ANR Plus – An Improved Noise Reduction System

Noise is a persistent enemy of hearing instrument users. Not only is noise uncomfortable but it also increases listening effort and affects the ability to understand speech. To combat these issues, hearing instruments use a noise reduction algorithm. Noise reduction in hearing instruments is not new. However, as a hearing care professional, you know how your clients struggle with noise. Their situation has improved only with time, and the best results are now available with state-of-the-art algorithms like Bernafon’s new Adaptive Noise Reduction (ANR) Plus.

Even in the recent past, Kochkin (2010) reconfirmed the detrimental effect that noise has on hearing instrument satisfaction. He identified the situations in which hearing instruments received the poorest ratings. The results are shown in Fig. 1.

Fig. 1 shows that four out of the five most negatively rated conditions involved noise. So, noise and poor understanding in noise were primary reasons for dissatisfaction.

On the other hand, improvements to the performance in noise have the potential to increase customer satisfaction. Indeed, when Kochkin (2010) investigated the factors that correlate most with overall satisfaction, he found “use in noisy situations” and “comfort with loud sounds” among the 10 most important (p. 22). As performance in noise plays such a key role for hearing instrument success, we will look at the improvements that Bernafon’s new Adaptive Noise Reduction (ANR) Plus offers. In particular, we will show that ANR Plus increases comfort and reduces listening effort, while at the same time, it preserves speech understanding.

Favorable Noise Reduction Properties

Among the favorable properties of current state-of-the-art noise reduction systems are:

- Attenuation across all noise levels,
- Fast-acting adaptation, and
- Preservation of speech understanding.

Let us look at each property in turn.

Attenuation across all noise levels. Traditionally, noise reduction systems are associated with comfort. Their goal is to reduce background noise and provide comfort to the listener. Previous noise reduction algorithms attenuated noise only at high input levels. This required the noise to reach a certain intensity before the noise reduction would activate. A plausible reason for that strategy was the wish to avoid degradation of soft speech.

Based on today’s detection capability, ANR Plus, however, attenuates noise at all input levels: soft, medium, and loud. Your clients will, therefore, experience increased comfort in noisy and soft listening environments.
**Fast-acting adaptation.** A further improvement of ANR Plus is its speed. In particular, speed is necessary to activate and deactivate noise attenuation with accuracy. Only with sufficient speed is it possible to attenuate noise even during pauses in ongoing speech.

In contrast, previous algorithms acted more slowly and therefore not only reduced the noise but the speech as well (Brons, Houben, & Dreschler, 2012). In this way, speech cues were compressed along with the noise. The difference between slow- and fast-acting adaptation is illustrated in Fig. 2.

In contrast, ANR Plus is fast enough to deactivate the attenuation for speech sounds and consequently preserves the important speech cues. To achieve this result, ANR Plus constantly analyzes and estimates the signal-to-noise ratio (SNR) to determine when noise is present. When there is a negative SNR (more noise than speech) the attenuation activates rapidly to suppress the noise, and when there is a positive SNR (more speech than noise) the attenuation rapidly deactivates. The fast activation and deactivation provide a comfortable yet precise listening experience.

**Preservation of speech understanding.** With previous technology, it was a challenge to maintain speech understanding while noise reduction was active. Today’s technology, on the other hand, has the potential to overcome the challenge. A speech-in-noise test can be used to confirm that a hearing instrument preserves speech understanding while its noise reduction is active. For ANR Plus, sixteen participants took part in an Oldenburg Sentence (OLSA) test in noise. The test results are shown in Fig. 3.

The bars in Fig. 3 indicate the average SNR which the test participants needed to maintain 50% speech intelligibility. Without ANR Plus, they needed an SNR of 2.2 dB. When ANR Plus was switched on, they achieved the 50% speech intelligibility with a 0.5 dB lower SNR.

The results of our in-house test concur with a study by Brons et al. (2013). Neither study found a significant improvement nor an adverse effect of noise reduction. For your clients, this means a
more comfortable listening experience with no negative impact on speech intelligibility.

**More Comfort and Less Listening Effort**

In the past, it was difficult to provide any objective measures that proved the benefit of noise reduction. Many studies have failed to show a significant effect of noise reduction on speech intelligibility (Alcántara, Moore, Kühnel, & Launer, 2003; Mueller, Weber, & Hornsby, 2006; Pisa, Burk, & Galster, 2010). As shown by the in-house speech-in-noise test, results do not significantly improve when noise reduction is applied. Therefore, noise reduction was viewed as a feature that provided only subjective comfort as measured by questionnaires.

More recently, however, noise reduction has been proven to reduce listening effort by means of objective dual task measures. In fact, listening with a hearing loss requires extra cognitive effort from hearing-impaired listeners (Hornsby, 2013). Studies have shown that when given an additional task while listening to speech in noise, hearing-impaired listeners perform more poorly on that task than those with normal hearing. However, when noise reduction is applied, performance on the additional task improves. The noise reduction hence reduces the effort needed to understand speech and allows that effort to be applied to the other task at hand (Sarampalis, Kalluri, Edwards, & Hafter, 2009; Ng, Rudner, Lunner, Pedersen, & Rönnberg, 2013).

In conjunction with the testing for reduced effort, another measure is now widely used to demonstrate the benefit of noise reduction: the Acceptable Noise Level (ANL) test. Various studies using the ANL have shown that when noise reduction is applied, hearing-impaired listeners can tolerate between 0.5 dB to 4 dB more noise (Pisa et al, 2010; Fredelake, Holube, Schlüter, & Hansen, 2012; Wu & Stangl, 2013). For ANR Plus, the improvement is illustrated in Fig. 4.

**Ease Your Clients’ Listening Effort**

ANR Plus is a feature that will benefit all of your clients. They will appreciate the ability to listen comfortably amid more background noise and still understand speech. So, let your clients enjoy the benefits of ANR Plus with the Acriva and Carista hearing instrument families.
References


