The Complexity of Neural Responses in Auditory Cortex and Its Functional Implications

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In contrast to the visual system, the auditory system has a longer subcortical pathway and more spiking synapses between sensory receptors and the cerebral cortex. This unique organization reflects the needs of the auditory system to process time-varying and spectrally overlapping acoustic signals using strategies different from those used by other sensory systems. We have systematically studied a large number of single neurons in auditory cortex of awake marmoset monkeys. During these experiments, neurons were tested with a large repertoire of stimuli, from pure tones to narrow- and broad-band sounds such as amplitude- and frequency-modulated sounds, harmonic complex and species-specific vocalizations. A number of important observations have emerged from these studies. For example, auditory cortex neurons recorded in awake condition appear much more selective and nonlinear than cortical neurons studied in anesthetized animals. A striking characteristic of neural firings in the awake condition is the prominence of sustained firing that lacks stimulus-synchronized patterns, especially when a neuron is driven by its optimal stimulus. This poses challenges to computational methods based on reverse-correlation to characterize a neuron's receptive field. Furthermore, we observed neurons in particular cortical areas that appear to perform high level computations, such as computing pitch of harmonic complex and spectral contrasts. All together, these observations suggest that neural representations of acoustic information in auditory cortex represent transformations from acoustic features to internal neural representations and from acoustical dimension to perceptual dimension.