Implementing a Gain Learning Feature

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Audiologist's Goal for a hearing aid fitting

- Return audibility
- With Comfort
- Eventually normal loudness perception

Background

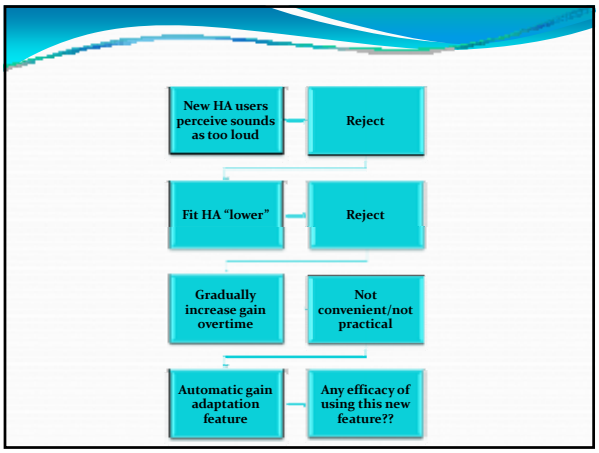
- Most new hearing aid users find that soft sounds are too loud (or louder than preferred) at the time of hearing aid fitting if audibility is achieved (targets are met).
- Different ways to handle this…

Protocols

- You'll adapt over time (full time use), fine tuning in a few weeks – could reject, not be able to use full time
- Tune it down, we'll tune it up in a few weeks – could be multiple visits, too time consuming
- Use first fit, generally underamplifies (reject?)
- Adaptation feature – it will turns itself up over time
- Use the VC as you get used to it
- Set the program button like a VC
- Gain learning/training feature

Loudness Adaptation in New Hearing Aid Users

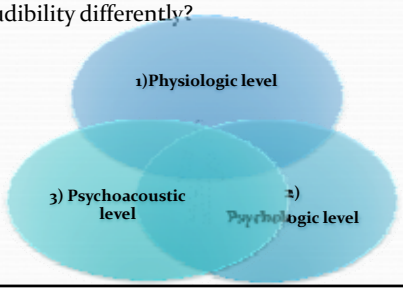
What would we expect?



- Would we expect new hearing aid users adapt to changed audibility differently?

Levels of Variables

- Why new hearing aid users adapt to changed audibility differently?



Physiologic level: With cochlear hearing loss

- With cochlear hearing loss, three changes account for changed perception of loudness:
  1. Elevation in absolute threshold (OHC/IHC loss)
  2. Reduction in compressive nonlinearity in the input-output function of the basilar membrane (OHC loss)
  3. Reduction in frequency selectivity (OHC loss)
  4. Recruitment
  5. Changes in loudness summation

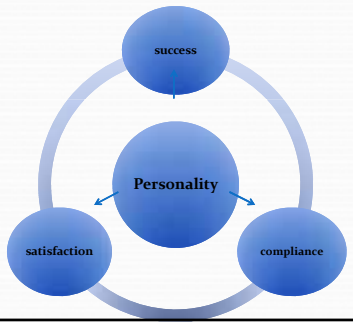
Chen et al (2011)

1)Physiological level - *Central*

- Conflict in literature!
  - Literature is less suggestive of central auditory components
    - more suggestive of peripheral excitation patterns explained by models of loudness
  - the actual changes that produce recruitment are changes in the input-output functions or hyperexcitability of central neurons, secondary to peripheral impairment.

Philibert et al. (2002); Heinz et al. (2005)

2) Psychological level



3) Psychoacoustical level

1. Loudness tolerance correlates with accepting loud sounds after amplification
   - Result in better compliance
   - result in faster/easier loudness adaptation
- Hours of use

Individual differences

- Put the the individuals in control…

Background

- Currently, "trainable" hearing aids refer to hearing aids that employ a strategy to track gain adjustments (either overall gain or compression based on gain as a function of input level) made by the hearing aid user and to modify the hearing aid gain/compression settings based on these user selections.

- Mueller et al (2008) and Keidser et al (2008) reported that the final gain preferred by hearing aid users using trainable hearing aids is largely dependent on the starting point (i.e., the gain setting that they start with). This finding supports the notion that the trainable hearing aid will be significantly impacted by the clinician's fitting rationale.
- Current hearing aid users

Potential Problem

- If the hearing aid is set to "trainable" from the first day of the fitting (when one might expect the user to turn the hearing aid down as they get used to it), the final gain achieved may be lower than desired based on audibility and ability to hear in difficult listening situations. If the user has no impact on training the hearing aid gain until after an adjustment period (so the training is activated in what might be considered a "fine tuning" stage), one might expect a different final outcome in terms of preferred gain which might result in satisfaction and better audibility and performance in difficult listening situations.

Specific Aim

Does the timing of turning on the trainable gain (compression) feature of a hearing aid impact the final outcome as measured by

- return to normal loudness,
- satisfaction with loudness,
- overall satisfaction with the hearing aids,
- audibility for soft sounds,
- performance in speech understanding in noise

Subjects

- adults
- Moderately severe sloping sensorineural hearing loss
- No previous hearing aid experience
- Sample size calculation based on an alpha of .05, power of .8 with a medium effect size indicated that 18 subjects are needed in each group

Group	N	F/M	Av Age	500 Hz	1k Hz	2 k Hz	3k Hz	4 kHz
Control	18	9/9	64	26	27	44	57	57
Experimental	18	10/8	63	31	35	48	56	59

Methods

- Frequency specific threshold and UCL measured.
- Individuals \randomly placed into Experimental group (training on from the beginning) or Control group (training starts at 4 weeks)
- Hearing aids were fit to achieve audibility for soft, moderate, and loud sounds while maintaining comfort.
- The study was double blinded.

Hearing Aids

- Siemens Pure 701 with input-specific and situation-specific gain learning implemented.

Outcome Measures

- Audibility – AAI
- International Outcome Inventory (IOI-HA)
- Perception of Aided Loudness (PAL)
- HINT
- Journal
- Final Preference

Group	4 weeks	4 weeks	10 days
Experimental	Feature on PAL; IOI-HA	Feature on PAL; IOI-HA	2 settings (prescribed and preferred) Journal HINT Preference Survey
Control	Feature off PAL; IOI-HA	Feature on PAL; IOI-HA	2 settings (prescribed and preferred) Journal HINT Preference Survey

Figure 1. SII change obtained from the two groups for the soft speech (55dB SPL) and the soft noise (55dB SPL) inputs. SII change is determined by subtracting prescribed SII from preferred SII.

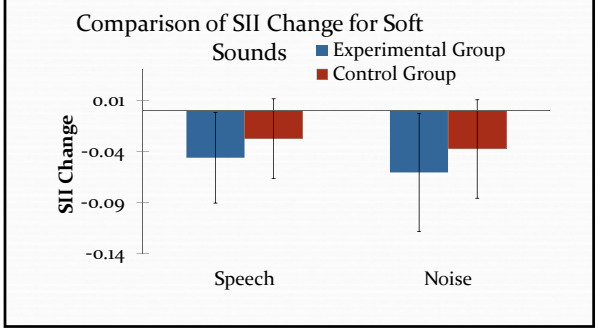


Figure 2. Comparison of mean score of IOI-HA. No significant change in the mean score of seven items over time for either group. The rating scale is from 1 (Poorest outcome) to 5 (Best outcome).

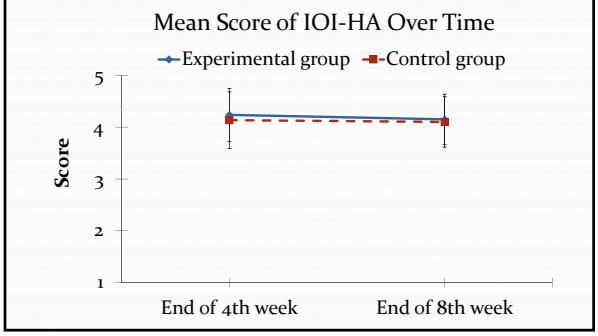


Figure 3. Comparison of Profile of Aided Loudness (PAL) rating among experimental group, control group and target from normative data. Rating scale is from 0 (Do not hear) to 7 (Uncomfortably loud).

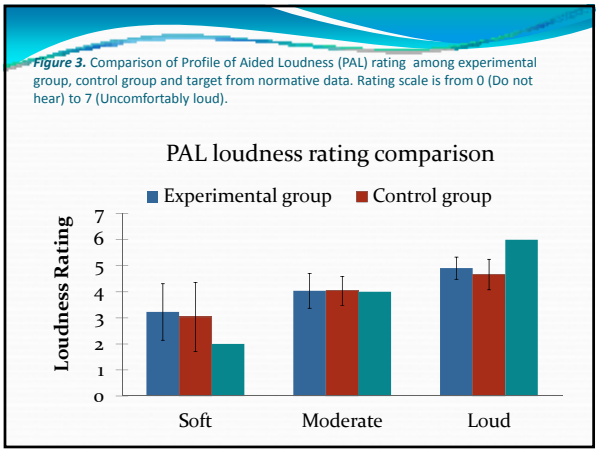
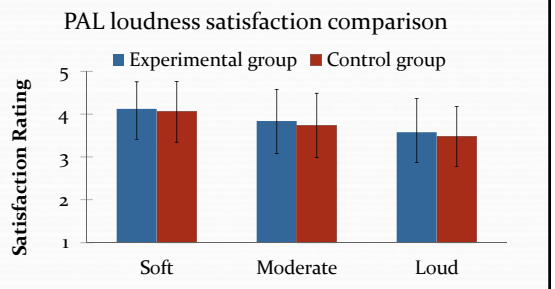
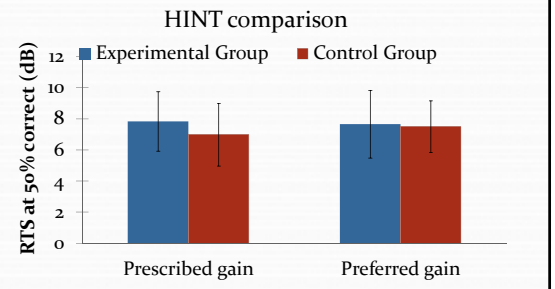
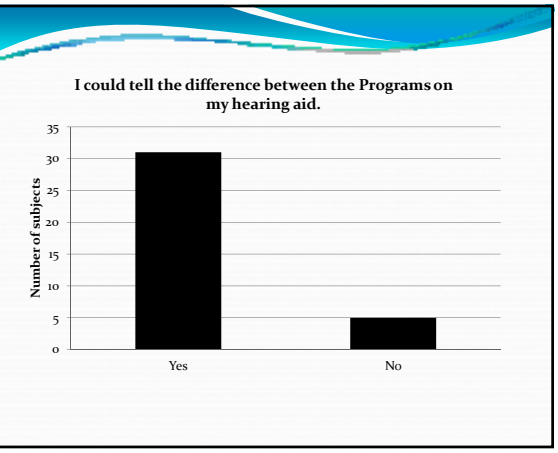


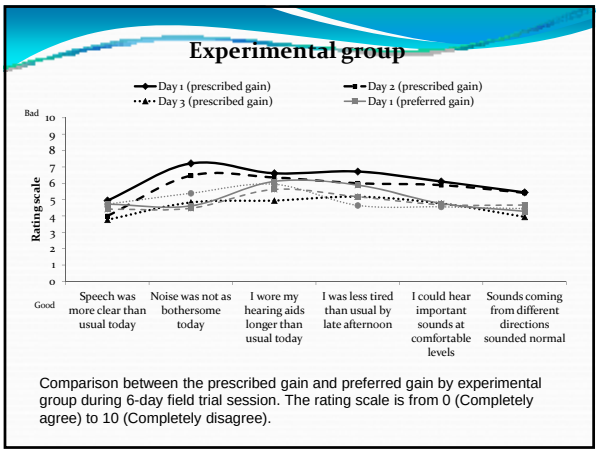
Figure 4. Both groups were satisfied with loudness for all input levels. However, the satisfaction for soft sounds was significantly higher than for moderate and loud sounds, $p<.001$. Rating scale is from 1 (Not good at all) to 5 (Just right).



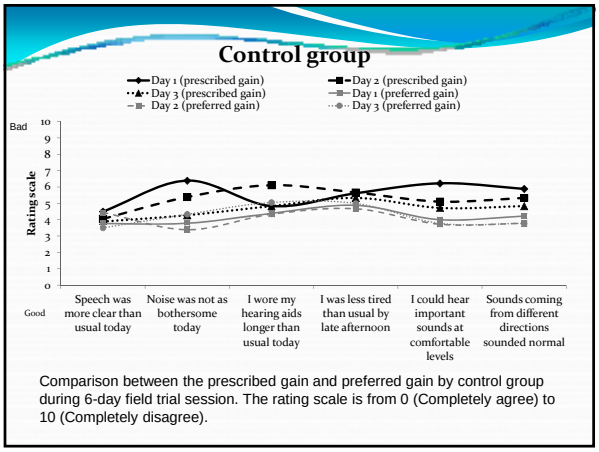
igure 5. The mean aided HINT Reception Threshold for Sentences (RTS) values for the two groups and the two gain settings (HINT noise = 65 dB SPL).







Comparison between the prescribed gain and preferred gain by experimental group during 6-day field trial session. The rating scale is from 0 (Completely agree) to 10 (Completely disagree).



Comparison between the prescribed gain and preferred gain by control group during 6-day field trial session. The rating scale is from 0 (Completely agree) to 10 (Completely disagree).

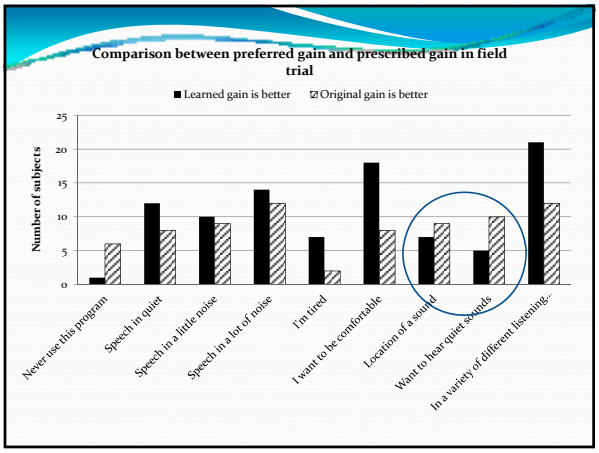
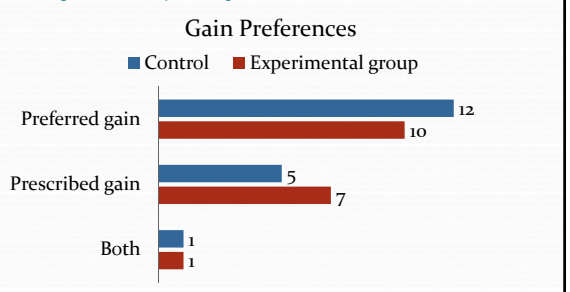
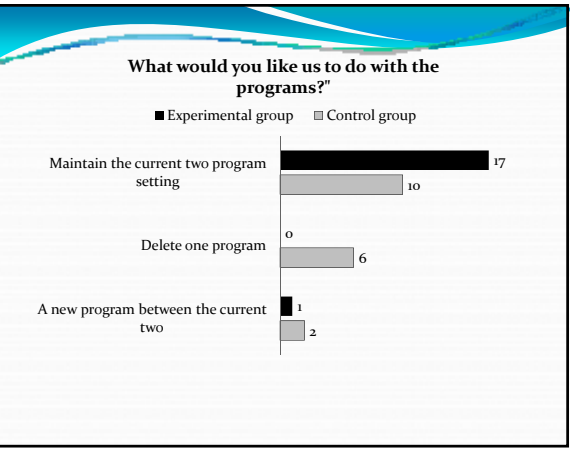
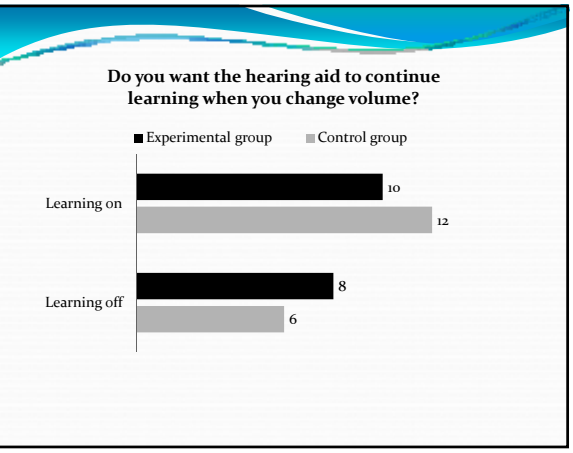


Figure 6. Gain preference by number of participants: 22 out of 36 participants preferred continuing to use the final preferred gain.







Conclusion

- The timing of turning on the gain learning feature has an impact on preferred gain for soft sounds obtained at the end of 8th week after fitting, but no impact on speech performance or self-report outcome measures.
- Note: did not measure at equal amounts of time with feature on.

What to do Monday morning?

- There were individual difference (just as we would predict).
- On average, having the feature on does not appear to have a negative impact and it may have a positive impact.