Externalization versus Internalization of Sound in Normal-hearing and Hearing-impaired Listeners

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The externalization of sound, i.e., the perception of auditory events as being located outside of the head, is a natural phenomenon for normal-hearing listeners, when perceiving sound coming from a distant physical sound source. It is potentially useful for hearing in background noise, but the relevant cues might be distorted by a hearing impairment and also by the processing of the incoming sound through hearing aids. In this project, two intuitive tests in natural real-life surroundings were developed, which capture the limits of the perception of externalization. For this purpose, an auralization system for headphones using individual cues was implemented and a strategy to modify the degree of the externalization was proposed. While normal-hearing listeners obtained consistent results, both individually and across subjects, the limits of externalization varied more within and across listeners in the hearing-impaired group. Partly, there was an influence by the direction of sound incidence. On average across subjects, the dynamic range available to perceive externalization was reduced compared to normal-hearing subjects. Overall, it was shown that hearing-impaired listeners are able to perceive externalization, but also that they are less sensitive to minor deviations from complete internalization and externalization.

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