Predicting the benefit of binaural noise reduction algorithms with FADE

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Abstract

The simulation framework for auditory discrimination experiments (FADE) was adopted and validated to predict the individual aided speech-in-noise recognition performance of listeners with normal and impaired hearing with and without a given noise suppression strategy. FADE uses a simple automatic speech recognizer (ASR) to estimate the lowest achievable speech reception thresholds (SRTs) from simulated speech recognition experiments in an objective way, independent from any empirical reference data. Empirical data from the literature was used to evaluate the model in terms of predicted SRTs and benefits in SRT with the German matrix sentence recognition test when using eight single and multi-channel binaural hearing aid pre-processing algorithms. To allow individual predictions of SRTs in binaural conditions, the model was extended by implementing a simple "better ear" approach and individualized by taking into account the audiograms. In a realistic binaural cafeteria condition, FADE explained about 90% of the variance of the empirical SRTs for a group of normal-hearing listeners and predicted the corresponding benefits with a root-mean-square prediction error of 0.6 dB. This high prediction accuracy highlights the potential of the current approach for the objective assessment of benefits in SRT without any a-priori knowledge about the empirical data. The predictions for the group of hearing-impaired listeners explained 75% of the variance of the empirical SRTs, while the individual predictions explained less than 25%. This indicates that additional individual factors, such as, e.g., a supra-threshold processing deficiency, should be taken into account for improving the accuracy of individual predictions with impaired hearing. A competing talker condition clearly showed one limitation of current ASR technology, as the empirical performance with SRTs lower less than -20 dB could not be predicted.

Index Terms: speech recognition; aided hearing; objective evaluation; model