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Single-unit fMRI mapping: new perspectives on brain organization

The visual brain of humans and other primates is evolutionarily adapted for the perception of important stimuli. The functional organization of neural circuits across the brain often assessed through functional mapping, using either neuroimaging or electrophysiological methods. Perhaps the strongest example of cortical regions defined by their stimulus selectivity is a collection of functionally distinct islands known as face patches. Face patches are robustly identified using fMRI and are replete with neurons that respond more vigorously to images of faces than to those of other stimulus categories. While responses of the face patch system have been studied in detail, relatively little work has been directed to understand its operation during naturalistic modes of stimulation and behavior - namely, the visual conditions under which the primate brain evolved. In this talk, I will describe an approach in which we investigate neural responses in the face patch system during the viewing of naturalistic videos. In contrast to most visual electrophysiology studies, which ask how neural responses encode or represent stimuli, we instead analyzed single cell responses based upon their functional relationship to fMRI activity elicited elsewhere in the brain during video viewing. Using this method, we found that face-selective neurons from four nodes of the face patch system fell into distinct functional groups, or subnetworks, each with a distinctive brain-wide signature of coactivation. Importantly, each functional subnetwork spanned multiple face patches, and each face patch contained a mixture of nearly all subnetworks. These findings offer a new view of activity within face patches and contrast with long-standing assumptions about segregation of function that commonly shape the design and interpretation of experiments in cognitive neuroscience. The striking parallelism of distinct functional threads within in the face patch system further offers clues about how new perceptual operations might emerge, through development and evolution, within an existing domain-specialized system.