U01: Multiscale modeling of the cocktail party problem

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Abstract

At every instant of our lives, a cacophony of sounds impinges on our ears and challenges our brain to make sense of the complex acoustic environment in which we live – a phenomenon referred to as the cocktail party problem (CPP). Up till now, efforts to understand this phenomenon focused on the role of acoustic cues in shaping sensory encoding of auditory objects in the brain. Yet, listening is not the same as hearing. It engages *both* sensory and cognitive processes to enable the brain to *adapt* its computational primitives and neural encoding to the changing soundscape and shifting demands to attend to various sounds in the scene. The current project puts forth an adaptive theory of auditory perception which integrates the role of *both* sensory mechanisms and cognitive control in a unified multiscale theory that combines neural processes at the level of single neurons, neural populations and across brain areas. Central to this hypothesis is the role of rapid neural plasticity that reshapes brain responses to acoustic stimuli according to the statistical structure of the soundscape, guided by feedback mechanisms from memory and attention. The research plan translates this hypothesis into a unified multiscale model employing a distributed inference architecture. This scheme employs hierarchical dynamical systems that track the statistical structure of the stimulus at different resolutions and time-scales, and adapt their responses based on both memory and attentional priors. This architecture is used as springboard to predict the interaction between sensory and cognitive mechanisms at play during the CPP.