



Do new hearing aid users prefer less low-frequency, high-frequency, or overall gain than experienced users?



By Gitte Keidser¹, Anna O'Brien¹, Lyndal Carter¹, Matthias Froehlich², and Harvey Dillon¹
¹ National Acoustic Laboratories, Australia, ² Siemens Hearing Instruments, Germany

Background:

There seems to be a widespread belief among clinicians that new hearing aid users prefer less gain than experienced hearing aid users, and therefore that new users will acclimatize to more gain over time. This belief is reinforced by tools in most proprietary fitting software (variously called Adaptation Managers, Acclimatization Levels, Client Experience Levels, etc.) that allow the clinician to select reduced gain levels relative to target before the fitting is verified and validated. Intuitively, the assumption that new hearing aid users prefer less gain than experienced hearing aid users may seem reasonable as many clients who are being fitted with a hearing aid for the first time have lost their hearing gradually over a period of years, and therefore have become accustomed to a quieter environment. However, a literature review by Convery et al. (2005) found very little support for gain acclimatization in new hearing aid users. Specifically, data from three studies (Cox & Alexander, 1992; Horwitz & Turner, 1997; Humes et al., 2002), providing gain preferences relative to the NAL-R prescription (Byrne & Dillon, 1986) for 98 new and 77 experienced hearing aid users in total, suggested that the difference in preferred gain between new and experienced users was no more than 2 dB. This difference was not statistically significant nor did it appear to change over a period of up to 12 months. The paper further concluded that no studies have directly investigated this matter with appropriate control of all relevant parameters.

References:

- Byrne D, & Dillon H. 1986. The National Acoustic Laboratories' (NAL) new procedure for selecting the gain and frequency response of a hearing aid. *Ear Hear*, 7, 257–265.
- Convery E, Keidser G, & Dillon H. 2005. A review and analysis: Does amplification experience have an effect on preferred gain over time? *Austr & NZ J Audiol*, 27, 18-32.
- Cox RM, & Alexander GC. 1992. Maturation of hearing aid benefit: objective and subjective measurements. *Ear Hear*, 13, 131–141.
- Horwitz AR, & Turner CW. 1997. The time course of hearing aid benefit. *Ear Hear*, 18, 1–11.
- Humes LE, Wilson DL, Barlow NN, & Garner C. 2002. Changes in hearing-aid benefit following 1 or 2 years of hearing-aid use by older adults. *J Sp Lang Hear Res* 45, 772–782.

Research questions:

- 1) Do gain preferences of new and experienced hearing aid users differ overall (averaged across 0.5, 1.0, 2.0, and 4.0 kHz), or only in the low (averaged across 0.25, 0.5, and 1.0 kHz) or the high (averaged across 2.0, 3.0, and 4.0 kHz) frequencies?
- 2) If gain preferences differ between new and experienced hearing aid users, at what point post-fitting do the gain preferences of these groups converge?
- 3) If preferred gain does change post-fitting, is it related to changes in perceived loudness and does the shift in preferred gain affect speech recognition in noise performance?

Participants:

Parameter	New	Experienced
Hearing aid experience (years)	0	>3
Number recruited to date (withdrawn)	76 (19)	22 (0)
Recruited and tested at	13 AH* centres + NAL	NAL
Male/female proportion (%)	52/48	68/32
Average age (years) and range	70.7 [30, 87]	73.3 [40, 90]
BTE/ITE/ITC fit proportion (%)	48/20/32	100/0/0
Bilateral/unilateral fit proportion (%)	77/23	73/27
Average LF HTL (dB HL) and range	29.1 [5, 58.3]	31.8 [15, 58.3]
Average HF HTL (dB HL) and range	49.8 [32.5, 68.3]	57.0 [43.3, 75]

*AH = Australian Hearing



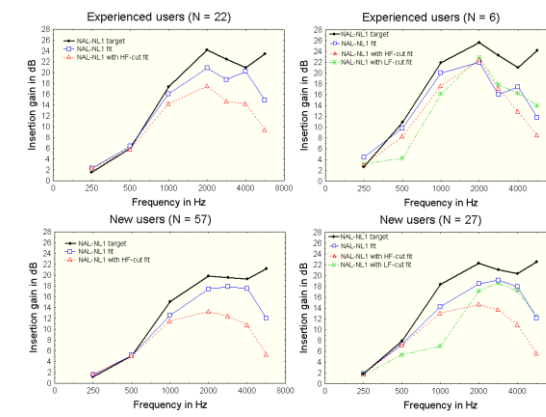
Test device:

Siemens Music Pro*: a digital, three-memory, two-channel wide dynamic range compression device with a volume control. No noise reduction was activated, but a directional microphone was enabled on all programs if wanted by the participant.

The following programs, the order of which was balanced across participants, were implemented:

- NAL-NL1
- NAL-NL1 with a 6 dB high-frequency cut (HF-cut) at 3 or 4 kHz
- NAL-NL1 with a 6 dB low-frequency cut (LF-cut) at 0.5 kHz

The LF-cut could not be achieved for all participants.



Test protocol:

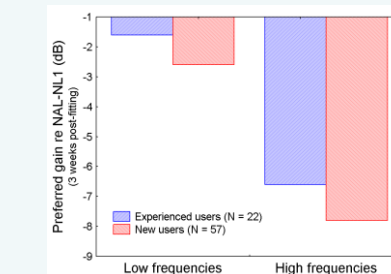
Measured 3 weeks, 3 months and 12 months post-fitting:

- Preferred program and "walk-in-the-door" preferred gain (REIG and 2cc for a 65 dB SPL input)
- Gain preference on all three programs in the clinic when listening to 65 dB SPL speech in 45 dB SPL babble noise (REIG for a 65 dB SPL input)
- Loudness perception of speech presented in 3 dB steps from 50 to 80 dB SPL (NAL-NL1 program)
- Signal-to-noise ratio required to understand 50% of speech (NAL's BEST test) presented at 55 dB SPL in babble-noise (NAL-NL1 and preferred program)

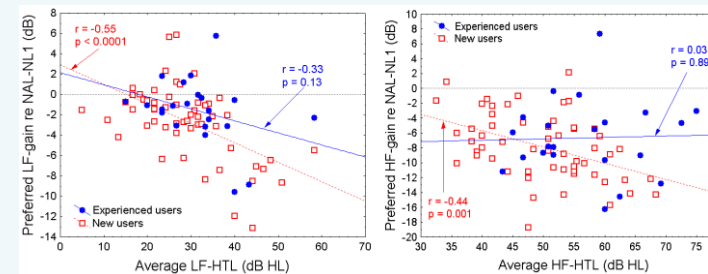
Experienced hearing aid users were only tested 3 weeks post-fitting.

Preliminary results – question 1

At 3 weeks post-fitting, there was no significant difference in the average preferred gain relative to NAL-NL1 between new and experienced hearing aid users in the low ($t_{77} = 1.14, p = 0.26$) or high ($t_{77} = 0.99, p = 0.32$) frequencies.



For the new hearing aid users, there was a significant correlation between the preferred gain relative to NAL-NL1 and the HTL in both the low ($r = -0.55, p < 0.0001$) and high ($r = -0.44, p = 0.001$) frequencies. No significant correlation between the same two parameters was found for the experienced hearing aid users. The regression lines suggest that new hearing aid users may prefer increasingly less gain relative to NAL-NL1 than experienced users as the degree of hearing loss increases.



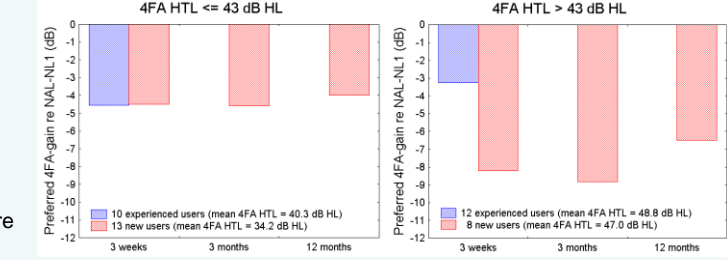
When dividing new and experienced participants into two groups based on their 4FA hearing loss, using 43 dB HL (the average median value across the two groups) as a divider, there is a significant interaction between group and degree of hearing loss ($F_{1,75} = 9.65, p = 0.003$). New hearing aid users with a more severe hearing loss selected significantly less overall gain re NAL-NL1 (-8.7 dB) than experienced users with a similar degree of hearing loss (-4.6 dB). There was no significant difference between the overall gain re NAL-NL1 selected by new and experienced hearing aid users with a milder hearing loss (-4.3 and -3.2 dB, respectively).

Generally, 60% of the participants preferred NAL-NL1 with a HF-cut and one-third preferred NAL-NL1. The percentage of new hearing aid users who evaluated NAL-NL1 with a LF-cut and who preferred this program has currently decreased from 19% at 3 weeks to 8% at 12 months. Of the participants who have completed the testing to date, 2/3 maintained a preference for the same program throughout the study.

Group and time	Experienced		New	
	3 weeks (N = 22)	3 weeks (N = 57)	3 months (N = 56)	12 months (N = 22)
NAL-NL1	36%	31%	32%	43%
NAL-NL1 with HF-cut	55%	60%	63%	52%
NAL-NL1 with LF-cut	9%	9%	5%	5%

Preliminary results – question 2

Based on the 21 new hearing aid users who have completed testing to date, there is no significant change in preferred overall gain relative to NAL-NL1 over time ($F_{2,38} = 1.86, p = 0.17$). Neither is there a significant interaction between degree of hearing loss and time ($F_{2,38} = 0.64, p = 0.53$).

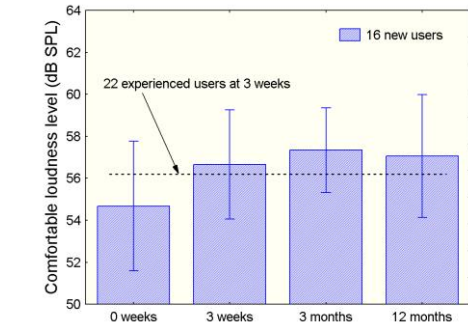


At 12 months, however, there is a trend for the 8 inexperienced hearing aid users with a more severe hearing loss to start to converge to the gain preferred by the experienced hearing aid users.

Preliminary results – question 3

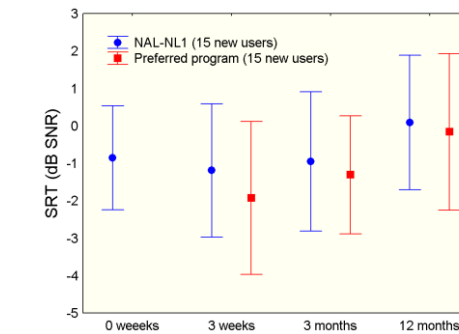
Loudness perception: The 16 new hearing aid users who have completed loudness testing with the NAL-NL1 program at all appointments, rated a significantly higher level comfortable at 3 weeks and at subsequent appointments than immediately after fitting at 0 weeks ($F_{3,42} = 3.44, p = 0.03$).

There was no significant interaction between time and degree of hearing loss ($F_{3,42} = 2.06, p = 0.12$). Neither was there a significant difference in comfortable loudness level selected at 3 weeks by experienced participants with a mild and more severe hearing loss ($t_{20} = 0.63, p = 0.54$).



Speech recognition in noise: There is no significant difference in performance across scheme for the 15 new participants who have completed speech recognition testing at all appointments, or for the experienced hearing aid users at 3 weeks ($F_{1,13} = 0.33, p = 0.58$; and $t_{21} = -0.51, p = 0.62$, respectively).

For the new hearing aid users, performance with NAL-NL1 does not change significantly over time ($F_{3,39} = 2.70, p = 0.06$). There is no significant interaction with the degree of hearing loss for neither of the main factors (scheme and time) ($F_{1,13} = 2.56, p = 0.13$; and $F_{3,39} = 1.63, p = 0.20$, respectively).



Conclusions:

Based on preliminary data the following conclusions may be made:

- 1) In terms of overall gain (4FA), new hearing aid users, on average, prefer significantly less gain relative to NAL-NL1 than experienced hearing aid users (by -4.1 dB) when the 4FA hearing loss is greater than 43 dB HL. When the loss is mild ($4FA \leq 43$ dB HL), there is no significant difference in the overall gain preferred relative to NAL-NL1 by new and experienced hearing aid users.
- 2) Both new and experienced hearing aid users, on average, prefer less gain than prescribed by NAL-NL1, more so in the high than in the low frequencies, and for new users increasingly so as the hearing loss gets more severe. The observed deviations will be adjusted for in NAL-NL2.
- 3) There is no significant change in the overall gain preferred by new hearing aid users over the first 12 months post-fitting. However, at 12 months, the overall gain preferred by new hearing aid users with a hearing loss greater than 43 dB HL seems to begin to converge to that preferred by experienced hearing aid users with a more severe hearing loss.
- 4) For new users, the comfortable loudness level increases significantly from week 0 to week 3 post-fitting. The increase in level does not appear to explain the slower convergence to more gain by those with a more severe hearing loss.
- 5) There is no significant difference in speech recognition in noise performance between NAL-NL1 and the program preferred by the participants. Neither is there a change in performance with NAL-NL1 over the first 12 months post-fitting for new hearing aid users.

Acknowledgement:

We would like to thank the clinicians at the various Australian Hearing centers for helping out with data collection, and the many wonderful volunteers who agreed to participate in this lengthy study.