Adaptive Processes in Distance Perception

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Abstract

Distance perception is typically dominated by the overall received stimulus intensity. Louder sounds appear to be closer, softer sounds appear to be further away. However, distance processing can also be guided by intensity-independent cues. Specifically, the interaural level differences (ILDs) provide distance information for nearby lateral stimuli and, in reverberant space, the direct-to-reverberant energy ratio (DRR) cue provides distance information for sources from all directions. Importantly, the mapping from the cues to source distance is room-dependent for both ILD and DRR. Therefore, the auditory system has to adapt the mapping for each new room we enter. A series of experiments was performed to examine 1) what is the relative weighting of the DRR and ILD cues for intensity-independent relative distance judgments, 2) how the brain combines the overall level and DRR information to learn to judge absolute distance in a new room, and 3) how vision re-calibrates auditory distance perception in a ventriloquism (after)effect paradigm. The results show that the interpretation of distance cues by the brain is highly adaptive, depending on the relative cue reliability, on previous exposure to the cues and the room, and, in the case of ventriloquism, also on the direction in which the bias is induced (closer vs. further away than the actual sound source location). These results are consistent with the hypothesis that the brain dynamically updates its model of the acoustic environment, preferring the most reliable cue combination in each situation. However, future studies will need to be performed to examine what dynamic processes are responsible this adaptation and what neural mechanisms underlie it.

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