Is normal loudness the appropriate goal for hearing aid fitting?

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Presented at the American Auditory Society Convention, Scottsdale, AZ, March, 2013

Introduction

One common goal of hearing aid fittings is to restore loudness perception to normal levels for all sound inputs. This goal assumes that hearing-impaired people would like to perceive sounds with normal loudness. Some research (e.g., Smeds, 2004; Smeds, et al., 2006) suggests that this might not be the most appropriate loudness goal for hearing aid fittings. Nevertheless, the most commonly-implemented prescription procedures for nonlinear hearing aids either are based on the principle of loudness normalization (e.g., DSL [i/o]) or else aim to maximize speech intelligibility while ensuring that overall loudness of amplified sounds are as loud as or are no louder than for a normal-hearing person (e.g., NAL-NL1/NL2). Hearing health care providers attempt to execute these prescriptive goals by adjusting amplification characteristics to match REAR prescription targets for different input levels. In addition, evidence-based hearing aid fitting procedures call for further modification of amplification characteristics in the clinic and in the field according to hearing aid wearers' individual preferences. These fine-tuning modifications can result in fittings with loudness characteristics that are considerably removed from the original loudness goals.

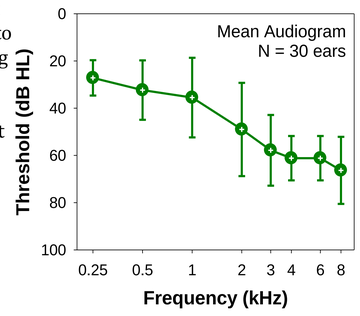
This research explored whether this widely-used and successful approach to hearing aid fitting results in normal loudness perception, as called for in fitting goals, for adults with mild to moderate sensorineural hearing loss.

Specifically the following questions were asked:

- Do hearing aid fittings that result from best fitting practices differ from prescribed fitting goals?
- Do best fitting practices result in acceptable self-reported loudness perception in the real world?
- Do best fitting practices result in normal loudness perception in the real world?

Participants

Eleven male and 4 female adult hearing aid wearers with mild to moderate sensorineural hearing loss participated in this study. Ages ranged from 62-82 yrs (X=71). Six participants had not worn hearing aids prior to this study, the remaining 9 participants were experienced users. The average audiogram for these participants is represented at right.



Acknowledgements

Supported by NIDCD.
PAL normative data provided by Catherine Palmer, Ph.D.

A pdf version of the poster can be found at www.harlmemphis.org

Methods

Fifteen participants were fitted with four different pairs of mini-BTE hearing aids, resulting in 60 hearing aid fittings. A structured 5-step fitting and verification procedure was implemented for each pair. Participants wore each pair of hearing aids for one month as they went about their daily activities. After each one month field trial, participants completed the Profile of Aided Loudness (PAL; Palmer, et al., 1999). This self-report questionnaire provided a measure of the participants' perceptions of, and satisfaction with, the aided loudness of soft, average, and loud everyday sounds.

Five-Step Hearing Aid Fitting and Verification Procedure

Step 1 - *First Fit*	• Programmed according to the manufacturer's recommended method and settings of all features. Appropriate ear coupling chosen.
Step 2 – *Adjustment to match Real Ear Targets*	• Maximum power output and gain of the hearing aids adjusted to match NAL (in these cases, NL1) targets for MPO and for speech input levels of 55 and 70 dB SPL.
Step 3 – *Subjective Verification*	• Gain and MPO fine-tuned using rule-based subjective assessments of: bilateral loudness balance, loudness of average speech, loudness comfort, and quality of own voice.
Step 4- *Real world optimization of settings*	• Remote controls and hearing aid learning capabilities used for a total of one month to optimize hearing aid performance in participants' daily lives.
Step 5- *Follow up Fine Tuning*	• Follow up telephone interview after two days and again after six days of use. Follow-up fine-tuning after one week of daily use when needed.

Results

Hearing Aid Fittings

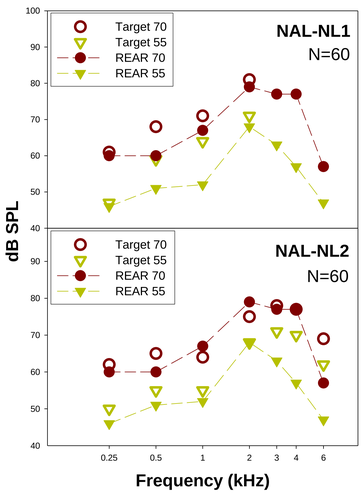
Q: Do hearing aid fittings that result from best fitting practices differ from prescribed fitting goals?

A: For NL1 – Yes

- These fittings provided gain for 70 and 55 dB SPL inputs that was less than the NAL-NL1 fitting targets for those levels.

A: For NL2 – Not much

- Although fittings initially were matched to NL1 targets, modifications based on best fitting practices resulted in REARs that were much closer to NL2 targets.
- Still, fittings resulted in less gain for low-level high-frequency inputs than was prescribed by NL2.

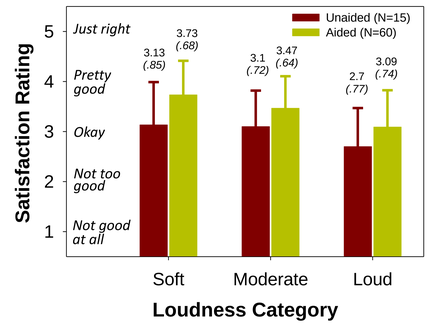


Results (cont'd)

Satisfaction

Q: Do best fitting practices result in acceptable self-reported loudness perception in the real world? A: Yes

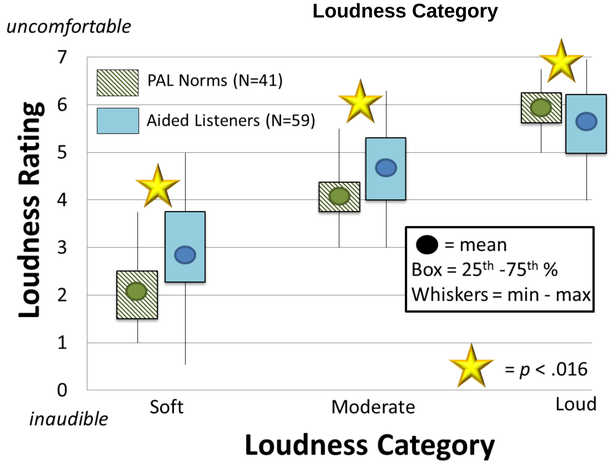
- The PAL includes a Satisfaction Rating that ranges from "Not good at all" to "Just right". On average, participants rated their aided loudness perception between "Okay" and "Pretty good".
- The15 participants' aided satisfaction ratings (N = 60 hearing aid fittings) are presented at right compared to their unaided ratings.
- Amplification increased satisfaction with loudness of non-speech sounds compared to listening without hearing aids.



Loudness

Q: Do best fitting practices result in normal loudness perception in the real world? A: No

- The PAL also includes a Loudness Rating that ranges from "Do not hear" to "Uncomfortably loud".
- On average, aided listeners with mild to moderate hearing impairment perceived soft and moderate everyday sounds louder and loud sounds softer than normal hearers.
- In like comparisons, Mueller & Powers (2001) and Shi et al. (2007) reported similar trends, especially for soft and loud everyday sounds.



Results Summary

- For listeners with mild-moderate hearing impairment, evidence-based fitting practices resulted in hearing aid fittings that provided less gain than was called for by the NAL-NL1 prescription. Instead, the fitting protocol resulted in gain closer to that called for by NAL-NL2, but still provided less low-level high-frequency gain than was prescribed. Regardless, the results of 59 hearing aid fittings revealed that aided hearing-impaired listeners perceived soft and moderate non-speech sounds louder than, and loud sounds softer than, normal hearers. These data are consistent with findings of Mueller & Powers (2001) and Shi et al. (2007). Although participants with hearing impairment did not perceive non-speech sounds to have "normal" loudness, they reported that loudness was acceptable to them in their daily lives, and that it was more satisfactory than unaided loudness.

On target? Or missing the mark?

- The observation of small but statistically-significant differences between theoretical loudness goals and the perceived loudness resulting from best-fitting practices calls for some consideration.
- We should keep in mind that "normal" loudness is not necessarily preferred loudness. This is true even for normal-hearing listeners.
- On the other hand, it is not clear whether these findings represent true preferences of hearing aid wearers or if they are the result of a fine-tuned compromise between patient preferences and technology constraints.
- When real ear measures are used to evaluate hearing aid fittings, practitioners should be aware that loudness data consistently demonstrate differences between theoretical goals and patient preferences.

References

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