Attentional modulation and cue-specificity of cortical biases in favor of looming sounds

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Abstract

Our auditory sense allows us to constantly be aware of our surroundings. The increased alertness to looming versus receding sounds is termed the auditory looming bias. Researchers have elicited and studied the phenomenon by creating moving stimuli through varying either broadband or spectral intensity, thereby exposing this bias across various species and ages. Studies show behavioral responses to be faster and more accurate for looming stimuli. Prior imaging literature has unveiled a distributed network at play, spanning temporal, parietal and frontal regions. Electrophysiological investigations partially argue for an intervention of the frontal cortical areas, prioritizing looming over receding motion; others highlight the role of bottom-up processing of looming sounds at the time points of maximum bias manifestation. These discrepancies may result from differences in cue types and task difficulty. Therefore, in our present study, we directly compared the two cue types used to elicit the looming bias: our sound pairs crosswise varied in either broadband or spectral intensity, with the other remaining constant across stimulus change. We further looked into the role of attention, to identify effects of task engagement. 28 normal-hearing listeners were initially passively exposed to the stimuli, being directed to focus on a muted and dubbed movie. Subsequently, in a second condition, they were asked to actively judge the direction of sound motion by keypress. In both conditions neural activity was simultaneously recorded through high-density electroencephalography (EEG). Cortical source activity was localized given individual brain anatomies and electrode positions. Behaviorally, we verify the presence of the looming bias and its manifestation in faster reaction times and higher accuracies in all conditions, though this effect was more pronounced for changes in broadband intensity compared to spectral intensity. Neurally, we see the emergence of the bias as early as 80 ms after change onset. The bias is evoked later but stronger for changes in broadband vs spectral intensity and weaker but still present in passive vs active listening. The bias occurs already at the level of the primary auditory cortex (PAC) with a hemispheric lateralization that is specific to cue type: changes in broadband intensity bias activity more in the left PAC whereas changes in spectral intensity bias activity in the right PAC. Together, our findings of early and preattentive biases suggest a bottom-up directed priorization in the neural processing of looming sounds that is amplified through attention and recruits cue-specific processing sites. Ongoing directed connectivity investigations are aimed at unraveling the interplay between frontal and temporal areas in the processing of looming sound motion.

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