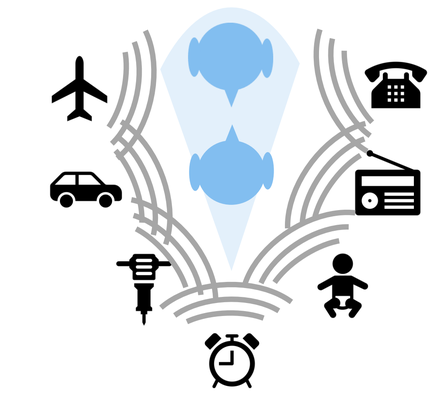
Improving Localization in Binaural Beamforming for Hearing Aid Wearers

Nadja Schinkel-Bielefeld, Christos Oreinos, Homayoun Kamkar Parsi
Sivantos GmbH, Erlangen, Germany

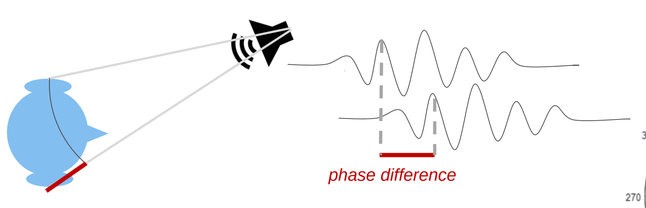
Motivation



In noisy environments binaural beamforming helps to understand speech [1,2] and reduces listening effort [2,3].

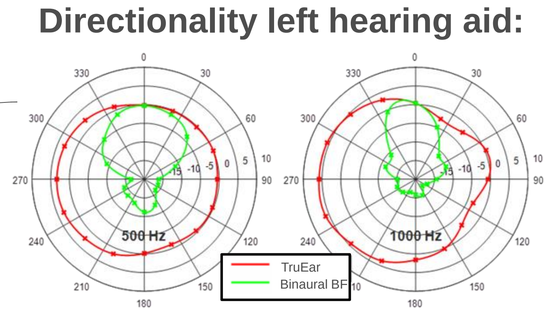
In binaural beamforming mode it can be harder to localize sound.

We developed a new beamforming algorithm (Signia Nx BF) that preserves the phase information in the low frequencies better. Here we compare speech understanding and localization performance for this new beamforming mode, its predecessor beamforming mode (previous BF), and TruEar, a microphone mode that mimics the natural directivity of the head.



Localization in low frequencies based on interaural time difference.

Directionality left hearing aid:

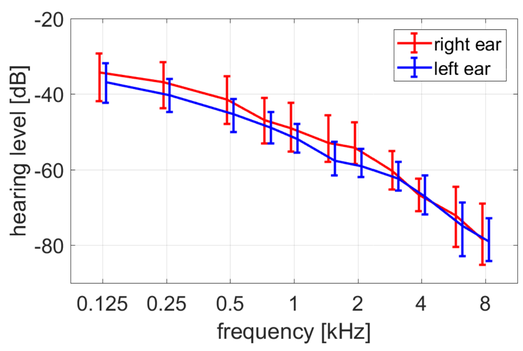


See [4] for details of measurement

Experimental Methods

Subjects

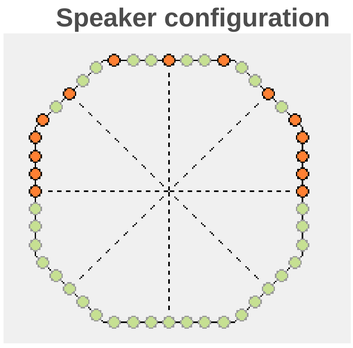
- N = 19
- Age: 23 – 86 years, (mean 69.6 years, SD 15.6 years)
- Mean HL (0.5, 1, 2, 4) = 42.3 dB HL
- Signia Pure 13 BT 7px hearing aids, with first fit performed



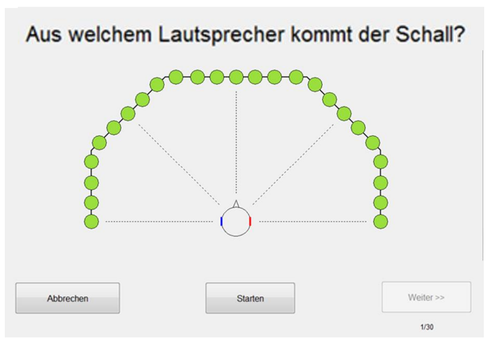
Localization Test

- Canteen noise (70 dB) from all speakers
- A sentence with 6 dB SNR from one speaker
- Subjects had to indicate which speaker the sentence came from
- Subjects were fixating towards the front before the sentence started

Speaker configuration



GUI



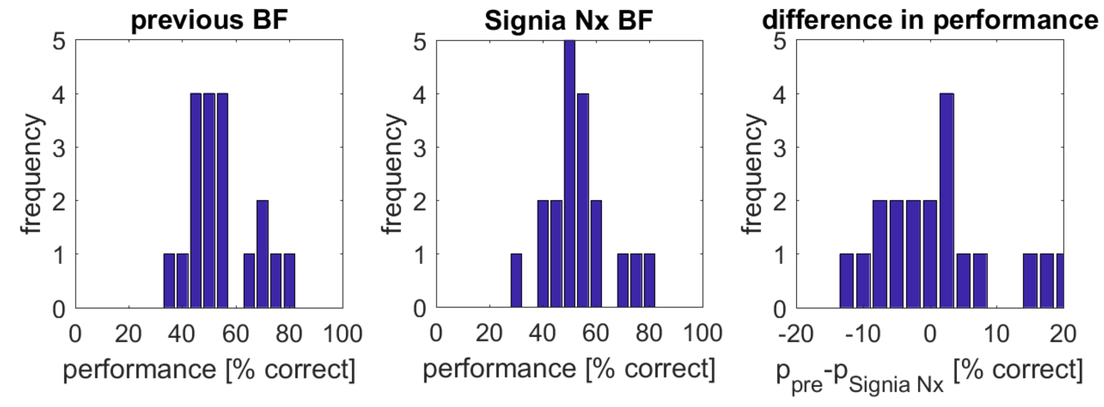
- 30 trials per round, one training round (TruEar), two rounds for each of the three microphone modes
- Each condition presented once in the first half and once in the second half of the test to analyze adaptation effects
- Order of conditions permutated to average out learning effects

Speech Understanding in Noise (OLSA)

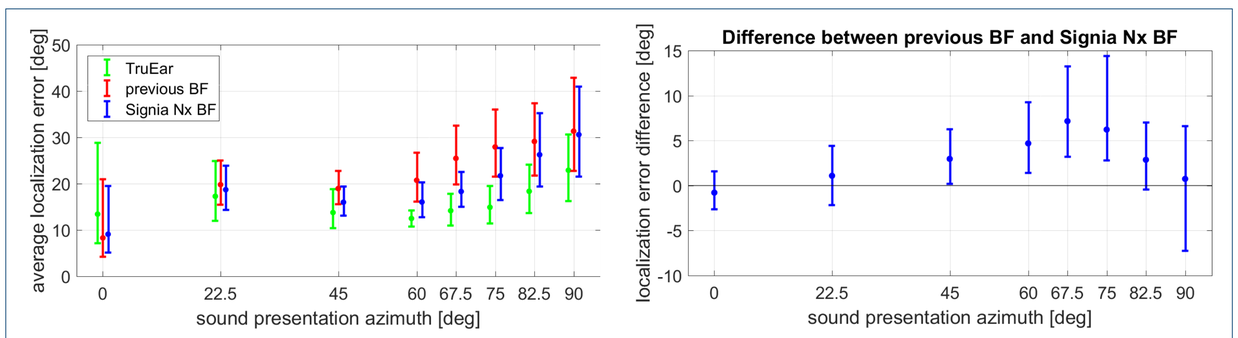
- Distracting babble noise from all speakers
- Subjects had to understand and repeat a sentence coming from the front speaker [5]
- Sentences had the form: name verb number adjective object
  i.e. *Ulrich schenkt sieben schwere Sessel.*
- After 20 sentences training (TruEar), we measured the SRT (adaptive SNR test, with noise level 70 dB and starting at 6 dB SNR, 30 sentences)
- Then we determined the performance for the two beamforming modes with a fixed SNR close to the subjects SRT (cross balanced design)

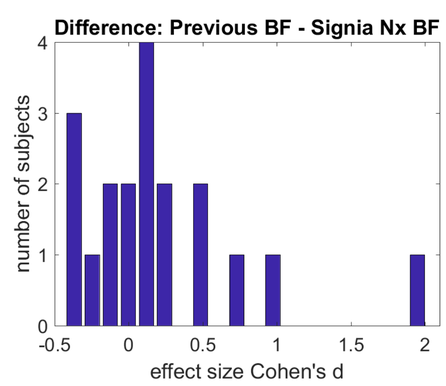
Results: Speech Understanding (OLSA)

No significant difference in speech understanding performance in noise (OLSA). (Permutation test using bootstrapping: p=0.29)



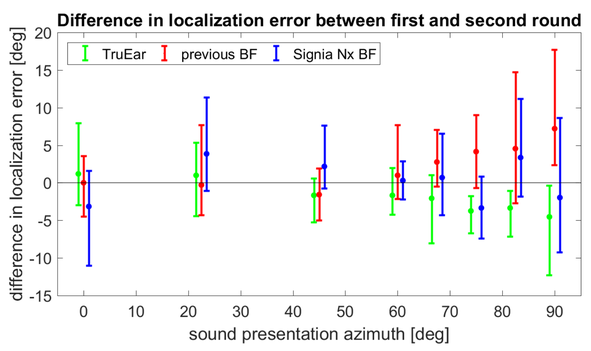
Results: Localization Test





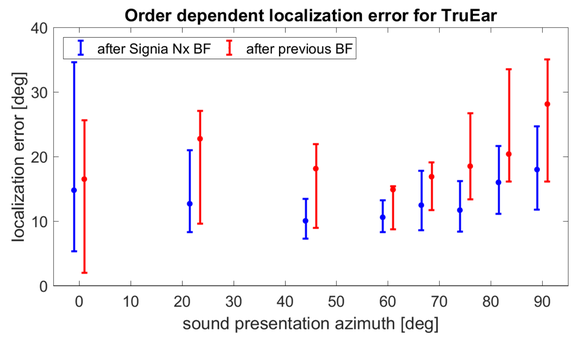
- Naturally, localization is best in TruEar
- Signia Nx beamforming mode with better preservation of phase cues in the low frequencies is significantly better than the predecessor (Friedman test: p=0.03)
- Large improvement for some subjects

Results: Adaptation



In the second round localization errors tend to increase for TruEar and decrease for the predecessor beamformer.

➔Adaptation to localization in beamforming mode.



Performance for TruEar better after Signia Nx BF than after previous BF (ANOVA: p<0.001)

No significant effect of round one or two and no significant interaction effects

Thus, preserving phase cues in low frequencies seems to give subjects the additional advantage of not having to adapt as much to different localization strategies (i.e. concentrating more on phase or level differences) when the hearing aids change microphone modes.

Conclusions

The Signia Nx beamformer preserves the interaural phase cues in the low frequencies better than its predecessor. This leads to

- Better sound localization
- No impairment of speech understanding in noise
- Less need of adaptation by the hearing instrument wearer when changing between microphone modes

References:

[1] H Kamkar-Parsi, E Fischer, M Aubreville. New binaural strategies for enhanced hearing. *Hearing Review*. 2014;21(10):42-45.
[2] J Mejia, L Carter, H Dillon, V Littman. Listening Effort, Speech Intelligibility, and Narrow Directionality, Hearing Review, 2017
[3] C Bernarding, D J Strauss, R Hannemann, H Seidler, F I Corona-Strauss. Objective assessment of listening effort in the oscillatory EEG. Comparison of different hearing aid configurations, in *Conf Proc IEEE Eng Med Biol Soc*, 2014; 2653–2656.
[4] M Aubreville, S Petrausch, Measuring directionality of modern hearing aids. *Canadian Audiologist*. 2015;2(3).
[5] KC Wagener, T Brand, B Kollmeier. Entwicklung und Evaluation eines Satztests für die deutsche Sprache. I-III: Design, Optimierung und Evaluation des Oldenburger Satztests, *Zeitschrift für Audiologie (Audiological Acoustics), 1999; 38,* 4-15, 44-56, 86-95.

Corresponding author: nadja.schinkel-bielefeld@sivantos.com