Estimating the individual effects of transparent headphones on front-back confusions

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Abstract

Head-worn devices may alter the sound arriving to the listeners' ears, potentially affecting the listeners' ability to determine the sound direction. In this study, the aim was to investigate the feasibility of estimating the individual effects on front-back confusions caused by a given head-worn device. Individual head-related transfer functions of a group of 15 participants were measured in three conditions: (i) Open ears (no headphones); (ii) while wearing the Mysphere 3.2 (in open frames position); (iii) while wearing the AKG K702 (with a transparency modification). A computational auditory model was used to estimate the subject-specific front-back confusion rate.

This study was motivated by a previous subjective test, where the subjects' performance on localising sound sources while wearing head-worn devices was assessed. The goal was to evaluate the transparency of headphones that were designed to be used in augmented reality applications. The results showed a general increase of front-back confusions, but due to high inter-individual variability, the device-specific detailed effects could not be generalised. These individual differences may have been caused by (a) the different interaction between the given headphones and each subject's head morphology; and/or (b) the frequency ranges of monaural cues that each subject use to resolve a front-back confusion may be different.

The computational model results revealed that it was not always possible to predict the subjective test data. While a subset of participants was more affected in the listening condition (ii) than in (iii), the model results showed a bias towards being (iii) the condition in which the front-back confusion rate was always estimated higher. A detailed analysis of the measured head related transfer functions supported the idea that different subjects may rely on different frequency ranges of monaural cues to resolve front back confusions. This generates a problem for assessing head-worn devices' quality when monaural cues are distorted but not completely destroyed.

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