

THE **WIDEX FITTING RATIONALE** FOR **EVOKE**

ERIK SCHMIDT, TECHNICAL AUDIOLOGY SPECIALIST
WIDEX GLOBAL RESEARCH & DEVELOPMENT

Introduction

As part of the development of the EVOKE hearing aid, the Widex Fitting Rationale has been revised in the following two ways:

- A new setting, 'hearing aid experience', has been implemented, which affects the overall gain applied when performing a new fitting in Compass GPS.
- For open fittings, the gain at mid frequencies has been reduced – with the gain reduction being greatest for inexperienced users.

In this Widex Press we will look at the background for these changes and how they will appear in the Compass GPS 3.0 fitting software.

The Widex Fitting Rationale

The goal for Widex has always been to provide the hearing aid user with a pleasant and transparent sound – achieving improved speech intelligibility and a natural sound quality for soft, moderate and loud sounds present in the various environments in daily life.

The amplified sound presented to the hearing aid user can be regarded as the combination of the basic frequency response provided to compensate for the user's hearing loss, and the effects of advanced features (such as noise reduction and sound-class-specific signal

processing) that aim to optimize the listening experience in different sound scenarios (Kuk et al, 2015).

The aim of the Widex Fitting Rationale (WFR) is to prescribe the optimum gain, compression, and feature settings, that will fulfil the above objectives.

When listening to speech at normal conversation level in a quiet environment, the Widex Fitting Rationale will prescribe a long-term aided response similar to that prescribed by the NAL-NL1 algorithm (Byrne et al, 2001). Building on the principle of 'loudness equalisation', the gain is prescribed in such a way that speech sounds at mid and high frequencies are given relatively more gain compared to the sounds at low frequencies. The goal is to optimize speech intelligibility and reduce the effect of the upward spread of masking.

For soft and loud sounds, the principle of loudness normalization is applied, in order to make soft sounds audible and provide the user with the sensation of the dynamics in loud sounds.

Whenever noise at moderate to high levels is detected by the hearing aid, the Widex RT Speech Enhancer noise reduction system will reduce the gain in frequency regions where the noise is strongest, while preserving gain in frequency areas important for speech

intelligibility. The HD Locator (directional microphone) will also become active.

Changes in gain prescription over time

Looking at the general trend in hearing aid amplification over the past years, an overall reduction in gain has been seen, both in the proprietary fitting rationales and in the most commonly used generic rationales, NAL and DSL (Smeds et al, 2015).

The latest version of the NAL-NL2 fitting algorithm prescribes less gain in the frequency region around 1-2 kHz, compared to the earlier NAL-NL1 version. The algorithm also applies an overall gain reduction for inexperienced hearing aid users (Keidser et al, 2012).

As part of the development of the Widex UNIQUE hearing aid, an evaluation study was carried out where the Widex Fitting Rationale was compared to a NAL-NL2-like prescription (Smeds et al, 2016). Only small differences in outcomes between the two settings were found. The Widex Fitting Rationale produced better speech test results for low-level speech, compared to the NAL-NL2-like setting, and the sound quality was reported to be very good with the default setting. But a number of participants in the evaluation indicated that the loudness in general was somewhat too high.

Based on this result, the gain frequency response shape prescribed by the Widex Fitting Rationale was kept in the UNIQUE hearing aid, but an overall gain reduction of 2-3 dB was implemented – with the aim of providing a somewhat more comfortable first fit. This change has seemed to be well received by new hearing aid users fitted with Widex UNIQUE and BEYOND.

Individual needs for gain adaptation

It has been debated in literature whether the concept of gain adaptation to hearing aid amplification exists, and the extent of this effect regarding differences in preferred gain between experienced and inexperienced hearing aid users.

An approach in some clinical practices is to provide new users with gradually increasing gain over the first weeks or months of hearing aid use – also denoted as ‘short-term gain adaptation’ (Dillon, 2012).

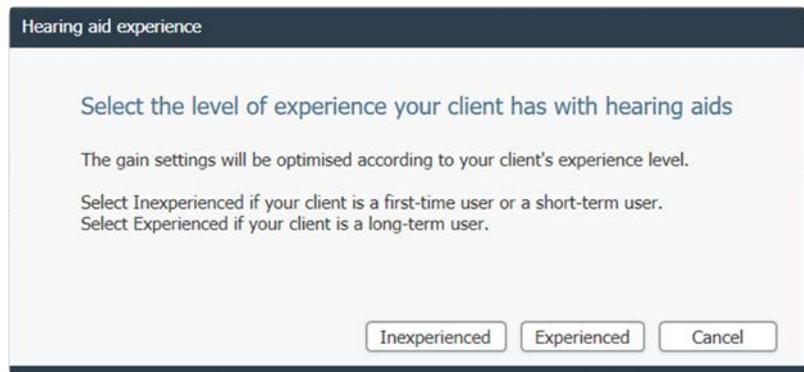
In the long-term perspective, a trend towards a user preference for increased amplification over time has been seen in some studies. Keidser et al (2008) found a significant change in gain preferred over time, amounting to 2.7 dB on average. The difference in preferred gain was found to be significant for new users with moderate hearing losses (4FA HTL > 43 dB HL). The change was shown to happen during a time period of up to 13 months, but it seemed to continue for up to 36 months after the participants started using hearing aids. A similar trend was reported by Convery et al. (2005) who, based on a review of literature, suggested that new hearing aid users on average prefer 2 dB less gain relative to experienced users, although the difference was not statistically significant.

In addition to the notion of long-term gain adaptation, the term ‘hearing aid acclimatization’ was established by Gatehouse (1993). He considered this to be not only a question of changes in the preferred gain setting, but also changes in a broader range of outcome measures, i.e. improvements in the hearing aid user’s ability to understand speech with the hearing aid.

New setting of experience level in Compass GPS

Based on the findings in the literature and the appreciation of the individual listening needs of our users, different gain settings for experienced and inexperienced hearing aid users have been implemented in the Widex Fitting Rationale for the EVOKE hearing aid.

When performing a new fitting in Compass GPS 3.0 for EVOKE, the hearing health care provider (HCP) will now be prompted at the beginning of the fitting and be asked to select whether the client being fitted is inexperienced or experienced in the use of hearing aids.



When selecting the inexperienced user setting, a gain setting similar to the one applied previously for UNIQUE and BEYOND hearing aids is used. When selecting the experienced user setting, an overall gain increase of up to 2 dB is added to the gain setting applied.

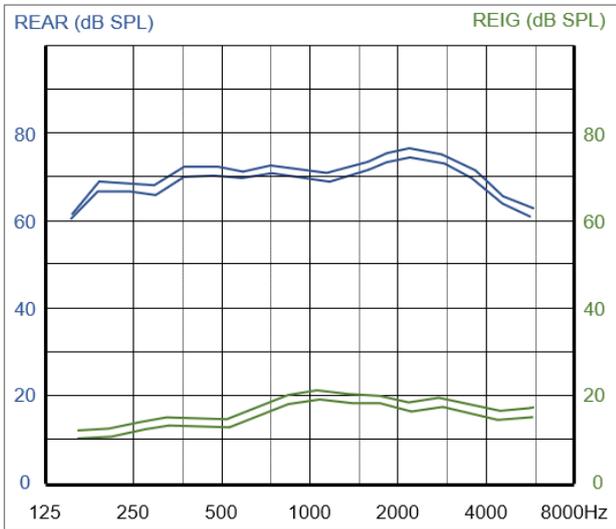


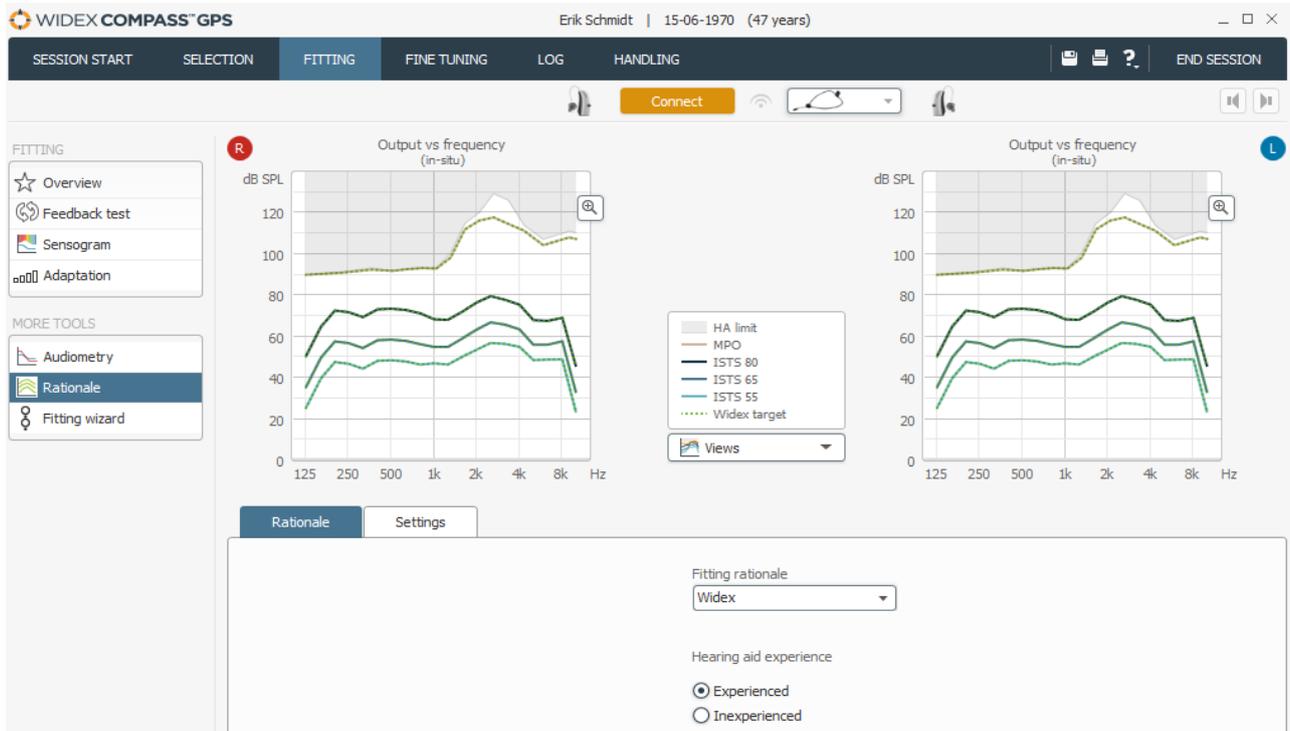
Fig. 1. Example of the difference in real ear aided response (blue curves) and insertion gain (green curves) between the inexperienced and experienced user setting in Widex EVOKE, for a flat 50 dB HL hearing loss.

The experience setting selected by the HCP is reflected in the green dotted target curves for full prescribed gain and output (adaptation step 4), shown in the performance graphs in Compass GPS.

The inexperienced user setting may be applied for new users who have never worn hearing aids before and therefore need a somewhat more comfortable gain setting during the first years of hearing aid use.

The experienced user setting may be applied for existing hearing aid users who have been using hearing aids for more than a year. They will have been accustomed to amplification and will therefore require a somewhat higher loudness to benefit fully from their hearing aids.

The experience level setting selected for the given fitting can also be found in the Rationale tool on the Fitting page in Compass GPS. The Rationale tool has been redesigned, and it now also includes performance graphs where the targets and simulated responses can be viewed when selecting a given fitting rationale (Widex, NAL-NL2 or DSL v5).





The rationale settings related to the handling of bone conduction levels (BCL), uncomfortable loudness (UCL) and AISA vent compensation are now found in a separate tab, named 'Settings'.

In Compass GPS 3.0 for EVOKE, the acclimatization tool has now changed its name to '**Adaptation**', to reflect its application for short-term gain adaptation in users who need to get accustomed to the sound of the hearing aid during the first weeks and months of use. The functionality of this tool is the same as in previous versions of Compass GPS – i.e. when performing a new fitting, gain adaptation is turned off by default.

When adaptation is turned on, the gain is reduced to adaptation step 2, and it will then automatically be increased to step 4 (full prescribed gain) within a period of 3 weeks and up to 6 months, depending on the time period per step selected by the HCP. Alternatively, the change in steps can be made manually over time by the HCP.

New gain setting for open fittings with EVOKE

In recent years, the use of open instant or custom eartips has become very popular with HCPs and hearing aid users alike. The ease of fit, combined with good physical comfort and a reduced occlusion effect, makes open eartips the earware of choice for many users with mild to moderate hearing losses.

To fulfill the objective of providing hearing aid users with a transparent and natural sound quality, we investigated ways to optimize the gain setting for open fittings made with EVOKE hearing aids.

One frequency area of special interest in open fittings is the mid frequencies – i.e. the 1-2 kHz region. In open fittings, the mid frequency area is a transition zone between the direct sound from the outside passing into the ear canal, and the amplified sound from the hearing aid starting to compensate for the hearing loss at mid and high frequencies.

Several factors need to be taken into consideration when setting up amplification for open fittings, e.g. the effect of the natural ear canal acoustics, the possible interference between direct and amplified sound (comb-filter effect), the amount of gain needed at mid frequencies to preserve speech cues and the sound

quality of the total sound picture presented at the user's eardrums.

As previously mentioned, the Widex Fitting Rationale applies the principle of loudness equalisation, where relatively more gain is provided at the mid frequencies to improve audibility for important speech cues.

At the same time, the amount of gain given to compensate for the hearing loss at mid frequencies may overlap with the audibility provided by unamplified sound passing through the open eartip. Hypothetically, the gain in the mid frequency region might be reduced to improve the naturalness of the overall sound quality, without degrading speech intelligibility.

Study on alternative gain settings for open fittings

To investigate this hypothesis, a study with a total of 28 hearing-impaired participants was carried out at Widex in Lyngø (Copenhagen, Denmark), and at our two research centres, ORCA EU in Stockholm (Sweden) and ORCA US in Chicago (USA). All participants had mild to moderate sloping sensorineural hearing losses, with hearing thresholds no greater than 60 dB HL at 1 kHz and 70 dB HL at 2 kHz.

Test participants were fitted binaurally with Widex Beyond 440 Fusion hearing aids. All participants were fitted with open instant eartips, in sizes appropriate for their ear canal size.

Four listening programs were prepared, where the gain at 1-2 kHz was varied relative to the gain prescribed by the Widex Fitting Rationale (WFR) applied in Beyond. In the WFR+1 program, additional gain was applied relative to the WFR program. In the WFR-1 program, the gain was reduced relative to the WFR program and even more so in the WFR-2 program.

An example of the ear simulator gain provided in the four programs for a mild sloping hearing loss is shown in figure 2. The actual difference in gain at 1-2 kHz between programs would vary depending on the hearing loss of the participant, but it would typically be in the order of 5 dB, as shown in this example.

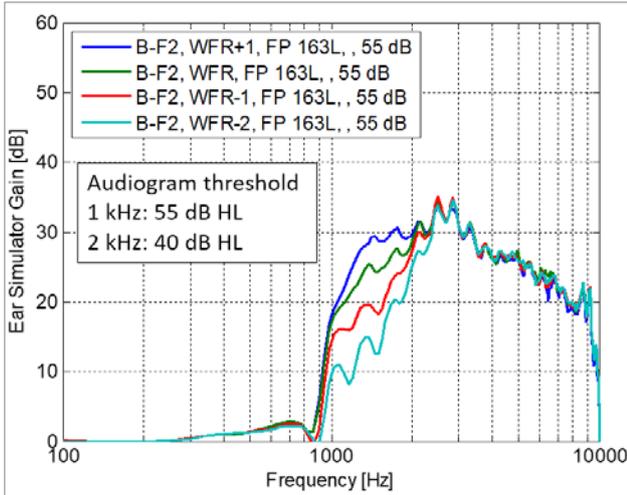


Fig 2. One example of gain curves for the four rationale settings in the study, produced by a Beyond Fusion hearing aid fitted with an M receiver and an open instant eartip. The graph shows box measurements of ear simulator gain for ISTS at 55 dB SPL input level for one participant with a mild hearing loss. The measurements were performed with hearing aid and receiver mounted in an open coupler adapter.

HINT testing

In one part of the study, the Hearing In Noise Test (HINT) was carried out with all participants for the WFR, WFR-1 and WFR-2 listening programs described above. The purpose was to investigate whether the two degrees of gain-decrease in the WFR-1 and WFR-2 programs would result in a significant change of the Speech Reception Threshold (SRT), compared to the SRT obtained for the WFR setting.

The HINT consists of everyday sentences presented in a stationary background noise. For this study an adaptive procedure was used, with the noise presented at 55 dB SPL and the speech presented at 62 dB SPL, and thereafter varying in level depending on the number of sentences scored correctly by the participant.

Figure 3 shows boxplots of the mean SRT, standard error and standard deviation obtained for the WFR-1 and WFR-2 programs, relative to the WFR-program (0 dB SRT on the y-axis).

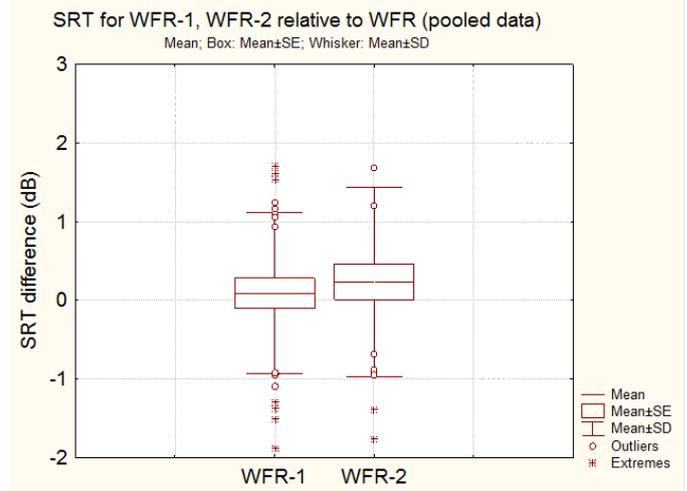


Fig. 3. Boxplot showing the mean, standard error, standard deviation, outliers and extremes of the speech reception threshold (SRT) obtained with the HINT for WFR-1 and WFR-2, relative to standard Widex rationale (WFR). The data shown are pooled from the three sites, Widex HQ, ORCA EU and ORCA US. The total number of participants was 28.

Based on data of the standard deviation in HINT tests carried out in previous studies, a power calculation showed that the difference in mean SRT should be greater than 1.3 dB if a significant difference in the reception threshold was to be found. As the mean difference across the three sites was no greater than 0.24 dB, it can be concluded that the gain reduction in the WFR-1 and WFR-2 programs did not result in a significantly poorer SRT, compared to the standard WFR setting.

Preference testing

The participants' subjective preference for either the standard rationale setting for open fittings (WFR), the WFR+1 setting with increased gain at 1-2 kHz or the WFR-1 and WFR-2 settings with reduced gain was investigated in a second part of the study.

At Widex in Denmark, 13 participants were asked to try out the four listening programs in their daily environments for approx. one week, while filling in a diary with personal observations on the sound quality in each of the four programs.

Similarly, at ORCA EU in Stockholm 10 subjects participated in a guided city walk, where they tried the

four listening programs while reporting their observations regarding the sound quality to a test manager who walked along with them.

For each of the sound scenarios experienced, participants were asked to select the listening program they preferred. Figure 4 shows the distribution (%) of the overall preference for the WFR+1, WFR, WFR-1 and WFR-2 programs. The higher the distribution for a given rationale setting, the more participants preferred this setting.

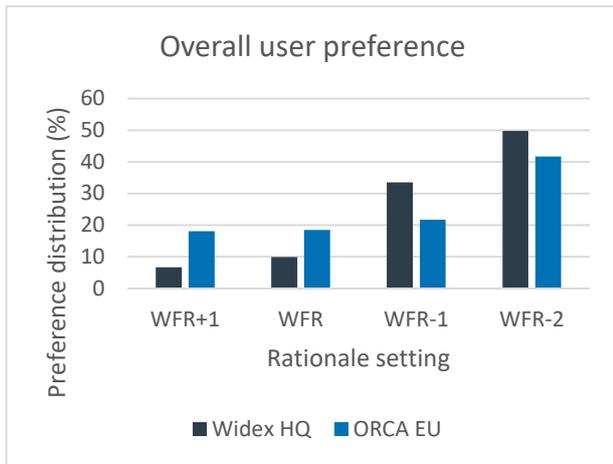


Fig. 4. Distribution (%) of overall preference for four different versions of the Widex fitting rationale, applied for open fittings. The bars indicate the preference found in two separate studies: a guided walk performed with 10 participants at ORCA EU (blue bars) and a field trial with 13 participants performed at Widex HQ (black bars).

As can be seen in figure 4, the WFR-1 and WFR-2 were increasingly preferred by the hearing-impaired participants, compared to the WFR+1 and WFR settings. A trend towards a difference between participants who were inexperienced and experienced hearing aid users was seen, in that experienced users seemed to prefer WFR-1 slightly more often and inexperienced users seemed to prefer WFR-2 more often.

Based on the results from the two preference tests, it was decided to apply the WFR-2 setting, with the largest gain reduction at 1-2 kHz, for inexperienced users fitted with Widex EVOKE. For experienced users, the WFR-1 setting with a smaller gain reduction was applied.

Conclusion

A new setting, 'hearing aid experience', has been implemented in Compass GPS 3.0 for the EVOKE. When selecting either the inexperienced or experienced setting, a difference in the overall gain of up to 2 dB is provided, thus yielding a slight difference in the loudness perceived by the hearing aid user. In addition, the gain at mid frequencies has been reduced for open fittings, with the gain reduction being greatest for inexperienced users. This provides a more transparent sound quality, while not compromising the user's ability to understand speech.

In this way, the Widex Fitting Rationale has been optimized for the EVOKE hearing aid, so that HCPs can now achieve a more individualized fitting, with the goal of improving user satisfaction and meeting individual listening needs.

References

Byrne D, Dillon H, Ching T, Katsch R, Keidser G. (2001). NAL-NL1 procedure for fitting nonlinear hearing aids: characteristics and comparisons with other procedures. *J. Am Acad Audiol.* 12(1):37-51.

Dillon, H. (2012). Hearing aids. Thieme Verlag.

Keidser G, Dillon H, Carter L, O'Brien A. (2012). NAL-NL2 empirical adjustments. *Trends Amplif.* 16(4):211-23.

Keidser G, O'Brien A, Carter L, McLelland M, Yeend I. (2008). Variation in preferred gain with experience for hearing-aid users. *Int J Audiol.* 47(10):621-35.

Gatehouse S. (1993). Role of perceptual acclimatization in the selection of frequency responses for hearing aids. *J Am Acad Audiol.* 4(5):296-306.

Kuk F, Schmidt E, Jessen A.H, and Sonne M. New technology for effortless hearing: A "Unique" perspective. *Hearing Review.* 22(11):32-36.

Smeds K, Dahlquist M, Wolters F, Larsson J, Hertzmann S. Widex Fitting Rationale. (2016). A Need for a Change? *Hearing Review,* 23(1):24.

Smeds, K., Dahlquist, M., Paludan-Müller, C., Larsson, J., Hertzman, Båsjö, S (2015). Proprietary Hearing Aid Gain Prescriptions: Changes Over Time. *Hearing Review,* 22(5):16-22.