The Linear auditory cortex: how far can it take us in cocktail party scenes?

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Though seemingly effortless, our auditory system engages in complex processes and transformations which enable us to segregate speech and other sounds in noisy environments and cocktail party settings. Though crucial for both engineering and perceptual sciences, the study of the neural underpinnings of auditory scene analysis remains in its infancy. This field is particularly challenged by the lack of integrative theories which incorporate our knowledge of the perceptual bases of scene analysis with the neural mechanisms along various stages of the auditory pathway. Because of the nature of the problem, the neural circuitry at play is intricate and multi-scale by design. Moreover, the complex nonlinearities of the nervous system limit significant advances in efforts to modeling such phenomenon. Often times, starting from a linearization of the problem augmented with other tools such as statistical and control theory can yield a tractable formulation in order to explore the role of different processes in scene analysis.

Here, we focus on the role of neural processing at the level of primary auditory cortex in parsing acoustic scenes. We view the cortical mapping as *linear* transformation of acoustic attributes into a higher-dimensional perceptual space. Such mapping is further augmented with Bayesian theory and Kalman filtering which defines a model of cortical inference. The feedback from kalman predictions acts as a control that reconciles sensory information with expectations about auditory objects in the scene. Though linearization oversimplifies the dynamics of neural processing in cortical ensembles, it allows tracking the evolution of auditory objects over time simply by tracing the trajectory of sound attributes in the linear cortical perceptual space. We also analyze the limitations of such model to capture the adaptive abilities of cortical networks, both in response to task demands and also to optimize computational load incurred by processing less-salient events. We shall discuss simple extensions of the linear formulation that provide added flexibility to capture these phenomena.

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