Trainable hearing aids: Friend or foe for the clinician?

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How do trainable hearing aids work?

- Using "Data Logging" the hearing aid "remembers" user adjustments to gain and frequency response; some products also allow for training of the strength of the noise reduction. This logging can be either "time-based" or "event-based." (more on that later)
- The hearing aid also remembers two other things:
  - The classification of the signal (noise, speech, music, etc.)
  - The input level of the signal

How do trainable hearing aids work?

- As more and more samples are gathered, the hearing aid then develops a "preference profile" for the listener. Based on previous adjustments, the hearing aid knows (or predicts) the settings the listener prefers for:
  - Average level speech
  - Loud speed
  - Loud speech in background noise
  - Average-level noise
  - Soft music
  - Loud music
  - And on, and on.

And . . . You don't have to listen to all levels of a given category for the training to be complete . . . Here is an example for the automatic music program:


Input=80 dB Gain=5 dB


Input=75 dB Gain=10 dB


Input=70 dB Gain=16 dB


Input=65 dB Gain=18 dB

Event-Based versus Time-Based

- Time-Based: At periodic intervals, such as once every minute, the hearing aids record the situation classification, the input level and the gain setting. The more time a user spends in a given environment, the more training that will occur for that listening situation. Might be best for patients who spend a considerable amount of time in a limited number of situations.
- Event-Based: Every time the patient makes a gain change, the hearing aid records the resulting gain, the situation that was classified, and the input SPL. The more adjustments a user makes for a given listening situation, the more training that will take place for that situation. Might be best for patients who are in and out of a lot of different listening situations.

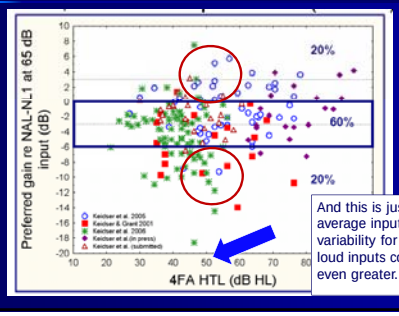
What we know (or think we know) about the need for trainable hearing aids:

- Prescriptive fitting targets are a starting point—for the average patient. For many people, the "best" gain and output is different from the prescribed fitting.
- Some patients have listening goals that are not consistent with the goals of a given fitting algorithm
- The clinic is not a very good place for the patient to determine what is best. They need the real world, with noise, reverberation, environmental sounds, etc.
- If the patient can find their "best" setting in the real world, they should obtain maximum benefit from their hearing aids.

Why some audiologists believe that trainable products are a good thing:

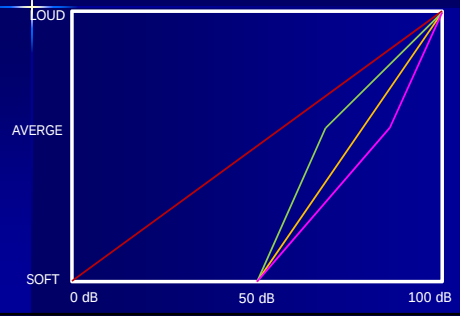
- Allows patients to "tweak the fitting" to get it just right for speech intelligibility and listening comfort.
- Allows patients to "tweak the fitting" to get it just right for listening comfort of different input levels for different listening situations.
- For hearing aids with no VC—a loaner remote for the first few weeks will help refine settings
- Allows patients to be an active participant in assuring that the fitting is optimum—they can "take ownership" of the fitting.
- Trainable products will reduce follow-up visits, as less minor tweaking will be needed.

Why we might want to allow the patients to help us: Pooled data from five preferred-gain studies (From Dillon, 2007)



And this is just for average inputs—the variability for soft and loud inputs could be even greater.

Another reason why we might want to have our patients help us: compression training



Why some audiologists believe that trainable products are *not* such a good thing:

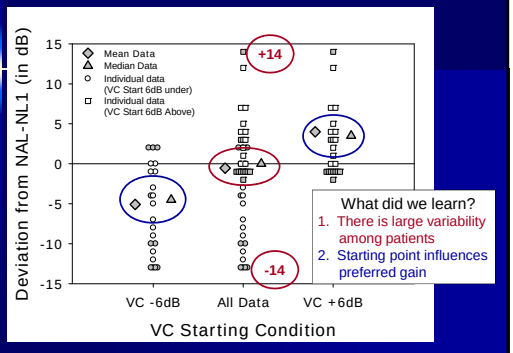
- Most patients simply do not want to expend the effort, or do not have the cognitive or dexterity skills to do the training.
- It's simply one more thing to explain to a patient, who are confused enough already with today's technology. And, it will add time to the fitting.
- The patients might train the hearing aids to some totally inappropriate fitting.
- The patients might think that the audiologist isn't too good at programming hearing aids if they have to train the hearing aid themselves.
- The notion of trainable hearing aids is yet another step to make hearing aids over-the-counter (and eliminate the audiologist).
- Trainable products will reduce follow-up visits, as less minor tweaking will be needed.

Preliminary research with a "gain training only" algorithm (Mueller et al, 2008)

- All subjects, experienced users (n=22), fitted bilaterally with hearing aids with learning VC
- In cross-over design, subjects were either fitted to NAL-NL1 +6 dB, or NAL-NL1 -6 dB.
- Fittings verified with probe-mic measures for 50, 65 and 80 dB SPL.
- Subjects used hearing aids in everyday environment for each condition for 10-14 days
- patients listening conditions (based on data logging)

Will subjects train gain to the NAL-NL1?

Does the starting point of the fitting matter?



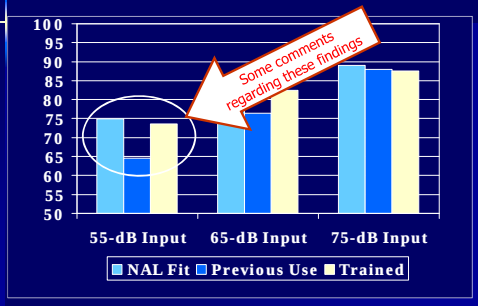
More on the Mueller et al, 2008 study:

- Average use time/home trial was 135 hours (range 49 to 226).
- What setting each subject had first (+6 dB versus -6 dB) did not influence trained gain.
- There was no correlation between use time and degree of gain learning.
- There was no correlation between use time and deviation from NAL-NL1 target
- There was no correlation between time spent in different listening situations and deviation from NAL-NL1 target.

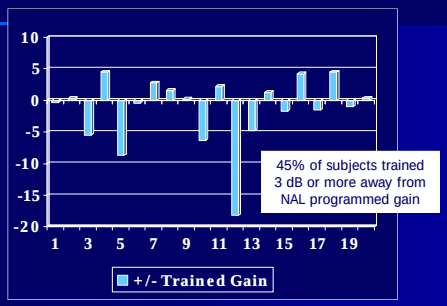
Follow up study with instruments that had "gain *and* compression training" (Mueller and Hornsby, 2011)

- Individuals fitted to NAL-NL1. Verified for 55, 65 and 75 dB SPL inputs using real speech inputs.
- Used hearing aids in real-world with all hearing aid features activated
- Subjects could train gain for soft, average and loud inputs independently (compression training)
- All participants were previous hearing aid users: Preferred gain for their current hearing aids also was measured.

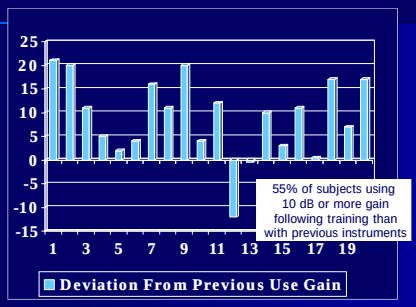
Comparison of trained gain to previous use gain (average of 2000-4000 Hz).



Degree of training for soft inputs (55 dB SPL) following fitting to NAL-NL1



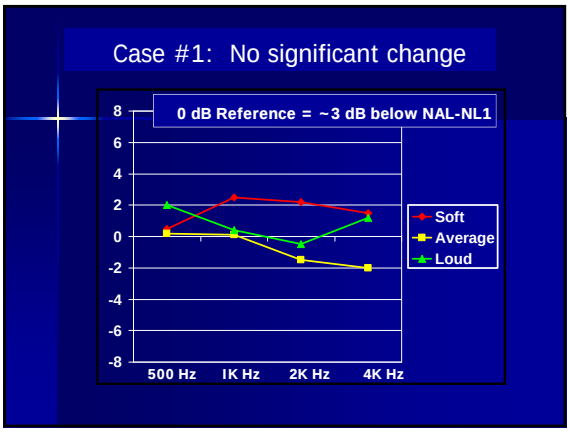
Trained gain compared to previous use gain for 55 dB SPL input



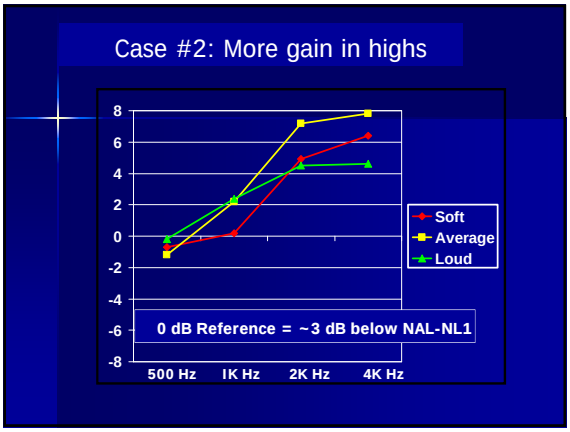
More research with trainable compression
(Keidser et al, 2008)

- Individuals fitted to ~ 3 dB below NAL-NL1. Verified for 55, 65 and 75 dB SPL inputs.
- Used hearing aids in real-world with all hearing aid features activated
- Subjects could train gain from soft, average and loud inputs independently (compression training)
- Subjects also could train frequency response of hearing aids using “treble control”

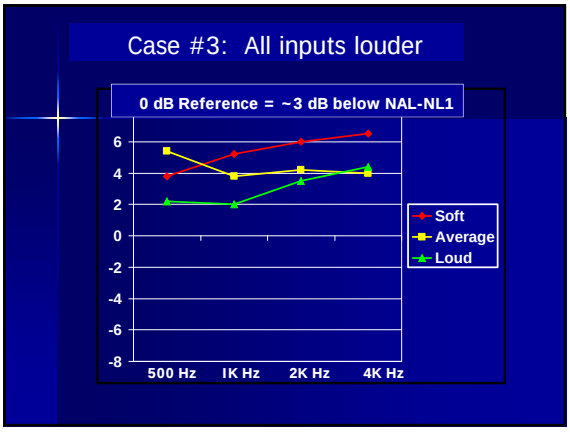
Case #1: No significant change



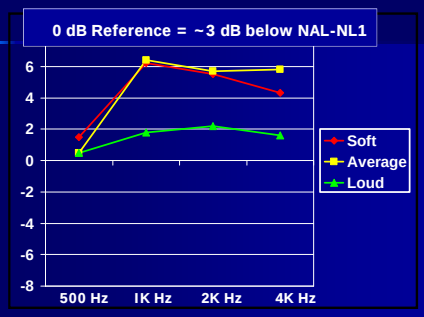
Case #2: More gain in highs



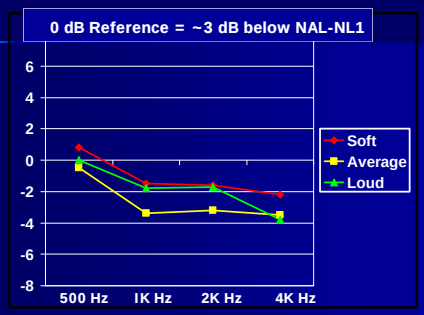
Case #3: All inputs louder



Case #4: Louder, but not for loud inputs



Case #5: Everything a little softer



More recent data on trainable hearing aids—3rd Generation.

(Palmer, 2012)

One of the purposes of the study was to examine the effects of the "start time" of the training. All participants were new hearing aid users (fitted to NAL-NL1):

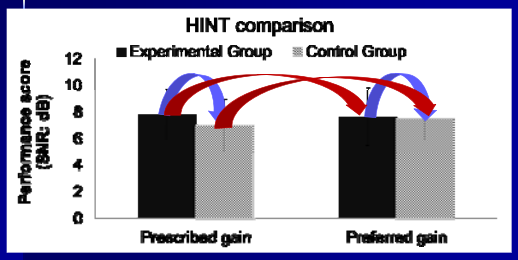
- Control group (n=18) = training was off and then turned on at the second visit
- Experimental group (n=18) = training was on from the beginning

Following training, comparisons made to the original NAL fitting, and comparative speech testing

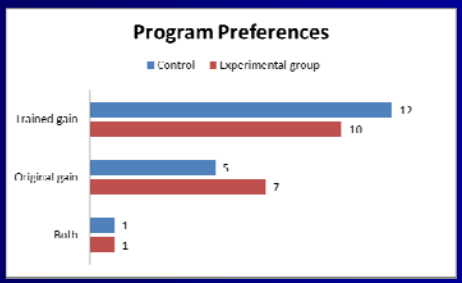
General findings regarding trained gain and real world loudness judgments

- Gain for soft was reduced slightly for both groups, but somewhat more for the group who had trained from the beginning:
  - Control: SII for soft speech reduced ~2%
  - Experimental: SII for soft speech reduced ~4%
- Real-world loudness judgments (PAL ratings):
  - No difference from programmed to trained gain.
  - No difference between groups.

Training had no positive or negative effect on overall HINT performance for either group



Preferences for trained gain versus original programmed gain (65% selected the trained gain;)



Trainable vs. Automatic Gain Increase (AGI)

Trainable: You program the hearing aid to a fitting that is "close" to what you believe is best, and allow the patient to fine tune.

AGI: You program the hearing aid to less gain than you think is best, and then program an automatic increase to occur gradually over time (e.g., weeks, months).

Potential advantages of AGI

- A new hearing aid user just seems to be "gain shy," and finds the amount of gain that provides appropriate audibility unacceptable. You sense that if you send him out the door with that prescribed gain, he'll never use the hearing aids.
- You program the hearing aids 5-8 dB below what you believe is appropriate and he finds this to be "okay."
- You set the gain to increase 1 dB/week over the next two months. You hope that this gradual increase will not be noticed, things will still be okay, and at the end, you'll both be happy.

Caveats regarding AGI

- Before sending the patient out, be sure that the new gain target won't create a feedback problem.
- AGI probably only will have the desired effect for hearing aids that do not have a VC. With a VC, you would expect that the patient would simply adjust the VC 1-dB-softer for every 1-dB-increase provided by AGI.
- Some refer to AGI as "acclimatization," although there really is no way to know if this will actually happen. The software can make automatic increases in gain, but only the patient's brain knows if automatic acclimatization occurs.

Can you (should you) use AGI with trainable?

- Option 1. Implement both training and AGI at the time of the fitting
- Option 2. Use AGI first. Push gain to higher level than patient might initially accept—process probably will take two months. Then implement training, to fine tune compression and obtain preferred gain for different listening situations.
- Option 3. Use training first. Allow patient to settle on preferred gain for different listening situations. This process will probably take a couple weeks (assuming hearing aids are used and adjusted regularly). Then, if audibility is not optimal, implement AGI.

Clinical implementation of trainable hearing aids

1. Assure that patient is in agreement that this is good for him or her.

2. Assure that patient is able (and willing) to make the necessary changes. This is especially important for event-based training.

3. Start with a fitting that is as close to your desired ending point as possible (e.g., validated fitting method). If not close, consider implementing automatic gain increase before training.

Some considerations

Keidser et al, 2007: Survey of a typical clinical population revealed that 59% of adult hearing aid users were interested in training their own hearing aids. Four parameters in particular, when combined, were found to discriminate between those who were interested in a trainable aid and those who were not:

- Younger
- Have a strong interest in technology
- Have a milder hearing loss
- Have less symmetrical hearing loss.

Other findings from the Keidser et al (2007) survey:

- Favored remote: 54%; Favored on-board control: 46%
- Believed that the training would possibly or definitely make the fitting better: 82% (66% gave "yes" answer)

Clinical implementation of trainable hearing aids

4. Give patient detailed instructions and a diary to complete during training.

5. Monitor training at two-week follow-up visit. Look at data logging to note listening situations, changes made, etc.

6. At one month interval, assuming all is well, training can be discontinued. Determine if AGI is needed.

7. Sit back and enjoy your fitting accomplishment (and give a little thanks to the patient for his help)

Oops . . . Don't get too relaxed, as you're not quite finished!

At periodic intervals you will want to implement training again (or there is probably no harm to just leave it on permanently):

1. To account for changes in the patient's hearing loss
2. To account for potential changes in the patient's listening situations
3. To account for overall acclimatization—at some point your new user will become an "experienced" listener

In Summary . . .

Validated prescriptive fittings are a good starting point, but they are geared toward certain attributes of amplification—most commonly intelligibility and appropriate loudness—for the average patient.

Your Monday Morning patient may not be average, or he may have other listening attributes that take priority—listening comfort, noise reduction, sound quality.

Trainable hearing aids allow your patients to tailor the fitting to their environment, based on their fitting goals. Not a bad thing.