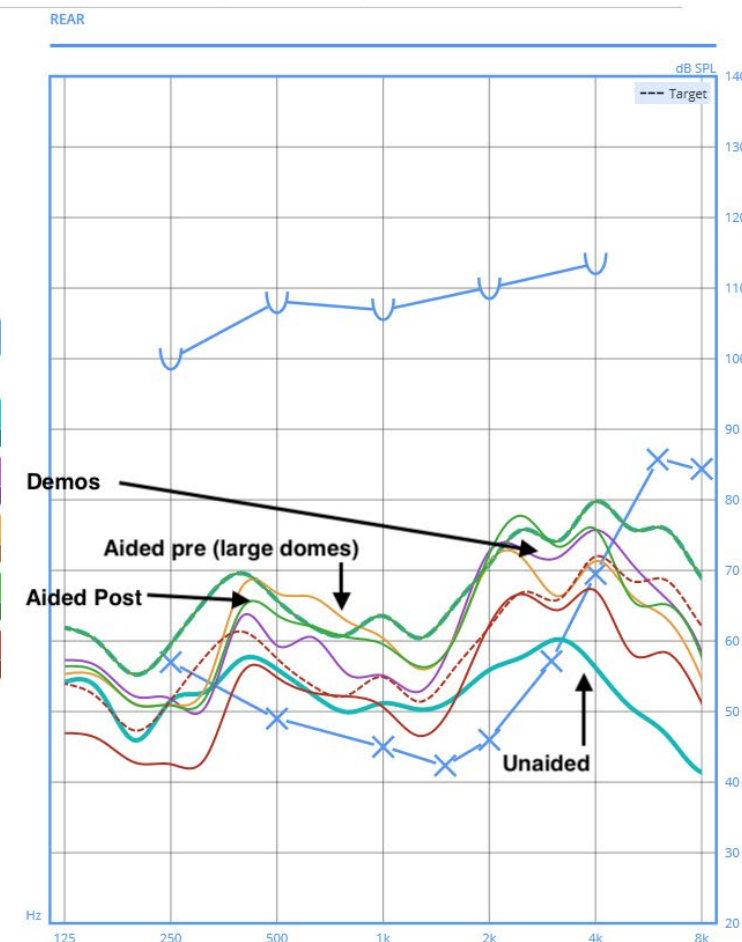
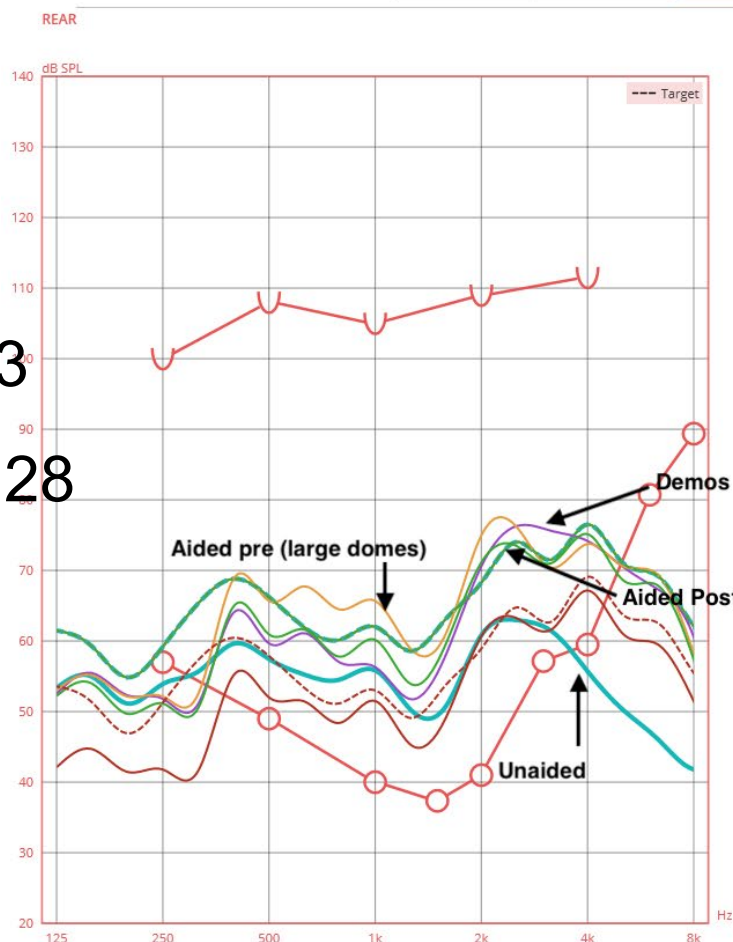


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Hearing Aid Fitting

RICs with closed domes

- **Change in SII65:**
 - Demos: R = 22; L = 23
 - Adjusted: R = 25; L = 28
- **Improvement on COSI:**
 - “Much better”
- **Datalog:** 10 hrs/day



Case Study #3

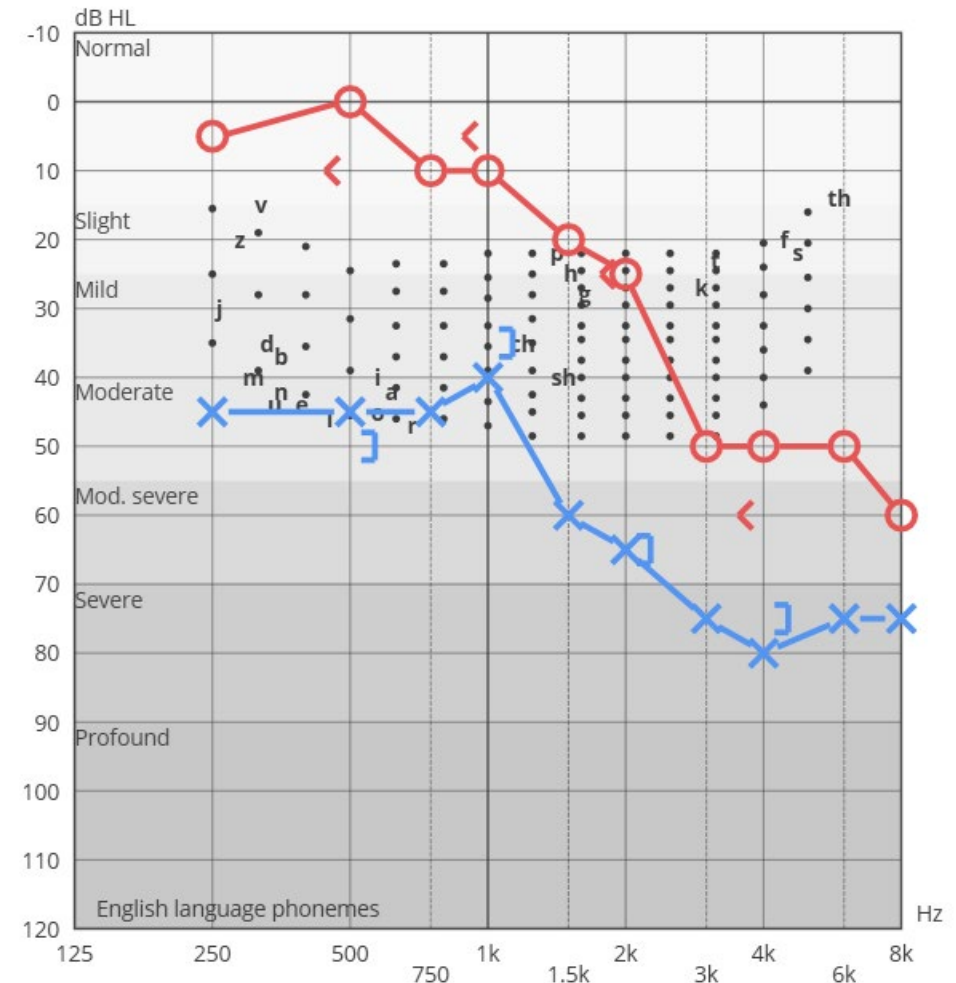


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Significantly asymmetrical SNHL

73 year old man; handyman, new user

- **History:** Longstanding SNHL in L ear (from 1980s, likely due to noise trauma)
- **AI** = 67 (R) and 5 (L)
- **Hearing Difficulties:**
 - cannot hear the servers in his regular restaurant
 - constantly turning head to R
 - phone calls on cell for work



Case Study #3

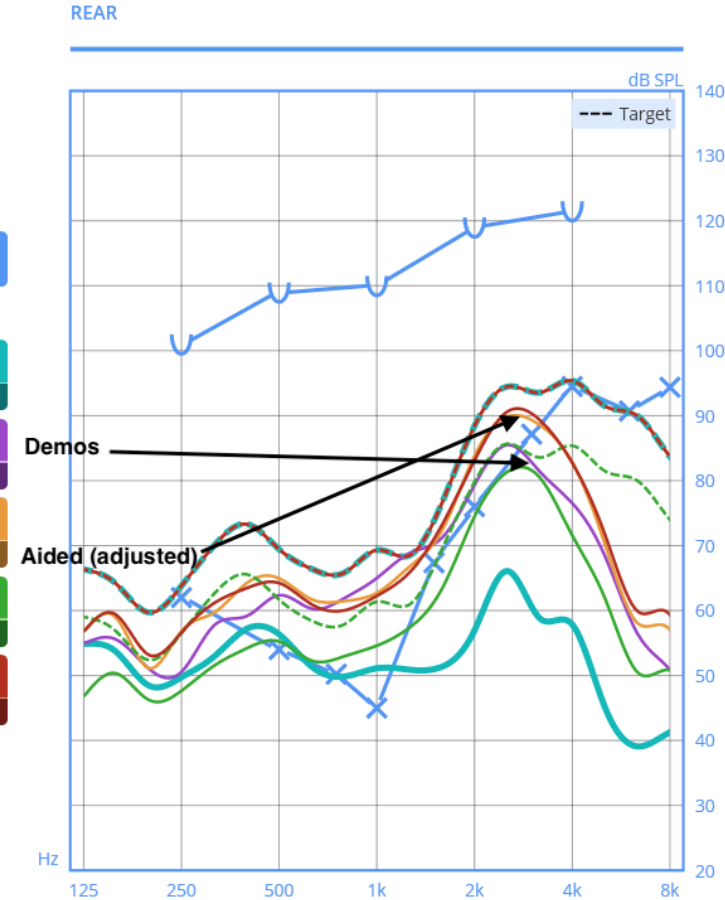
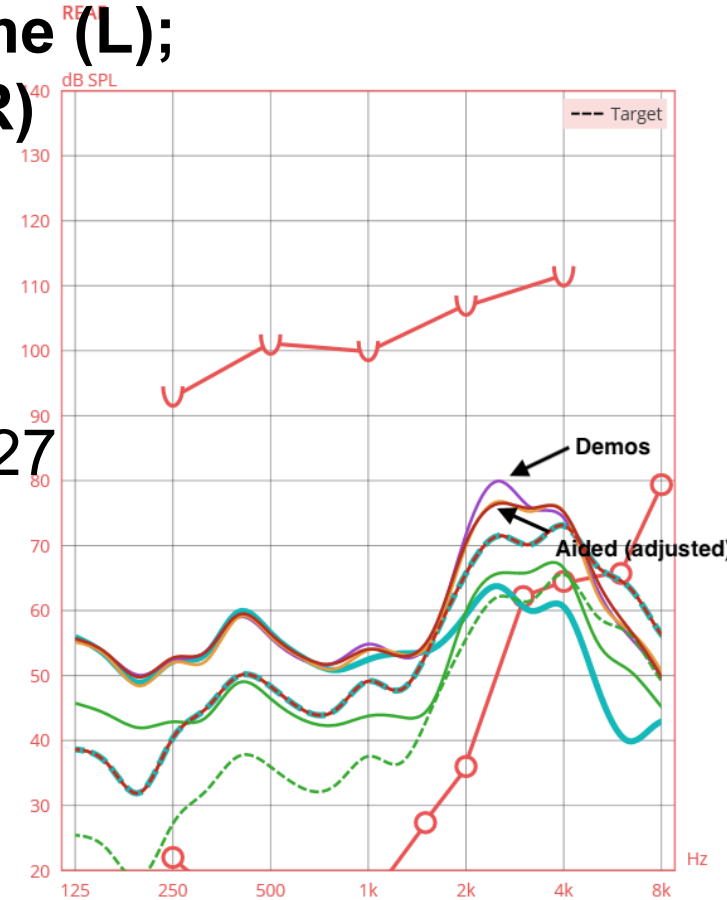


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Hearing Aid Fitting:

**RICs with P receiver and dome (L);
M receiver and open dome (R)**

- **Change in SII65:**
 - Demos: R = 13; L = 21
 - Adjusted: R = 12; L = 27
- **Improvement on COSI:**
 - “Much better”
- **Datalog:** 11 hrs/day



Case Study # 4

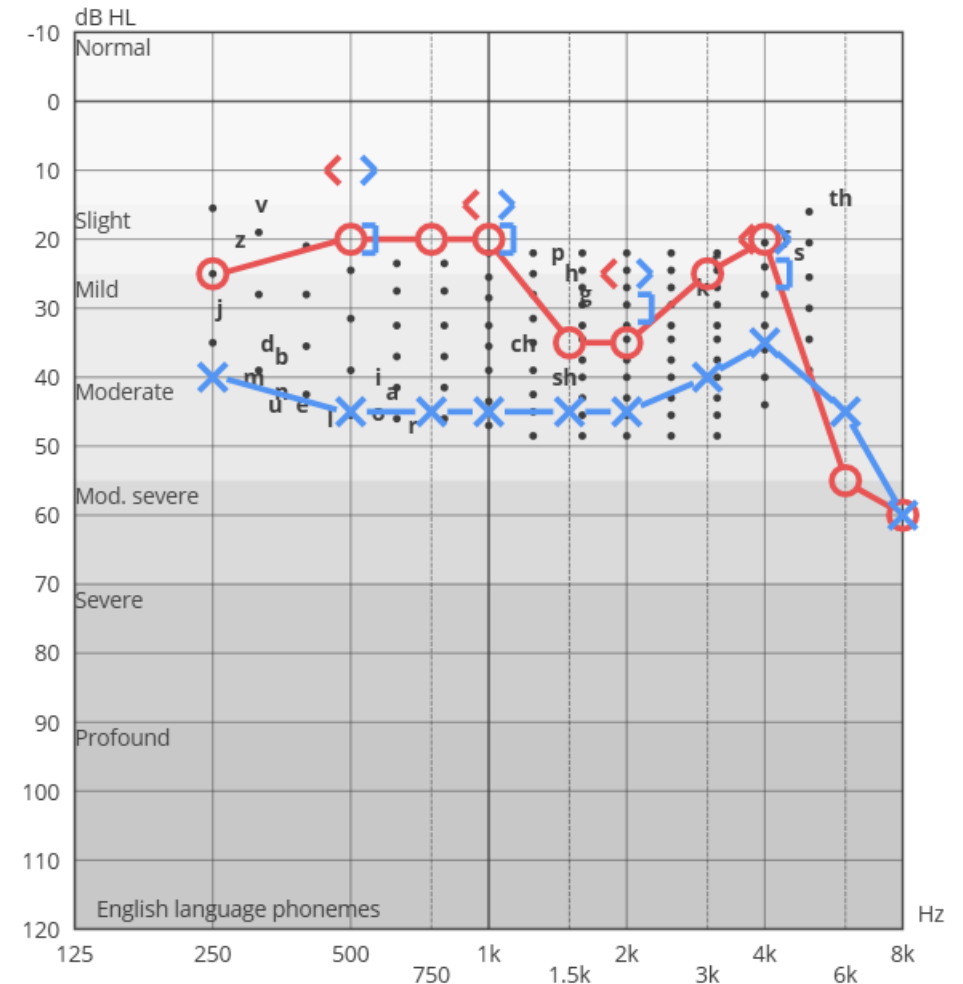


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Moderate Conductive Hearing Loss

39 year old woman; works office job, new user

- **History:** Known otosclerosis; had stapedectomy on R; hearing improved, but tinnitus began and stayed; doesn't want surgery on L
- **Audibility (AI):** 72 (R) and 20 (L)
- **Hearing Difficulties:**
 - groups/social; work meetings
 - hearing partner at home; TV at home
 - environmental sounds (e.g. kitchen timer)



Case Study # 4

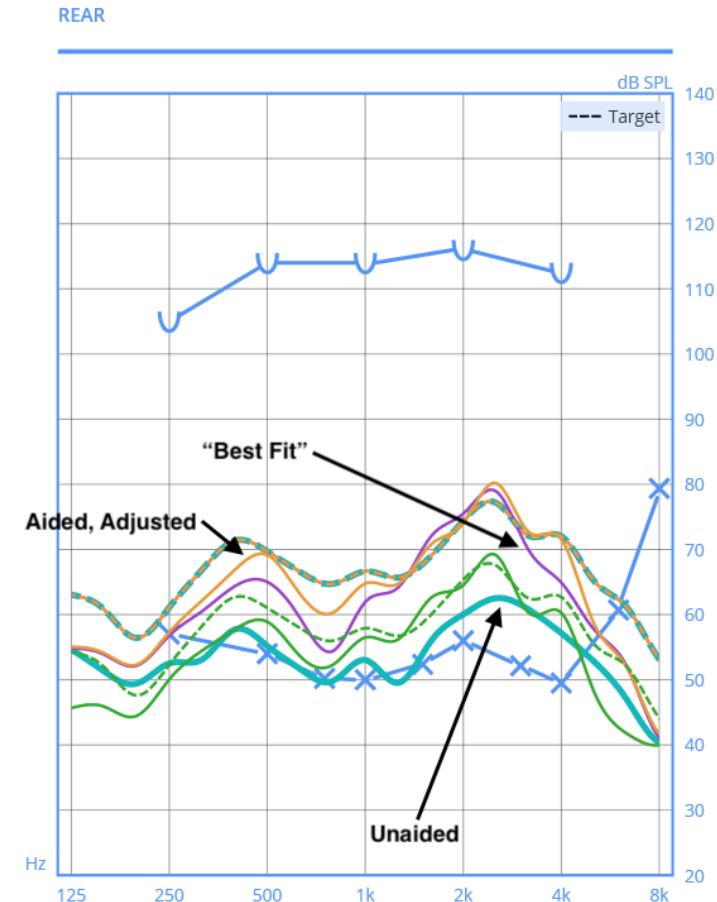
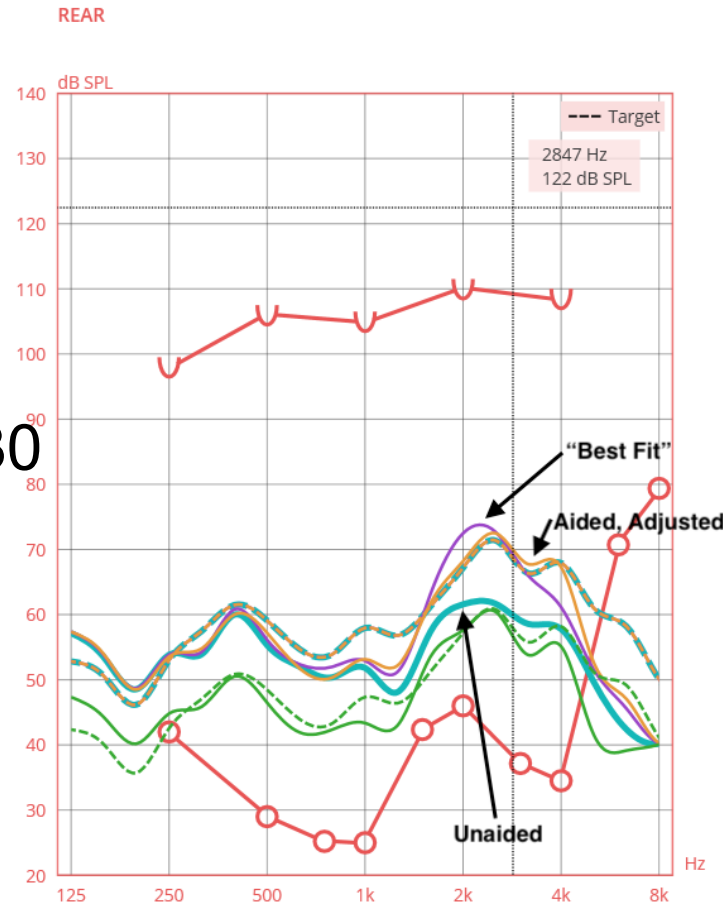


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Hearing Aid Fitting:

**RICs with M receivers R/L;
small closed domes R/L**

- **Change in SII65:**
 - BestFit: R = 5; L = 26
 - Adjusted: R = 5; L = 30
- **Improvement on COSI:**
 - “Much Better”
- **Datalog: 14 hrs/day**



Case Study # 5



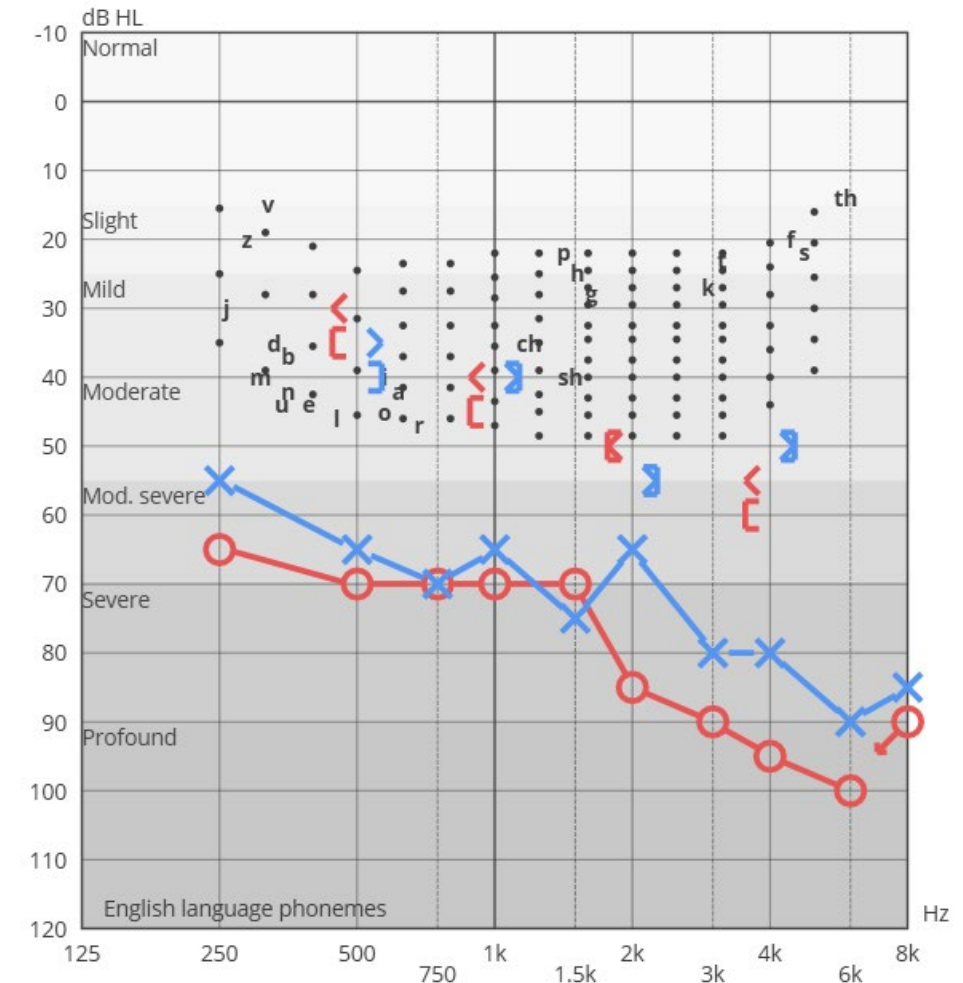
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Mod-severe to severe (L) profound (R) Mixed HL

53 year old businessman;

Longtime custom HA user (IIC/CIC)

- **History:** Longstanding progressive otosclerosis; has never opted for surgery
- **Audibility (AI):** 0 (R) and 0 (L)
- **Hearing Difficulties (With old HAs):**
 - Girlfriend “bluffing”
 - Noisy environment (e.g. kitchen or going out)
 - Phone calls on cell



Case Study # 5

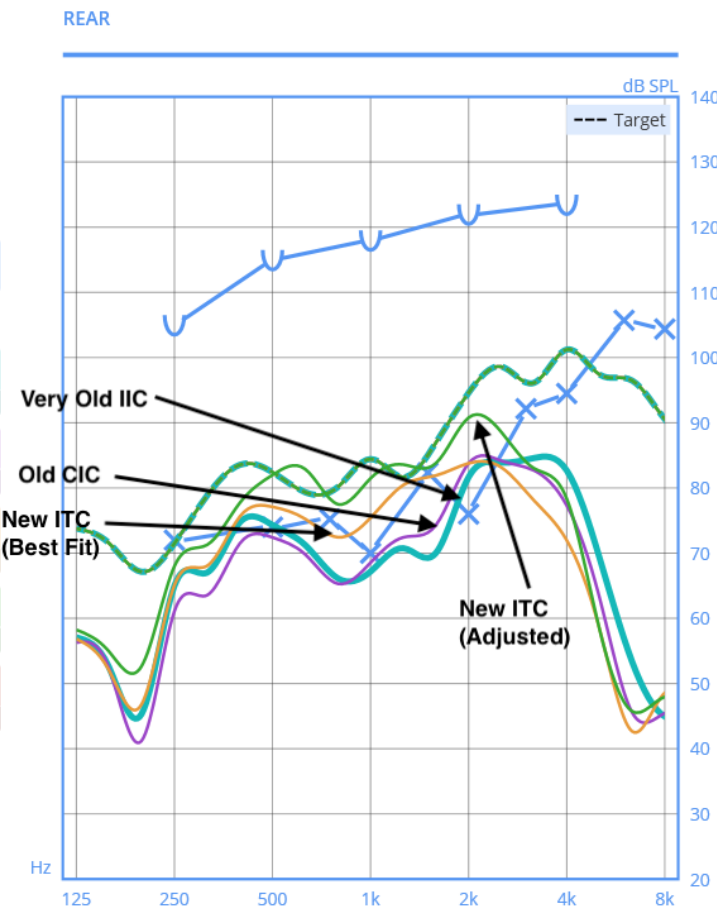
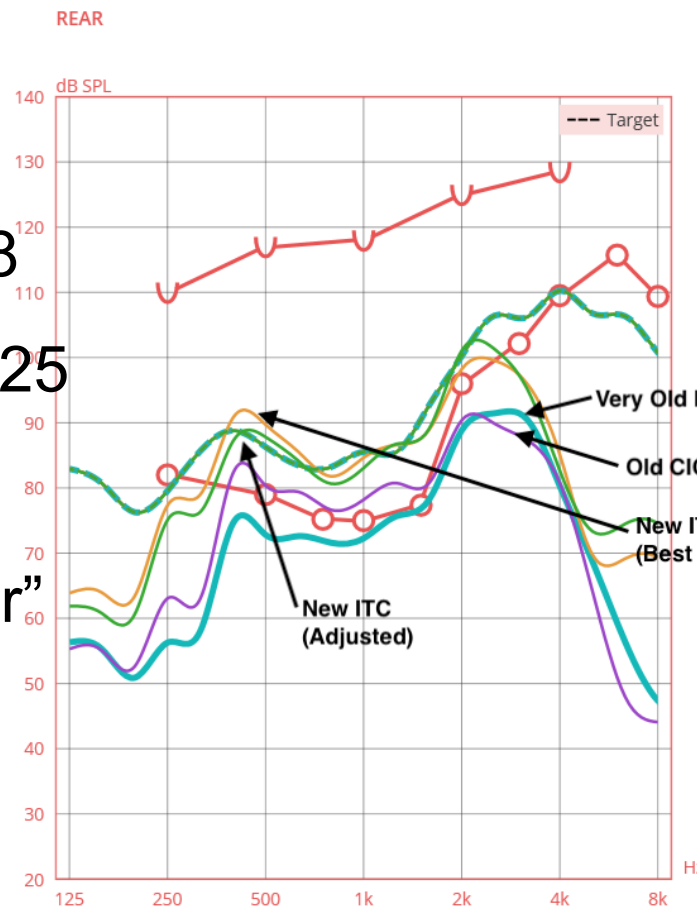


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Hearing Aid Fitting:

Custom ITC-Rs; 60dB Recs

- **Change in SII65:**
 - BestFit: R = 22 ; L = 18
 - Adjusted: R = 22 ; L = 25
- **Improvement on COSI:**
 - “Better” & “Much Better”
- **Datalog: 12 hrs/day**



Slight (R) and Mild (L) SNHL

- **History:** Feels hearing is down in L ear
- **Audibility (AI):** 89 (R) and 71 (L)
- **Hearing Difficulties:**
 - Meetings at work (notetaker)
 - Boss at work; soft voice; "mumbles"
 - Political Events; picking out voices
 - Listening effort; leans in with R ear



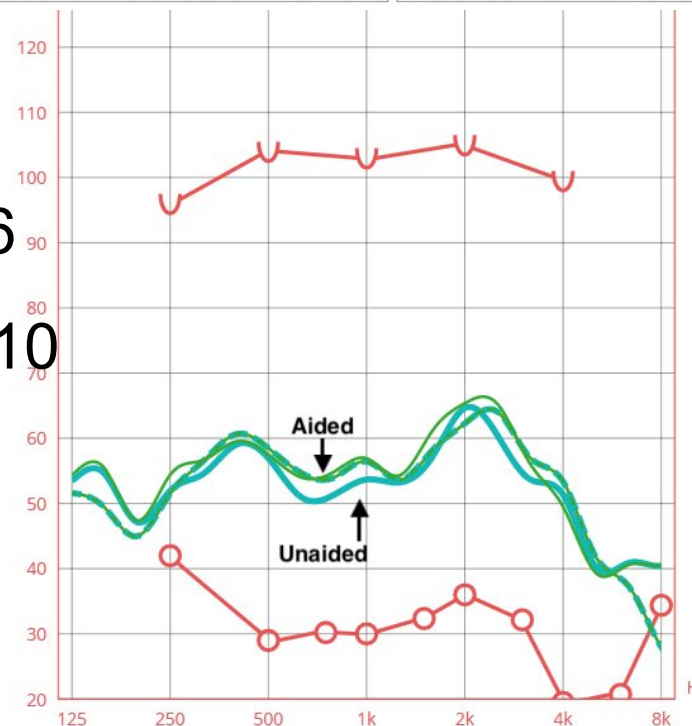
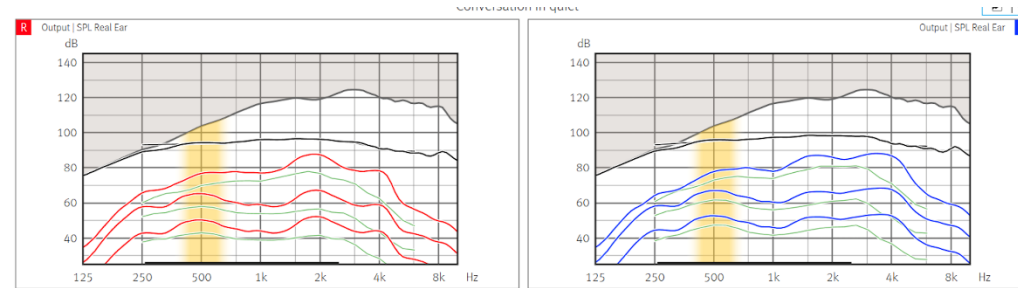
Case Study # 6



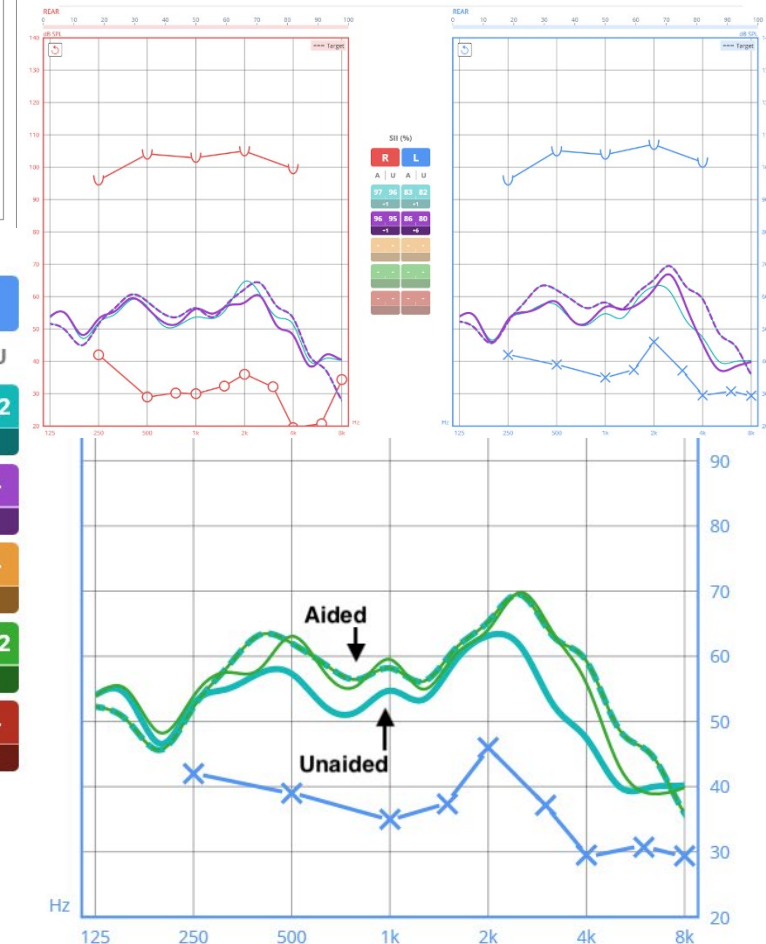
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Hearing Aid Fitting: RICs with M receivers; Medium closed domes

- **Change in SII65:**
 - “BestFit”: R = 1 ; L = 6
 - Adjusted: R = 2 ; L = 10
- **Improvement on COSI:**
 - “Much Better”
- **Datalog: 6 hrs/day**
 - (doesn't wear at home; mostly work/social)



SII (%)	
R	L
A U	A U
97 96	83 82
+1	+1
-	-
-	-
97 95	92 82
+2	+10
-	-
-	-



Case Study # 7

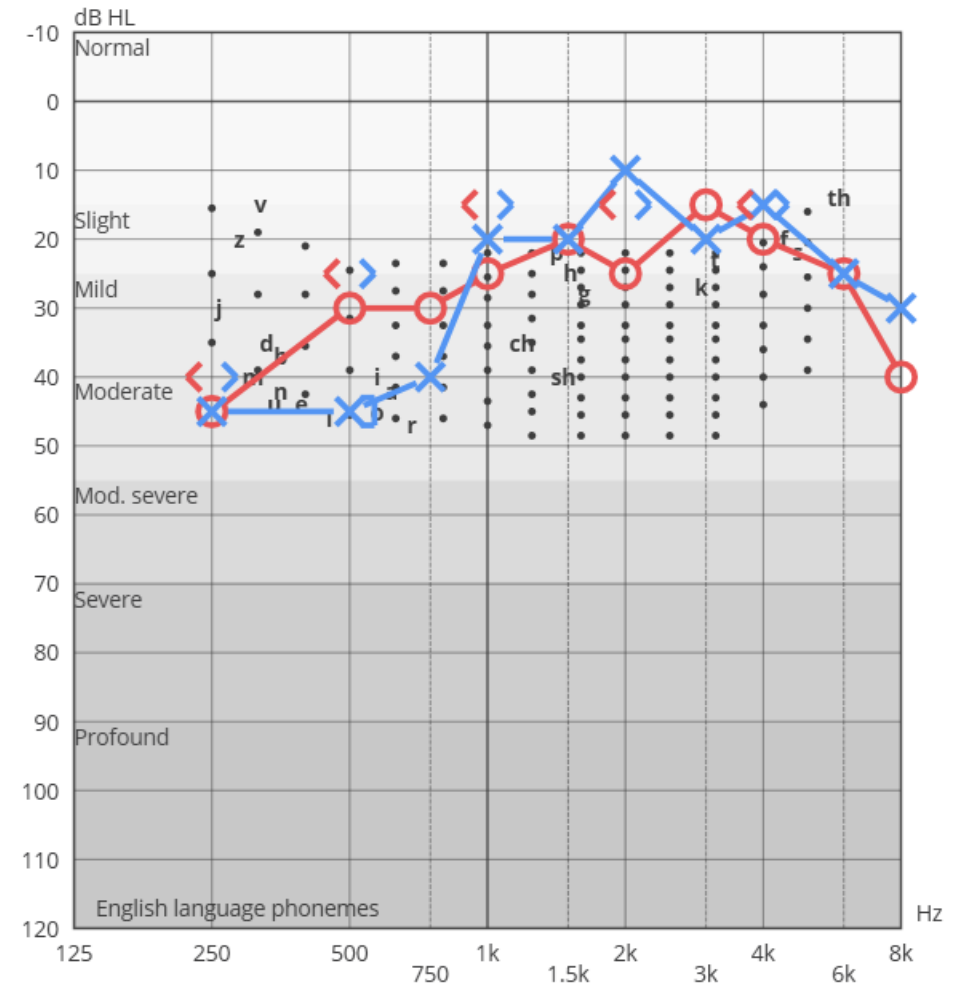


a c a d e m i a

Moderate rising to slight/mild SNHL

67 year old man; new immigrant to Canada

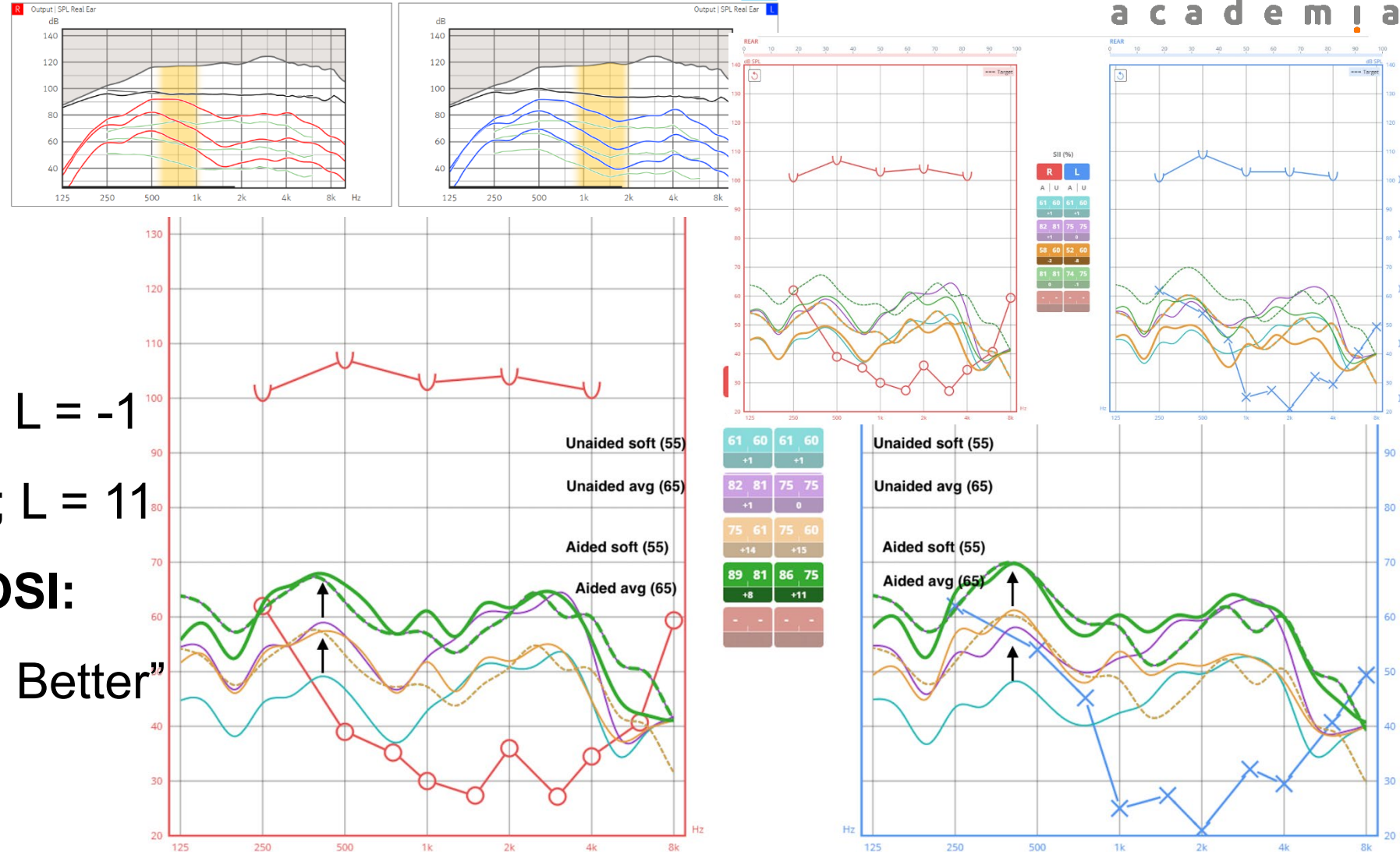
- **History:** Known HL from test outside Canada
 - Came in for ENT assessment
- **Audibility (AI):** 75 (R) and 70 (L)
- **Hearing Difficulties:**
- Official communication (ESL) in person and phone; brings someone with him
 - Social: cafeteria with friends
 - Family; repetitions;



Case Study # 7



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Hearing Aid Fitting: RICs with M receivers; S Power domes R/L

- **Change in SII65:**
 - “BestFit”: R = 0 ; L = -1
 - Adjusted: R = 8 ; L = 11
- **Improvement on COSI:**
 - “Better” & “Much Better”
- **Datalog:** 11 hrs/day

Summary



a c a d e m i a

- Some hearing loss configurations and degrees are harder to fit than others, but all require **careful measurement and adjustment**
- **SII change values** are a convenient means of assessing the potential expected benefit from your fittings
- We need to **document the quality and success of our fittings** by:
 - Measuring improvements in audibility (SII change)
 - Assessing perceived hearing improvement (COSI degree of change)
 - HA usage data (datalog hrs/day)

If you liked these case studies, you can watch more here: <https://pacificaudiologygroup.com/learnon/>

Thank you for your attention.



QUESTIONS?

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