Field Study News

Spice+ Processing

Superior first-fit acceptance

Abstract

The Phonak fitting philosophy is to provide a pleasant sound quality while also ensuring optimal audibility and intelligibility. The new Phonak Spice+ product portfolio launched in October 2011 feature a new signal processing algorithm called Spice+ Processing. The innovation focus for Spice+ Processing was to increase spontaneous user acceptance and provide the most natural hearing experience in quiet. This Field Study News reports on two studies conducted to investigate the achievement of these objectives.

Introduction

In the hearing instrument fitting process, hearing care professionals seek a positive initial reaction from the client without too much modification of the manufacturer's first-fit algorithm (Van Vliet, 2009). However, the precalculated target-amplification does not always meet the desired loudness and sound impression for the hearing impaired. This can be particularly the case for first time hearing aid wearers who often do not accept hearing aid settings without a corresponding phase of acclimatization (Cox et al., 1996; Munro and Lutman 2004). In fact some researchers go so far as to suggest that measuring initial satisfaction with hearing devices should be postponed by one month because self-reporting, often used in hearing aid fitting assessments, may be meaningless without any real-life experience (Kuk et al, 2003). All this speaks for an optimal first-fit precalculation to ensure the first impression with amplification or a new hearing instrument is as positive as possible.

A common approach is to sacrifice audibility and intelligibility for the sake of immediate, short-term acceptance. In contract, the Phonak fitting philosophy has always been to offer a pleasing overall sound experience while fostering the best possible speech intelligibility.

The Phonak Spice+ product range, launched in late 2011, features Spice+ Processing, a new signal processing algorithm designed with two key benefits in mind: increased spontaneous acceptance and a more natural hearing experience in quiet.

Increased spontaneous acceptance

The trend towards more open fittings (Johnson, 2008; Kochkin, 2011) for mild to moderate hearing losses means a fitting pre-calculation needs to take into account not only the amount of amplification lost through venting, but also the level of sounds presented directly to the eardrum, when calculating the appropriate amount of gain to compensate for the hearing loss. This interaction, between unamplified signals coming through the vent and the amplified sound coming from the instrument, must be accurately accounted for when calculating the most appropriate gain prescribed as part of a first fit precalculation.
Spice+ Processing includes an enhanced fitting formula which better addresses the variability from the individual properties of the ear, the chosen acoustic coupling, the direct sound reaching the ear and amplified sound.

More natural hearing in quiet

Quiet listening situations actually change more than is realized. For example, a quiet situation may be a soft conversation with or without low level background noise or complete silence. Spice+ Processing includes a refined expansion or soft-squelch approach which effectively manages subtle signal amplitude variability in real time. It also utilizes adaptive time constants to address temporal fluctuations in input signals.

The design aim of these changes to the processing algorithm was to significantly enhance spontaneous acceptance, reduce fine-tuning effort for the hearing care professional and maintain optimum audibility and speech understanding. To validate these Spice+ Processing objectives, two studies were conducted.

The purpose of the first study was to test the subjective initial reaction to the first-fit settings using two different hearing instrument models, with subjects with mild to moderate hearing losses.

The second study compared the Phonak Ambra M H2O with Spice+ Processing against various other hearing instruments to investigate sound quality ratings and spontaneous acceptance using paired comparisons.

PHONAK life is on

Study 1: Method

The Spice+ Processing validation study conducted in Switzerland included 20 test subjects wearing micro-size BTE and 10 wearing miniature CIC devices. Of the 20 micro-size BTE test subjects, nine had either no or less than 6 months wearing experience with hearing instruments, three between six months and three years, four between three and six years and four test subjects had over six years of experience with hearing instruments. The average age was 61 years (min. 48 and max. 73 years), with 3 female and 17 male patients. The average hearing loss for this group is shown in Figure 1.

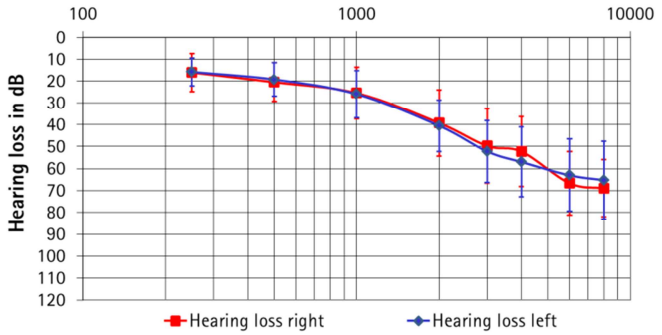

Fig.1: The average hearing loss and standard deviation of the 20 micro BTE validation participants.

Of the 10 miniature CIC test subjects, six had no wearing experience with hearing instruments, one between six months and three years, and three test subjects had over six years of experience with hearing instruments. For this group, the average age was 66 years (min. 41 and max. 77 years). All test subjects had good manual dexterity. The gender mix was balanced with 5 female and 5 male participants. Figure 2 shows the average hearing loss for this group of test subjects.

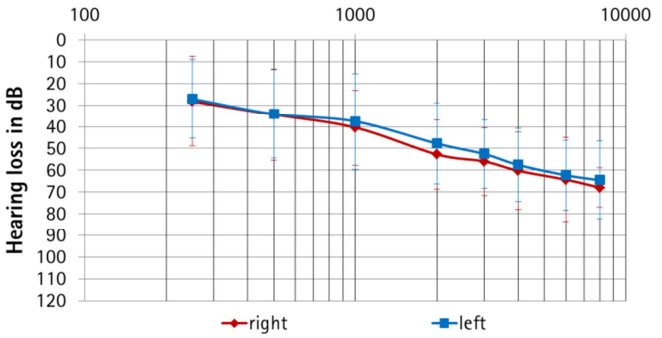

Fig.2: The average hearing loss and standard deviation of the 10 miniature CIC validation participants

Devices

The micro BTE group was fitted with Phonak Ambra M H2O instruments while the miniature CIC group was fitted with Phonak Ambra nano devices. All test subjects were fitted binaurally.

Procedure

Several subjective measurements were carried out during home trials and lab tests using questionnaires to investigate the spontaneous acceptance of the new Spice+ precalculation. The lab tests included presentations of three different sound samples (birdsong, female speech and water) at 55 dB. Clients rated loudness and sound quality.

Additionally observation protocols (filled out by the fitters) noted spontaneous test subject comments regarding loudness, sound quality as well as the fitter fine-tuning effort required.

Objective testing included evaluation of speech intelligibility in quiet using the Freiburger word recognition test and in noise using the OLSA Oldenburg Sentence test (Wagener et al, 1999).

Study 1: Results

Subjective ratings of the sound quality and loudness of both the test subjects and fitter's voice are shown in Figure 3 below.

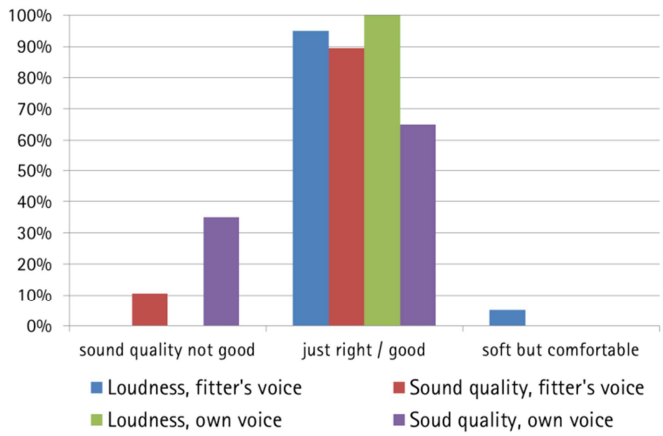

Fig. 3: Sound quality and loudness ratings with Spice+ micro-size BTE

Loudness of both own voice and the fitter's voice was rated as just right, with only 5% of the test subjects rating the fitter's voice as soft but comfortable. Of the test subjects, 65% rated their own voice as good, and 35% as not good. These were nearly all first time hearing aid wearers.

The Phonak nano test subjects group results showed the following sound quality and loudness ratings (Fig. 4).

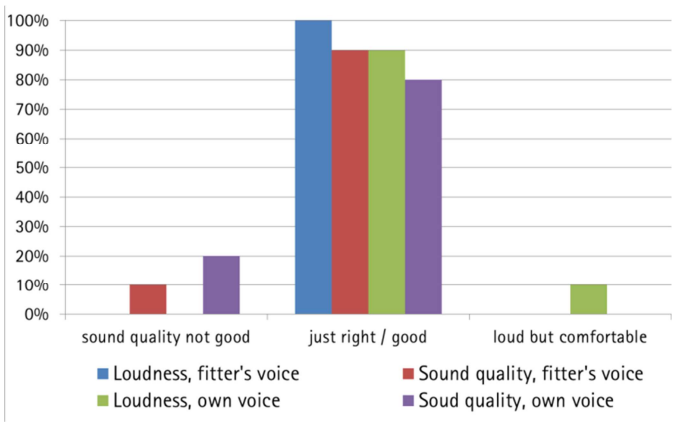

Fig. 4: Sound quality and loudness ratings with Spice+ nano device

The fitters also asked the test subjects if they felt any hearing instrument fine tuning was required (Fig. 5). For both groups this was asked after performing an first-fit precalculation based on the test subject's hearing loss, acoustic coupling and hearing aid experience.

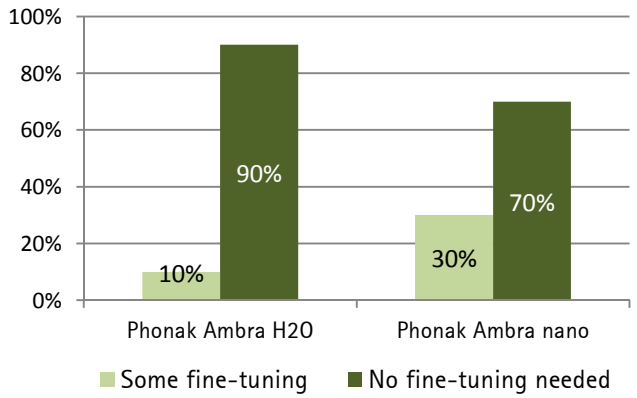

Fig. 5: Fine tuning required after precalculation for the micro-size BTE and nano instruments.

A total of 7 out of 30 test subjects required some degree of fine-tuning after precalculation, predominantly for first time hearing aid wearers with own voice (loudness or sound quality) issues.

Study 2: Method

The explorative study at the Hörzentrum in Oldenburg was carried out to conduct paired comparisons between the Spice+ Processing precalculation as reference and various Phonak and competitive products and precalculations. The aim of the study was to investigate subjective ratings regarding sound quality and speech understanding or clarity with a variety of sound samples. The 15 test subjects, aged between 31 and 76 years old, had an average age of 66.2 years. The group comprised of 13 male and two female patients, eight of which had previous experience with hearing instruments.

The average hearing loss can be seen in Figure 6.

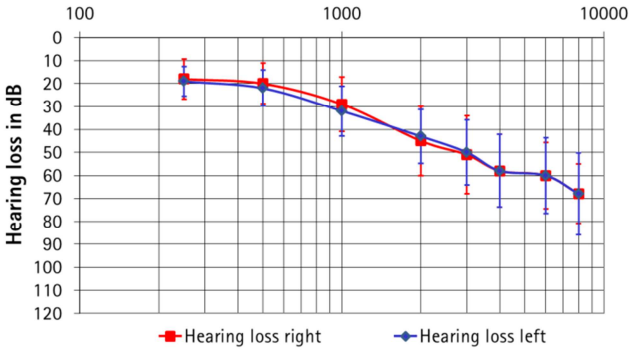

Fig. 6: The average hearing loss and standard deviation of the Oldenburg validation participants.

Devices

All 15 test subjects were fitted with Phonak Ambra M H2O (Spice+), Phonak Ambra microP (Spice) as well as with two competitive state-of-the-art hearing instruments (Competitor A and Competitor B).

Procedure

The settings of all hearing aids were pre-calculated by the respective fitting software based on the audiogram and acoustic coupling information. Where possible, settings were configured using the patient age, gender, hearing aid experience and type of previous processing. Feedback thresholds were determined and the feedback cancellation functionality was activated.

The hearing instrument experience level tool was then used to achieve good initial acceptance and no further fine-tuning was applied. At this stage the test subjects' spontaneous comments and sound quality ratings were noted.

Individual ear canal recordings with the hearing instruments in-situ and selected sound samples were then made and saved into a virtual hearing aid. On the test subjects' second visit paired comparison ratings using the virtual hearing aid were conducted. The paired comparison sound samples included soft speech (46 dB A) in quiet, moderate speech (56 dB A) in quiet and speech in noise with SNRs of -5 dB and -10 dB. The recordings were made with the target speech signal at 0° and where applicable interferer noise at 45°, 90°, 135°, 180°, 225°, 370° and 315°. The hearing instruments were set to the appropriate quiet or noise program depending on the sound sample being recorded.

The order of the paired comparisons was randomized and test subjects were asked to provide ratings on loudness, clarity, sound quality and intelligibility.

Study 2: Results

As one of the design aims of the Spice+ Processing was to optimize sound quality for quiet listening situations, the subjective ratings of sound quality in total and compared to the previous generation Spice instruments was of particular interest. Figure 7 below shows the results when rating speech in quiet.

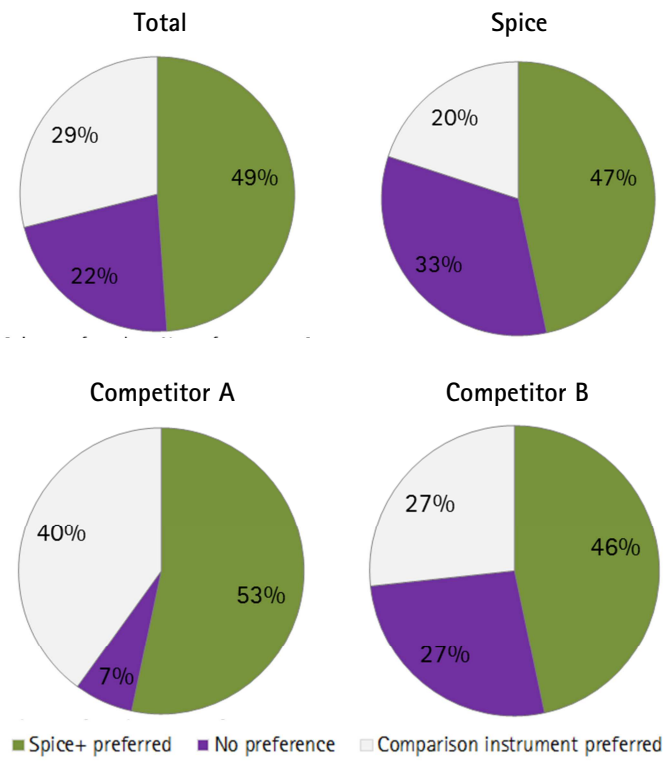

Fig. 7: Subjective ratings, total and by instrument, to the question "which hearing instrument has a better sound quality" with moderate speech in quiet.

The reference instrument was always the Spice+ instrument. The green area shows the percentage of test subjects who preferred the Spice+ hearing instrument compared to the other comparison hearing instruments. When comparing Spice+ to all comparison hearing instruments, 49% of test subjects preferred Spice+ and 22% had no preference. When comparing the Spice+ instrument to the Spice instrument, 80% either preferred the Spice+ instrument or had no preference, while just 20% preferred the previous generation Spice.

The Spice+ Processing algorithm aims to ensure not only enhanced spontaneous acceptance and sound quality in quiet, it also has to ensure optimal speech understanding both in quiet and in noise. As Figure 8 shows, the subject's personal preferences in terms of speech understanding when listening to speech in quiet at a normal level showed an overall preference for Spice+.

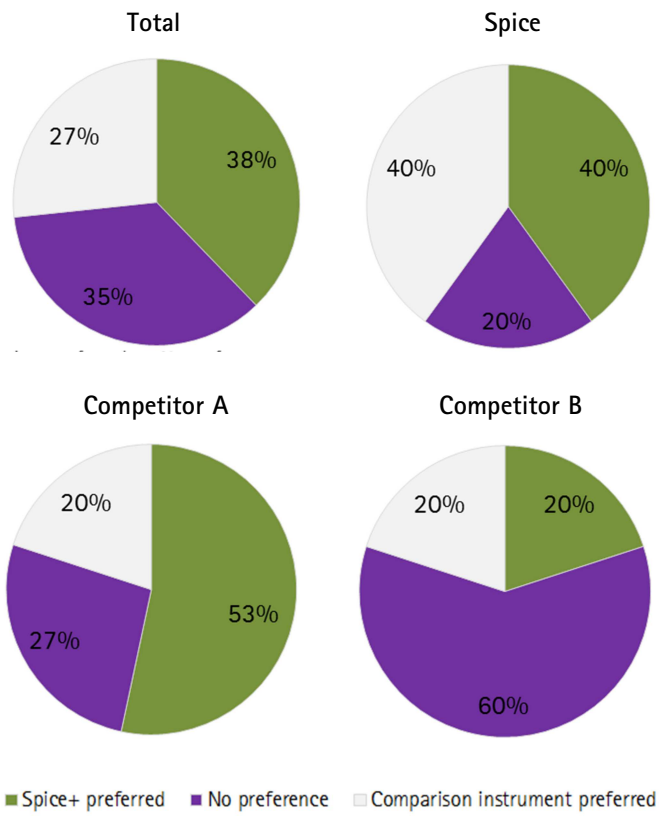

Fig. 8: Subjective ratings, total and by instrument, to the question "with which hearing instrument do you understand better" with moderate speech in quiet.

There was no difference between Spice and Spice+ and a strong preference for Spice+ when comparing it to the Competitor A hearing instrument. In the case of competitor B, for speech in quiet, the test subject showed no clear preference. This was rather different when rating sound quality, as seen in Figure 7.

Figure 9 below shows the total results for the question "with which hearing instrument do you understand better". The measurement condition in this case was speech in noise with an SNR of -5 dB and -10 dB.

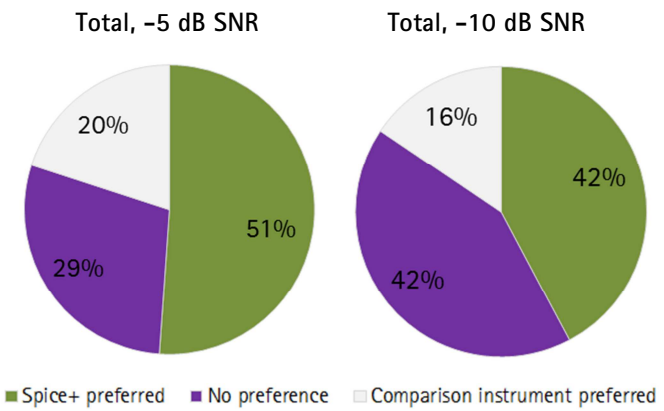

Fig. 9: Subjective total ratings to the question "with which hearing instrument do you understand better" at -5 dB SNR (top) and -10 dB SNR (bottom).

This showed that in comparison to Spice+, the preference for the previous generation Spice and competitor A and B instruments was only 20% and 16% respectively. The percentage of test subjects who had no preference was also relatively high, 29% and 42%. Looking at the data in detail, this was due to the high 'no preference' rating between Spice and Spice+, as shown in Figure 10.

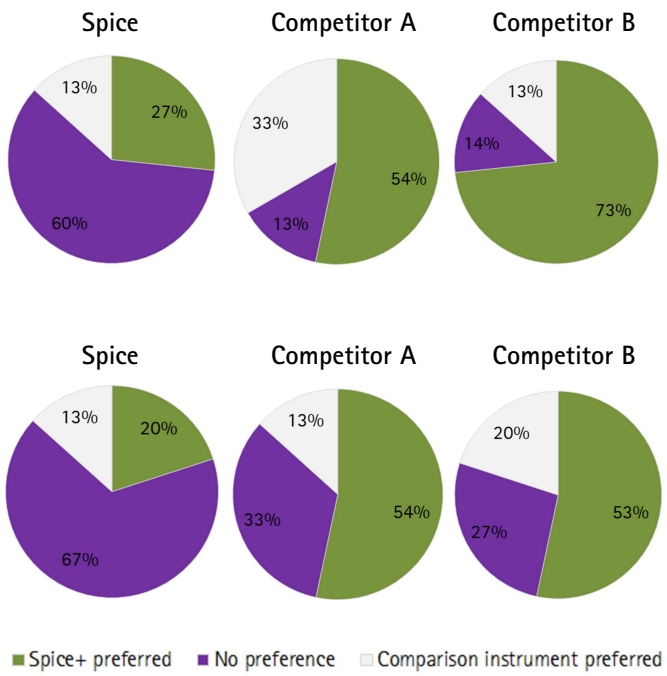

Fig. 10: Subjective ratings, by instrument, to the question "with which hearing instrument do you understand better" at -5 dB SNR (top) and -10 dB SNR (bottom).

From Figure 10 we can see that the preference to the comparison devices was between 13% and 33%. Spice+ was preferred over both competitor A and B instruments in the speech in noise listening situations.

Conclusion

The overall conclusion from the first validation study shows a very high subjective rating of the Spice+ Processing first-fit settings. Own voice and fitter voice loudness ratings was rated "just right" between 90 and 100% for the two groups, as was the fitter's voice sound quality rating. Very little fine-tuning after precalculation was needed and if so, this was mainly for the first time hearing instrument wearers who required a little fine tuning for the sound of their own voices. This study shows a very high spontaneous acceptance of the Spice+ Processing precalculation and initial settings.

The second study also showed very good subjective ratings of the Spice+ Processing hearing instrument. The results showed that ratings of speech understanding and sound quality in quiet were highest for Spice+ compared to the other, previous generation and state-of-the-art competitive instruments. The results also show the Spice+ instrument ranked highest in terms of speech understanding in a relatively easy situations as well as in a difficult speech in noise listening situation, when compared to two competitive hearing instruments.

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