

Perceptual effects of noise reduction

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Introduction

Clinical background

- Hearing impaired have difficulty understanding speech in noisy environments
- Technical properties of noise reduction differ largely between hearing aids
- Principles of the applied noise reduction in hearing aids are unknown to the clinicians
- · Perceptual effects of the differences in noise reduction are as yet unknown

Goals

- Investigate current benefits and possible future improvements of single channel noise reduction in hearing aids
- Measure perceptual effects of
 - 1) noise reduction implementations in modern hearing aid
 - 2) noise reduction algorithms that are considered state-of-the-art in literature

Corrected for speaker and room

Hearing aid

In hearing aids

From literature

• Relate current implementations to the state-of-the-art in literature

Study design

Open questions

Which noise reduction algorithms are considered state-of-the-art in literature?

Matlab implementations from Loizou 20071):

- Logmmse (Ephraïm and Malah 1985²); Cohen 2002³)
- Wiener filter based on a priori SNR estimation (Scalart and Filho 19964)

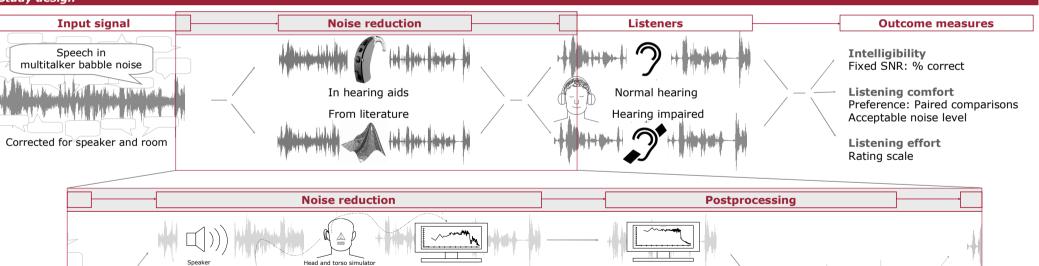
Which current hearing aids are appropriate for this study?

- Requirements: no compression; possibility to turn on/off noise reduction; unity gain
- Proposals: GN ReSound Azure or Phonac Exélia M

Which outcome measures can detect the relevant perceptual effects?

- Intelligibility • Fixed SNR: % correct
- Listening comfort
- Rating scale
- Preference: Paired comparisons
 Acceptable noise level (ANL)

Correction for the headphone frequency respons



Recording

Noise reduction algorithm in Matlab

1) Loizou, P.C. (2007). Speech Enhancement: Theory and Practice. CRC, Boca Raton, FL

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2) Ephraim, Y. and Malah, D. (1985). Speech enhancement using a minimum mean-square error log-spectral amplitude estimator. IEEE Trans. Acoust., Speech, Signal Process., ASSP-23(2), 443-445.
 3) Cohen, I. (2002). Optimal speech enhancement under signal presence uncertainty using log-spectra amplitude estimator. IEEE Signal Processing Letters, 9(4), 113-116.
 4) Scalart, P. and Filho, J. (1995). Speech enhancement based on a priori signal to noise estimation. Proc. IEEE Int. Conf. Acoust., Speech, Signal Processing, 629-632.

Correction for non-flat frequency response

of hearing aid and occluded ear cana

Bandpass filter to simulate

nearing aid frequency range