



# Valeo™

## SoundSelect Manager

### Summary

There is no "ideal" signal processing strategy for every type of hearing loss and hearing situation. The compression strategy chosen (WDRC, SC or linear) depends very much on the client's individual audiogram, personal preferences and habits, as well as the immediate listening situation. This makes multi-signal processing hearing instruments the best choice for catering to clients' needs across a broad range of situations and for increasing overall satisfaction. From the profile presented by the client's audiogram, Valeo with SoundSelect Manager appraises the client's needs and automatically selects the most likely compression strategy for each hearing program. This not only increases spontaneous acceptance of the hearing instrument, it also reduces fine-tuning and follow-up appointments. With SoundSelect Manager, tuning the compression strategy in each hearing program is simple, intuitive and client-oriented. This development brings out the full potential of flexible hearing program design.

**PHONAK**

hearing systems

## Introduction

WDRC (Wide Dynamic Range Compression) offers undisputed benefits over linear hearing instruments. It maps the natural dynamic range of the listening situation onto the residual dynamic range of the hearing-impaired person, so their perceived loudness matches that of a person with normal hearing. The amplified sound is clearly audible and easy on the ear, so the volume control can be left alone (see for example Jenstad et al., 2000). Now compare this with linear hearing instruments, which apply fixed amplification to loud and soft sounds alike. Simply truncating the loudest sounds (peak clipping) does prevent excessive sound pressure at the eardrum but at the same time introduces output distortion. There are hearing instruments that compromise between linear and WDRC systems: they operate in linear fashion over most of their dynamic range, but compress sounds above a certain threshold level (Super Compression, SC). Figure 1 shows typical input/output characteristic curves for these three types of hearing instrument.

Ever since the emergence of hearing instruments with dynamic compression to compensate individual recruitment, the specialist community has searched for an "optimal" compression system. There have been numerous studies of the advantages and disadvantages of WDRC vs. linear hearing instruments. They have investigated speech understanding, as well as numerous subjective factors like perceived sound quality and general preferences. Yet despite all the research, there is still no uniform consensus on dynamic compression, let alone the "ideal" compression system that works best with all cases of hearing impairment. One reason is the broad range of compression systems available. Their variations in compression ratio, threshold kneepoint, time constants and the number of independently compressed frequency bands all have a major influence on dynamic compression characteristics. For example, applying a very long time constant slows the system's gain response to changing input levels, effectively creating a linear hearing instrument. Differences like this make it difficult to compare the various findings directly. Wearers' individual preferences, habits and needs are further reasons why it is probably impossible to establish a single, "optimal" compression system.

## Compression and understanding of speech

WDRC hearing instruments amplify soft sounds more than linear instruments. Improved understanding of quiet speech



Fig. 1: Typical input/output transfer functions for WDRC, SC and linear processing.

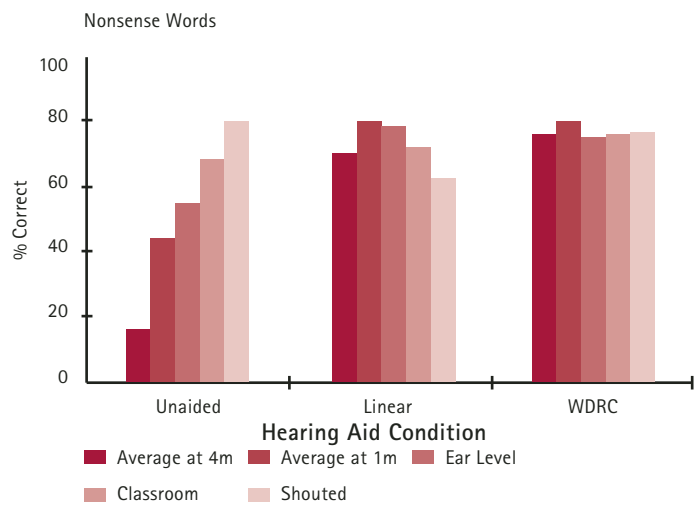


Fig. 2: Speech comprehensibility with WDRC and linear settings in differing situations (after Jenstad et al., 1999).

would be the main expected benefit, and several studies have indeed confirmed this. Jenstad et al. (1999) conducted speech recognition experiments in various simulated listening environments (e.g. normal speech volume at a distance of four meters, at one meter, and shouted from one meter away). WDRC provided consistently high speech understanding in all environments, while the linear setting did not perform as well with quiet speech and shouting.

Subjective loudness assessments in the respective situations confirmed these findings. In total, 11 out of 12 test subjects benefited more from WDRC than the linear setting. Souza and Turner (1999) obtained similar results. At quiet and medium speech levels, WDRC delivers better speech understanding than a linear strategy. This observation is linked with improved

Normal conversational level in quiet

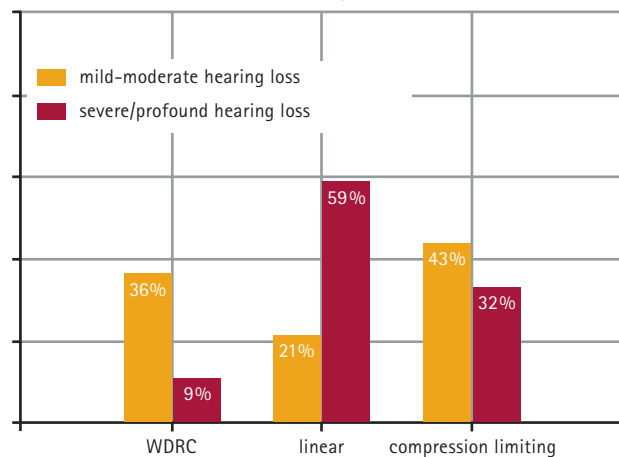


Fig. 3: Preference for differing signal processing strategies among individuals with moderate and severe hearing loss (in quiet speech situations; from Hayes, 2004).

audibility in terms of Articulation Index. It is thus generally true to say that WDRC boosts audibility of soft incoming sounds and hence benefits the understanding of quiet to normal speech.

### Influence of hearing loss

Although WDRC makes quiet speech more comprehensible, it is not always the first choice among hearing-impaired individuals. Obviously, there must be other factors involved. Kiessling et al. (1997) investigated the effect of the spectral audiogram type on preferences for WDRC vs. SC. While most test subjects with flat hearing loss preferred WDRC, those with marked high-frequency hearing loss clearly favored the SC strategy. These tests carry the proviso that a single-channel hearing instrument was used, which could not compensate frequency-dependent differences in the compression characteristic. However, a more recent study using a 4-channel hearing instrument with selectable compression strategies revealed a similarly clear correlation between the degree of hearing loss and the preferred signal processing strategy (Hayes, 2004). Test subjects with moderate hearing loss tended to favor a WDRC setting, while others with profound hearing loss were much more likely to prefer a linear strategy (see figure 3).

This result mirrors common clinical experience among individuals with profound hearing loss who tend to accept linear processing. One possible explanation lies in the nature of profound hearing loss: since spectral resolving

capability deteriorates with increased hearing impairment (broadening of auditory filters in the cochlea), people with profound hearing loss rely particularly on the amplitude envelope of sounds. WDRC with heavy compression smooths out the characteristic rise and decay, possibly discarding useful information that would aid speech understanding (Souza, 2002). Another possible reason to prefer linear processing might be these clients' pre-existing amplification experience which historically means predominantly linear fittings. Compressive processing is often not accepted by people who are highly dependent on a hearing instrument and have grown accustomed to a linear sound.

### Influence of surroundings

In addition to individual hearing loss, the listening situation itself bears strongly on signal processing preferences. While WDRC is quite frequently preferred in quiet situations, linear processing is often the choice in very noisy environments. Some people dislike the way WDRC raises the environmental noise floor; a hearing-impaired individual may feel overwhelmed by extraneous or irrelevant sounds (Hayes 2004; Kiessling et al., 1997). With music, the situation is different: most people with profound hearing loss who listened to classical and jazz music at 60-70 dB actually preferred WDRC (maybe because it brings out the subtler nuances), while

## Music

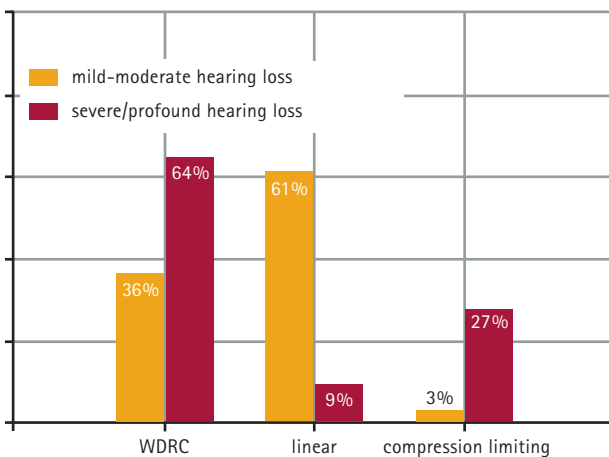


Fig. 4: Listening to music: preferred signal processing strategies among individuals with moderate and profound hearing loss (from Hayes, 2004).

subjects with moderate hearing loss tended to choose linear processing – probably in order to enjoy the music as “transparently” as possible (figure 4).

The listening situation clearly has a strong effect on preference for one or the other signal processing strategy. A comprehensive study has investigated how numerous factors affect the choice of compression strategy (Gatehouse et al., 2000). It showed a clear link between “acoustic lifestyle” and processing preference.

Thus, it becomes clear that one “ideal” compression strategy for all hearing impairments and listening situations simply cannot exist. Furthermore, certain individual needs clearly differ. A sophisticated hearing system must account for these factors, to maximize wearer satisfaction and benefit.

### Benefits of multi-program hearing instruments

With multi-program hearing instruments, a suitable processing strategy can be activated in various listening situations. Multi-program instruments such as Valeo feature a choice of hearing programs with different sound processing strategies. This gives hearingcare professionals the flexibility to tune instruments in a way that compensates their clients' hearing loss in various listening situations. The wearer can manually



switch to the desired hearing program, either via a remote control or a switch directly on the instrument. A hearing instrument satisfaction survey (Kochkin, 1996) indicated that the multi-program option was a significant plus-point for client satisfaction. Overall satisfaction with the hearing instrument likewise increased with the number of specific, everyday situations in which the hearing-impaired individual was satisfied with the instrument's performance (Kochkin, 2002).

### Valeo SoundSelect Manager

The Valeo multi-signal processing hearing instrument clearly reflects the latest research into signal processing strategies. Pre-calculation uses the audiogram profile to automatically select a compression strategy for each hearing program that is most likely to meet the client's needs. This increases spontaneous acceptance of the hearing instrument, and reduces the amount of fine-tuning and follow-up appointments. The PFG fitting software selects compression strategies based on four “typical” hearing instrument wearers. If the automatic choice is not ideal for the client, it can be changed in the SoundSelect Manager. Adapting the compression strategy to individual needs is straightforward and intuitive (see figure 5). This style of selection brings immediate client benefit. The hearingcare professional can respond rapidly and directly to client feedback, without having to set up individual signal processing strategies for each hearing program. Fitting becomes a more effective process, focused on the client's needs rather than hearing instrument technology.

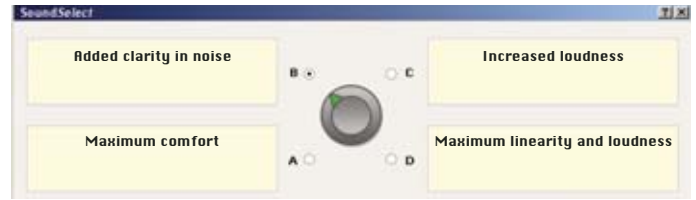


Fig. 5: SoundSelect Manager presets for four basic types of hearing instrument wearer.



Fig. 6: Manual selection of compression strategy for individual hearing programs.

Selecting one of the basic types applies appropriate compression settings for each hearing program (see table 1).

Compression strategies for the individual hearing programs were chosen on the basis of Phonak's longstanding and extensive experience with multi-signal processing strategies and with multi-program hearing instruments. The strategy applied directly addresses the needs of four basic types of hearing aid wearers in a variety of situations (see box).


For clients with more individual needs, it is also possible to manually tune the compression strategy for each hearing program (see figure 6).

This all means that Valeo can truly be "tailor fitted" to a client's needs for maximum acceptance and satisfaction in all listening situations.

	Program 1: Basic program	Program 2: Party noise + AZ	Program 3: Telephone (without T-coil)
A	dWDRC	dWDRC	dWDRC
B	dWDRC	dSC	dLim
C	dSC	dSC	dSC
D	dLim	dSC	dLim

Table 1: The basic type selection governs the compression strategy for individual hearing programs.

<b>A</b>	WDRC active in all hearing programs. Suitable for first-time fittings and clients who like optimal audibility and convenience in every hearing program. Also suitable for clients who are accustomed to WDRC-only instruments and like using them.
<b>B</b>	For clients with mild to severe hearing loss. The client values convenience and audibility in quiet situations, hence WDRC in the basic program. The client does not however want to be "overloaded" with sounds, hence dSC in the party noise program. The linear setting for telephone use provides greater dynamic contrast with speech.
<b>C</b>	Client with profound hearing loss, who values clear, high-contrast speech dynamics. The client is more accustomed to linear or compression-limited processing.
<b>D</b>	Client with profound hearing loss, long-time hearing instrument wearer, very accustomed to linear processing.



## References

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