Do models hear the noise? Predicting the outcome of the German matrix sentence test for subjects with normal and impaired hearing

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Abstract

Impaired hearing negatively affects the speech reception of an increasing proportion of aging societies world-wide. Recently, the German matrix sentence test was used with a fixed noise level to quantify the effect of impaired hearing on speech reception thresholds in 315 ears with differently pronounced hearing loss. Two domains with different linear dependences of the outcome on the pure-tone average hearing loss were identified. One domain where listening in noise dominates the results and one where the individual capacity for listening in "quiet" mainly dominates. The aim of this work was to test to which extent this behavior can be predicted by two different speech intelligibility models based on the individual audiograms. Therefore, the framework for auditory discrimination experiments (FADE) and the speech intelligibility index (SII) were individualized with the 315 audiograms, and the predicted outcomes were compared to the empirical data. Both models were found to predict the characteristic change in the slope, where FADE under-estimated and the SII over-estimated the linear dependence in the listening-in-noise domain. Over-all, FADE predictions were found to be more accurate than SII-based predictions with root-mean-square prediction errors (RMSE) of 5.6 dB and 6.8 dB, respectively. A group-wise analysis revealed that for special cases (e.g., steep hearing loss) with typically high pure-tone averages FADE provides much more accurate predictions (RMSE=6.7 dB) than the SII (RMSE=22.6 dB), while for low pure tone averages the root-mean-square prediction error is typically one to two dB lower with the SII. The conclusion of this paper is that the effect of impaired hearing on speech perception can be only partly explained with the absolute hearing threshold, which is primarily visible in the listening-in-noise domain. Probably a supra-threshold component that is moderately correlated with the absolute hearing threshold of hearing loss is responsible for up to 50% of the slope in the listening-in-noise domain.

Index Terms: speech intelligibility prediction, matrix sentence test, modeling approaches