

## ABSTRACT

Generic prescriptions, such as NAL and DSL, have over time decreased their prescribed gain, and the reduction has for NAL been largest in a fairly broad frequency range around 1 kHz.

These changes in the generic prescriptions prompted us to examine gain changes over time also in proprietary prescriptions. We wanted to answer the following questions:

1. How different are the proprietary prescriptions and have these differences increased or decreased over time?
2. Is the gain reduction seen recently for generic prescriptions mirrored in the proprietary prescriptions?
3. Do modern hearing aids implement gain reduction for first-time hearing-aid users in a way that is similar to the adjustments in the NAL-NL2 prescription?

## METHOD

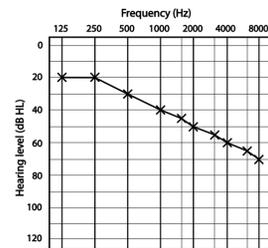
### Hearing aids

Hearing-aid gain was measured on three occasions, in 1998, 2008, and 2013. BTE hearing aids from various manufacturers, classified as top-end products at the time, were selected.

1998	2008	2013
<ul style="list-style-type: none"> <li>• Danavox Danasound</li> <li>• Oticon DigiFocus</li> <li>• ReSound BT4</li> <li>• Siemens Prisma (DSL[i/o])</li> <li>• Unitron Ikon K (FIG6)</li> <li>• Widex Senso</li> </ul>	<ul style="list-style-type: none"> <li>• Beltone ONE 75 D</li> <li>• Bernafon Icos 105</li> <li>• Oticon Epoq</li> <li>• Phonak Savia Art 211 dSZ</li> <li>• ReSound Azure 70D</li> <li>• Siemens Centra S</li> <li>• Sonic Velocity</li> <li>• Starkey Destiny 1200</li> <li>• Unitron Indigo</li> <li>• Widex Inteo</li> </ul>	<ul style="list-style-type: none"> <li>• Oticon Epoq XW</li> <li>• Phonak Ambra microP</li> <li>• Resound Alera AL977</li> <li>• Siemens Motion 700 M</li> <li>• Starkey Xseries 110 Vibrant</li> <li>• Widex DREAM 440</li> </ul>

## Measurements

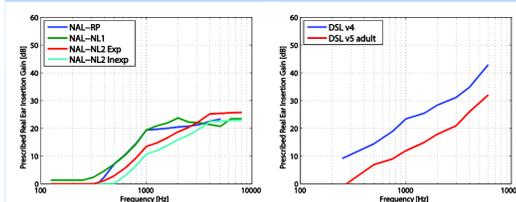
- Fitting according to manufacturers' suggested first fit
- Using a gently sloping reference audiogram



- Test-box measurements
- Re-calculation to estimated Real Ear Insertion Gain (REIG)
- Three test signals
  1. Low-level speech in quiet
  2. Average-level speech in moderately noisy background of other talkers
  3. High-level speech in noisy background of other talkers

## Generic prescriptions: NAL and DSL

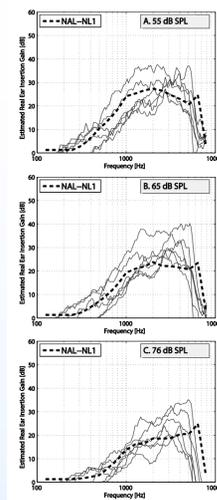
- NAL-R: for linear hearing aids
- NAL-NL1: WDRRC, similar to NAL-R at 65 dB SPL input
- NAL-NL2: WDRRC, reduced gain mainly at 700 Hz - 2 kHz, slightly increased gain over 3 kHz. For inexperienced users: 3 dB gain reduction.
- DSL [i/o]: WDRRC
- DSL m[i/o] v5: substantially reduced gain



It is important not to think of the generic prescriptions included as providing the "correct" gain to which the proprietary prescriptions should be evaluated, but rather as well-documented references.

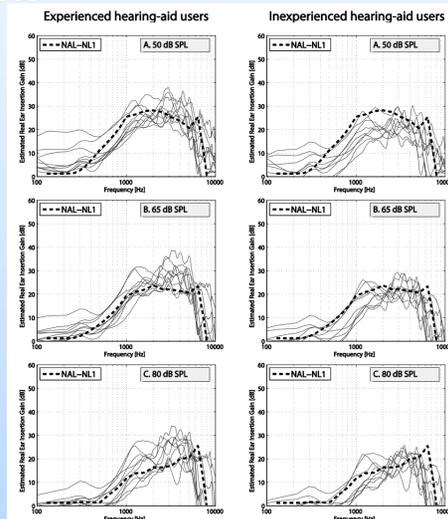
## RESULTS

### 1998

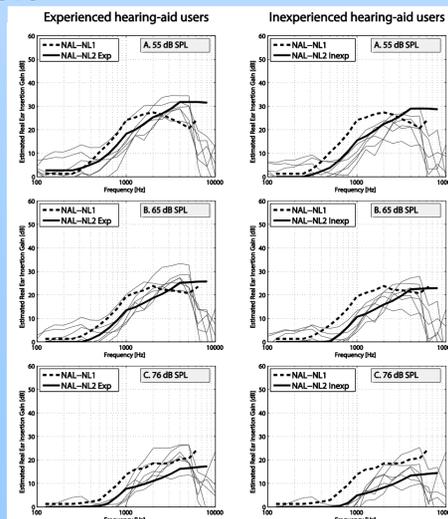


No gain adaptation strategies for first-time hearing-aid users were implemented in 1998

### 2008

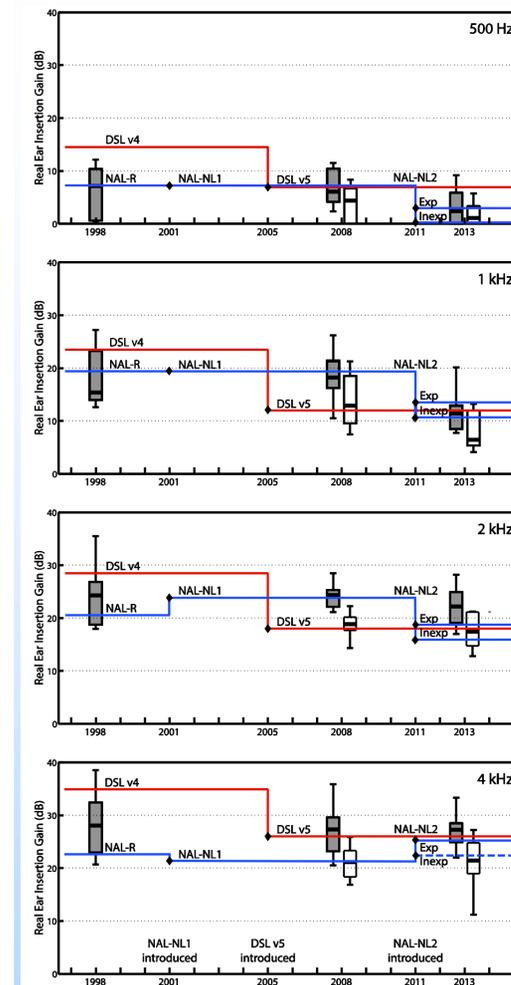


### 2013



## Gain over time

Illustration of gain changes over time for a 65 dB SPL speech signal for generic prescriptions (lines) and proprietary prescriptions (boxes) at four frequencies.



Largest change is seen at 1 kHz, where the gain has been substantially reduced.

For inexperienced hearing-aid users (white boxes), the median gain was in 2008 and 2013 reduced 5-6 dB (except at 500 Hz).

With the changes in the generic prescriptions (for the audiogram and input levels used in this comparison), NAL-NL2 and DSL v5 today prescribe very similar gain at 1, 2 and 4 kHz.

## DISCUSSION AND CONCLUSIONS

1. How different are the proprietary prescriptions?  
Less differences today than 1998. Today, proprietary prescriptions are generally fairly similar to NAL-NL2.
2. Is the gain reduction seen recently for generic prescriptions mirrored in the proprietary prescriptions?  
Yes. Largest reduction around 1 kHz. Some of these changes have taken place before the generic prescriptions changed, mainly by the use of special gain settings for first-time hearing-aid users.
3. Do modern hearing aids implement gain reduction for first-time hearing-aid users in a way that is similar to the adjustments in the NAL-NL2 prescription?  
No, there are large differences in the implementation of gain reduction for inexperienced hearing-aid users and many manufacturers have introduced larger gain reductions than in the NAL-NL2 prescription. Different time scales?

- NAL-NL2: compensation for small difference in preferred gain seen after several months.
- For some hearing aid manufacturers, on the other hand, the goal is to facilitate initial hearing aid use (over days or weeks).

## REFERENCE

Smeds K, Dahlquist M, Paludan-Müller C, Larsson J, Hertzman S, Båsjö S. (2015) Proprietary hearing aid gain prescriptions: Changes over time. *Hear Rev.* May 16-22.