Phonak
Field Study News

Phonak Naída M-SP outperforms other SuperPower products in high frequency audibility and performance in noise

People with severe-profound (S2P) hearing loss have additional challenges achieving audibility of high frequency speech sounds and hearing in noise. 20 experienced hearing aid wearers with S2P hearing loss underwent various tasks wearing the new Naída M-SP and 3 competitor SP devices. Results showed significantly better audibility and recognition of high frequency speech sounds and hearing in noise with the Naída M-SP compared with all other devices. The Naída M-SP was overall preferred in noise, and rated to require significantly less listening effort.

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Key highlights

- The new Naída M-SP delivered significantly better audibility of the higher frequency speech stimulus S9 and recognition of the higher frequency logatome ASA9 on the Phoneme perception test vs. the other devices.
- Participants performed significantly better in noise when wearing the Naída M-SP vs. the other devices.
- The Naída M-SP was overall preferred in the speech in noise environment, and listening effort was specifically rated significantly lower for the Naída M-SP vs. all other devices

Considerations for practice

- Use of adaptive, non-linear frequency compression algorithms should be considered in clients with severe to profound hearing loss as the findings of the current study are consistent with better audibility of higher frequency speech phonemes when this approach is utilised.
- Use of StereoZoom should also be considered in this client group as results of the current study show significantly better performance with, and a preference for, this approach in speech in noise environments.

Introduction

Individuals with severe-to-profound (S2P) hearing loss face additional challenges over those with lower degrees of hearing loss. This even starts with audibility; and the audibility of speech phonemes is a critical pre-requisite for higher order processing such as distinction, recognition and understanding to occur. Some speech phonemes have greater importance for understanding, reflected by their differential weighting in the articulation index (AI; Mueller & Killion, 1990) and the more recent Speech intelligibility index (SII; ANSI, 1997). In English, it's the higher frequency (lower energy) speech phonemes that contribute more to understanding, including the fricative /s/, which is the 3rd most common consonant and is used to denote a range of information such as plurals, possession and verb tense (Denes, 1963). /s/ is mainly comprised of energy >4 kHz, with peaks in the range of 4.2 - 6.9 kHz and 6.3 – 8.8 kHz for male and female speakers, respectively (Stelmachowicz et al., 2008). Studies have shown significant improvements in identification of /s/ by increasing bandwidth for people with high-frequency (HF) hearing loss (Stelmachowicz et al., 2002) and, accordingly, many modern hearing aids now include extended bandwidth (EBW). However, whilst EBW has been shown to provide some benefit for mild-moderate degrees of HF hearing loss (e.g., Seeto & Searchfield, 2018), these benefits are likely to decrease with increasing hearing loss, and provide limited or no benefit for those with S2P hearing loss due limitations of the receiver output and/or the presence of dead regions (Kuk & Baekgaard, 2009; Killion, 1980).

Frequency shifting algorithms, such as Phonak's adaptive, non-linear frequency compression (NLFC) SoundRecover2 (S/Rec2), are another method to improve audibility of higher frequency speech sounds. When activated, higher frequency information is shifted to a lower frequency region that has better residual hearing function and where hearing aid receiver output is more capable of meeting the gain required for audibility. Numerous studies have shown benefits of NLFC for a range of hearing loss configurations, including moderate-severe HF hearing loss (Wolfe et al., 2010; Wolfe et a;., 2011), steeply sloping severe HF hearing loss (Glista et al., 2009) and even those with S2P hearing loss (Bohnert et al., 2010; Fulton et al., 2016). Accordingly, this is on by default in Phonak power products, including the new Naída M-SP.

Another challenge for those with (especially S2P) hearing loss is they require a higher signal-to-noise ratio (SNR) in order to hear optimally. Indeed, performance on the hearing in noise test (HINT, Nilsson et al., 1994) has been reported to degrade by about 1 to 1.5 dB for every 10 dB of hearing loss (Nilsson et al., 2001, as cited in Bray & Nilsson, 2001). Many hearing aids have directional microphone (DM) technology to improve the SNR in near-field speech in noise listening situations (<1.5m). DMs typically comprise two-microphones that work together to attenuate sounds from directions other than the front (assumed to be noise), and this has been shown to significantly improve the understanding of speech from the front (Assumed to be signal of interest; e.g., Gravel et al., 1995; Valente et al., 1995). Striving to deliver even better performance in noise, in 2010, Phonak pioneered StereoZoom (SZ), the world's first binaural hearing aid beamformer. SZ utilises Phonak's unique Binaural VoiceStream Technology (BVST) to connect the 4 microphones across a pair of hearing aids, creating a very narrow beam to the front. Studies have shown multiple benefits of binaural beamformers relative to their two-microphone counterparts , including improved speech intelligibility in noise (Picou et al., 2014), reduced listening effort (Winneke et al., 2018) and greater participation in conversation (Schulte et al., 2018). Accordingly, SZ is available in Phonak's premium and advanced Naída M-SP hearing aids, and is active by default within AutoSense OS premium.

The aims of the current study were to compare the new Naída M-SP against three other super power (SP) devices on the market to see if there are any differences on these key areas of:

1. Audibility of higher frequency speech sounds
2. Performance in noise
3. Preference across various listening situations

Method

20 experienced hearing aid wearers with sloping moderate to severe-profound sensorineural hearing loss and normal cognitive function (on Demtect, Kalbe et al., 2004) were recruited to the study. Following recruitment, all participants underwent the 3 sessions outlined in Fig 1. At the 1st session, participants were fitted with the new Naída

M-SP devices as well as SP devices from 3 other manufacturers. It is common clinical practice to use a validated prescription formula when fitting hearing aids therefore the DSLv5–Adult fitting formula (Scollie et al., 2005) was used in this study. All adaptive parameters were activated as per the manufacturer default. As would also be common clinical practice, minor subsequent adjustments to gain were allowed to ensure the sound was sufficiently loud and comfortable. To further increase the ecological validity of the study, all fittings were done using the participants existing ear moulds. During the 2nd session, the Phonak phoneme perception test (PPT; Schmitt et al., 2016) was administered in quiet (Signal at 0⁰ azimuth) to explore aspects of detection, distinction and recognition of higher frequency speech sounds. Speech in noise testing was also performed using the Oldenburg Sentence Test (OLSA) (Wagener et al. 1999, Wagener & Brand, 2005). Target speech was presented at 0⁰ azimuth accompanied by concurrent cafeteria noise presented at 67 dB SPL from the remaining 11 speakers within the 12-speaker array. For speech in noise testing, all hearing aids were manually switched into their most advanced speech in noise program (which is speech in loud noise [SPILN] with SZ for Naída M-SP) and speech level was varied to determine SRT corresponding to 50% correct word score. For the 3rd and final session, a virtual hearing aid (VHA) concept (Helbling et al. 2013) was employed to facilitate paired comparisons across situations, including Speech in Quiet (SiQ), Speech in noise (SIN), Nature sounds (birds) and music. The VHA test involved recordings made through all 4 hearing aids in all 4 scenarios which were subsequently presented back under insert phones at the same level (spectrum) as the recordings.

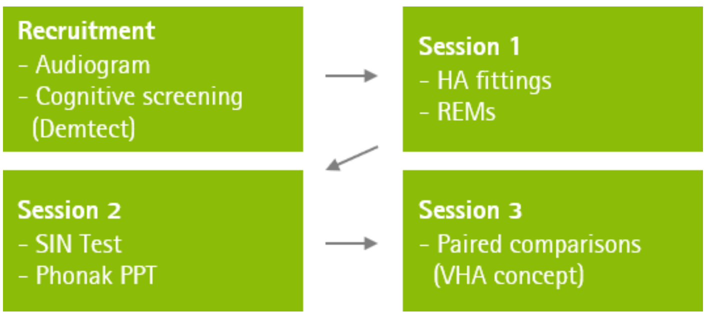


Fig 1: Schedule of sessions for the current study. HA – Hearing aid, , REMs – Real-ear measures, SIN – Speech in noise, Phonak PPT – Pitch perception test, VHA – Virtual hearing aid. Please note that further measures were made across these sessions (e.g., guided tour) but are not included here.

Results

The main outcomes of the PPT are shown in Fig 2.

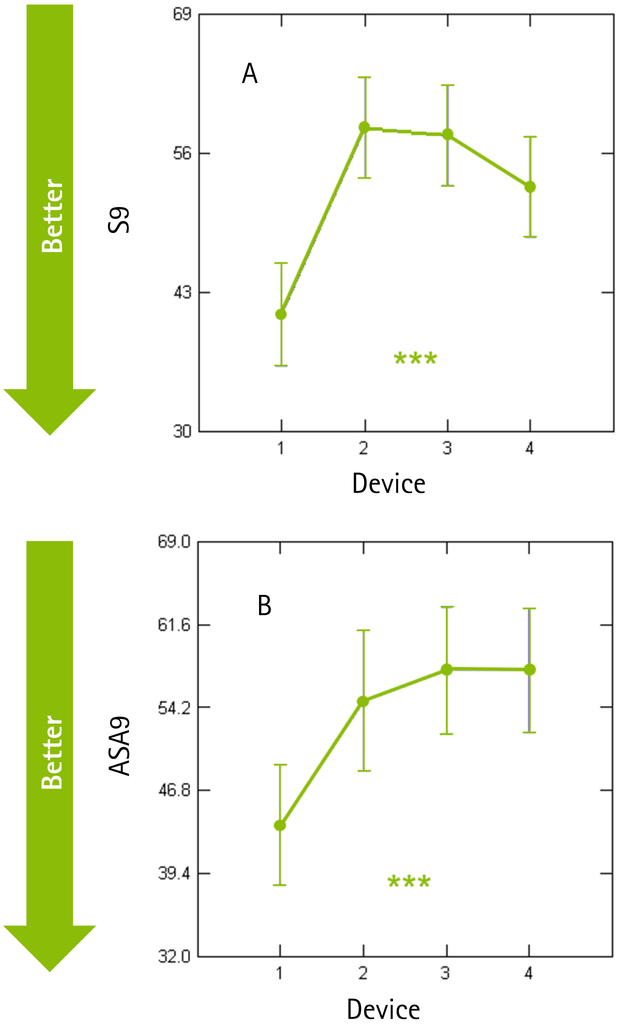


Fig 2: PPT results showing (A) – The detection of the S9 stimulus and (B) – the recognition of the ASA9 logatome of participant when wearing the 4 devices. Device 1 is the Naída M-SP. A lower score indicates a better result. *** p<0.001

PPT results

There was a trend of lower (better) detection thresholds for high frequency speech sounds when participants wore the Naída M-SP versus competitor devices, and this reached a high level of significance for the /s/ 9 kHz stimulus (Fig 2A, $p<0.001$). This means that the Naída M-SP gave better access to high frequency speech phonemes (detection threshold) than all the other devices. With audibility of high frequency speech phonemes improved, the next step was to assess the impact on recognition. Fig 2 (B) shows the results of the recognition of the ASA9 logatome within the PPT. Similarly to the detection results, participants were able to recognise this higher frequency logatome at significantly lower thresholds when wearing the Naída M-SP compared with the other devices ($p<0.001$).

SiN results

Speech understanding in real world environments also requires the extraction of this information from other competing sounds (i.e., noise). Results of the OLSA speech in noise test are plotted in Fig 3 and show significantly lower SRT50% correct thresholds for participants when wearing the Naída M-SP (in SPILN program) compared to when they were wearing the competitor devices in their speech in noise program ($p<0.001$).

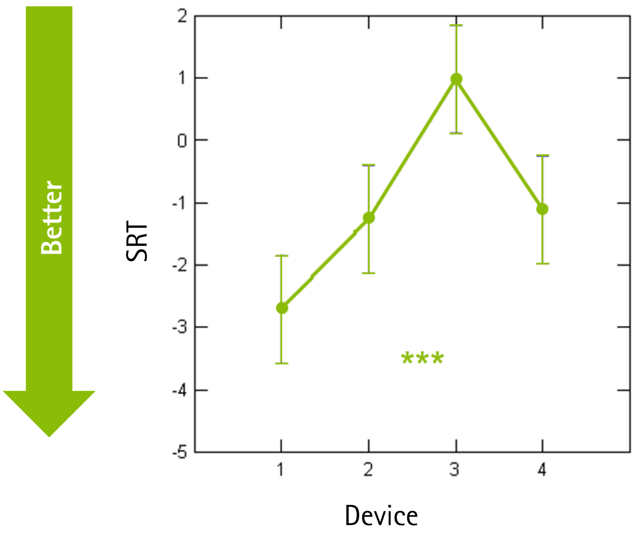
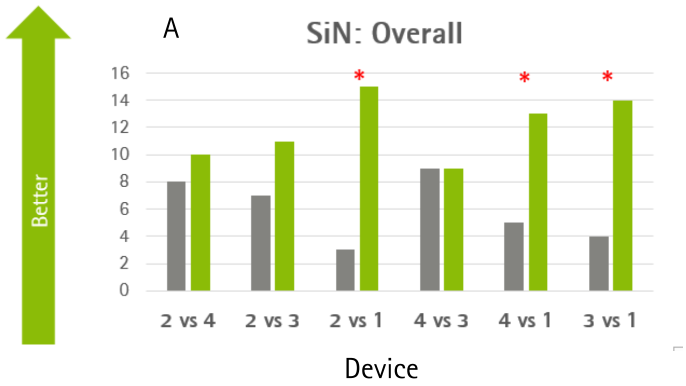


Fig 3: OLSA speech in noise test results showing the SRT for 50% correct word score across the 4 devices in the study. Device 1 is the Naída M-SP. A lower score indicates better performance. *** p<0.001

Subjective assessment

Paired comparisons of the subjective preference ratings from the VHA test showed that the Naída M-SP was overall preferred to all other devices in the speech in noise situation ($p<0.05$, Fig 4A). Furthermore, listening effort in the speech in noise situation was also specifically rated significantly lower for the Naída M-SP versus all other devices ($p<0.05$, Fig 4B).



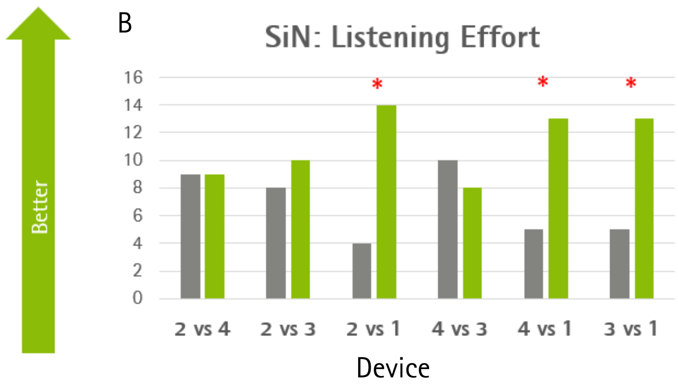


Fig 4: Paired comparisons of results from the VHA test showing (A) – the number of wins for each device comparison when reflecting on overall preference and (B) – The number of wins for each device comparison when reflecting on listening effort, both in the Speech in noise environment. Device 1 is the Naída M-SP. * p<0.05.

Discussion

The results of the current study show that the Nadia M-SP delivered better detection and recognition of higher frequency speech information versus competitor products. This is most likely due to the influence of frequency lowering which, in contrast to the other devices in the study, was enabled by default in the Naída M-SP devices for the participants hearing profile. This is consistent with the findings of other studies showing benefit of NLFC for steeply sloping severe HF hearing loss (Glista et al., 2009) and S2P hearing loss (Fulton et al., 2016), and provides further support for using S/Rec2 in clients with S2P hearing loss. It highlights the benefit of activating frequency lowering by default for severe hearing loss. The results also showed that the Naída M-SP delivered both better hearing performance (as reflected by the lowest SRT50% correct thresholds) and was the overall preferred product in a speech in noise situation. In the speech in noise conditions, due to the diffuse, higher level of background noise (67 dB SPL), the SPILN program with SZ was implemented in the Naída M-SP. This 4-Mic binaural beamformer helps to filter out more noise than is possible when using a 2-Mic DM, enabling the participants to better hear the speech material from front. The finding of better performance with SZ is consistent with those from other studies in the literature (e.g., Picou et al., 2014). The finding of reduced listening effort is also consistent with previous studies (Winneke et al., 2018) and joins a growing body of evidence in this potential area for validating hearing aid fittings.

Conclusion

The findings of the current study show that the new Naída M-SP delivers better audibility of high-frequency speech sounds and better performance in noise compared to the other SP devices. Additionally, overall it was preferred to all other devices in the speech in noise situation.

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Authors

David James Crowhen is the Director of Phonak and Operations NZ, where he has worked for over 10 years. An interest in music and helping people made Audiology a natural career choice, and David graduated from the Master of Audiology course at University of Auckland, New Zealand in 1999. David worked clinically for 10 years, in both public and private settings, and in both NZ and overseas. David has a special interest in advanced hearing instrument and wireless communication technology, the selection of these based on client and family needs and supporting verification and evaluation of these features in the clinical setting.

Micha Lundbeck has been with HörTech GmbH, Germany, since the end of 2014. As a Ph.D. student at the University of Oldenburg, he devoted his doctoral thesis to spatially-dynamic perception in the hearing impaired and the influence of hearing aid algorithms on it. In 2018, he received his Ph.D. and is, since then, involved in publicly funded projects as well as in cooperation with the industry. His research interest is the development of mobile applications for speech and hearing training and the evaluation of hearing systems.

Matthias Latzel studied electrical engineering in Bochum and Vienna in 1995. After completing his Ph.D. in 2001, he carried out his PostDoc from 2002 to 2004 in the Department of Audiology at Giessen University. He was the head of the Audiology department at Phonak Germany from 2011. Since 2012 he has been working as the Clinical Research Manager for Phonak AG, Switzerland