Sound source localization with varying amount of visual information in virtual reality

To achieve accurate spatial auditory perception, subjects typically require personal head-related transfer functions (HRTFs) and the freedom for head movements. Loudspeaker-based virtual sound environments allow for realism without individualized measurements. To study audio-visual perception in realistic environments, the combination of spatially tracked head mounted displays (HMDs), also known as virtual reality glasses, and virtual sound environments may be valuable. However, HMDs were recently shown to affect the subjects' HRTFs and thus might influence sound localization performance. Furthermore, due to limitations of the reproduction of visual information on the HMD, audio-visual perception might be influenced. Here, a sound localization experiment was conducted both with and without an HMD and with a varying amount of visual information provided to the subjects. Furthermore, interaural time and level difference errors (ITDs and ILDs) as well as spectral perturbations induced by the HMD were analyzed and compared to the perceptual localization data. The results showed a reduction of the localization accuracy when the subjects were wearing an HMD and when they were blindfolded. The HMD-induced error in azimuth localization was found to be larger in the left than in the right hemisphere. When visual information of the limited set of source locations was provided, the localization error induced by the HMD was found to be negligible. Presenting visual information of hand-location and room dimensions showed better sound localization performance compared to the condition with no visual information. The addition of possible source locations further improved the localization accuracy. Also adding pointing feedback in form of a virtual laser pointer improved the accuracy of elevation perception but not of azimuth perception.