Contextual plasticity in spatial hearing

Dissertation Thesis

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The thesis examines dynamic processes in auditory spatial perception by human listeners. In order to elucidate how temporal and spatial relationships between stimuli can influence the human ability to localize sound sources, it focuses on a new phenomenon referred to as “contextual plasticity”. This phenomenon shows that performance in a simple task of localizing a single target can depend on the context in which the task is performed. The context is represented by an interleaved more complex localization task, in which the target is preceded by another sound. We conducted two behavioral experiments examining various spatial aspects of contextual plasticity, with the aims of understanding why this effect occurs and what its underlying neural representation is. We found that the context, in addition to inducing biases in localization, provides a more stable and more correlated mapping between the locations of responses and sound sources. This suggests that listeners use spatial information provided by the context in order to improve their performance in a simple localization task. Contextual plasticity was also found to depend on the spatial configuration of the stimuli used in the experiment and in the contextual task. Based on the results it can be inferred that contextual plasticity is induced at later stages of auditory processing pathway at which spatial representation is Cartesian-like, i.e., beyond the stage at which binaural cues are processed and which is based on polar representation. A computational model was developed to describe observed plastic changes. The model assumes that the contextual stimuli induce local biases in the neural representation of auditory space. Several variants of the model were tested, differing in the assumptions about the spatial characteristics of the neural representation and interactions between its units. The model successfully described many characteristics of the behavioral data. These results are important for our understanding of the dynamic processes in auditory spatial perception, which can be useful for various technical and medical applications such as virtual reality, human-computer interaction and auditory prosthetics.