1324

Rapid recalibration of auditory distance perception in reverberant environments

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Background

Reverberation and the received sound level provide the most robust cues for auditory distance perception. Specifically, both the direct-to-reverberant energy ratio and the received level increase as the source-to-listener distance decreases. However, the relationship between reverberation, level, and distance varies from room to room. Thus, the auditory system must recalibrate in order to correctly map the cues to distance. Previous experiments showed that listeners are able to "learn" reverberation in a fixed room over the course of multiple hours and days [Kopco et al. (2004) "Learning to Judge Distance of Nearby Sounds in Reverberant and Anechoic Environments." Congress CFA/DAGA; Kopco et al. (2011). "Learning of reverberation cues for auditory distance perception," 161st ASA meeting].

Methods

Current experiments examined the process of rapid adaptation of distance judgments in a small reverberant room during a single 1-hour session. Each session consisted of 8 runs of 80 trials. Presentation level was either fixed during a run, resulting in natural variations in received level with the source distance, or roved by 12 dB for each trial in a run, eliminating the received level as a distance cue. The runs with fixed and roved level alternated during a session. Two groups of subjects participated, differing only by whether they started with a fixed-level or a roved-level run. No feedback was provided. Performance was evaluated in terms of correlation coefficients, means, and variance in responses. Only subjects whose performance was not correlated with presentation level during the roved-level trials were considered in the analysis.

Results

Results depended on whether the level cue was available during the initial run. Correlation coefficients improved over time only if the initial run was performed with roved level. Most of this improvement occurred immediately after the first run. In contrast, subjects who initially had both reverberation and level cues available did not improve over time, and their performance remained inferior compared to the initial-roved-level group throughout the whole session.

Conclusion

These results confirm that rapid recalibration processes occur in spatial perception when listeners enter a new acoustic environment, resulting in improved performance over time. However, the adaptation processes are not triggered automatically, and their occurrence might be conditioned on various factors. For example, distance recalibration occurs only if the level cue is unavailable during the initial exposure to sounds in the new environment.

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