Figure-ground Consistency Across Natural Image Patches in Monkey V4

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The primate visual system has an amazing capability in segregating a wide variety of objects from background in natural scenes. Investigating the intermediate-level visual cortical areas is a crucial step towards understanding the formation of the cortical representations of figure and ground (FG). We analyzed spiking activities of macaque V4 neurons in response to a variety of natural image patches and their variants (e.g., mirrored images, filled images, and reversed contrast). Approximately one fourth of the visually responsive neurons showed the response modulation depending on the positional relation between the Classical Receptive Field of the neuron and the figural region of the stimulus. Spike-triggered stimulus averaging (STA) revealed antagonistic structures with adjacent regions responsive to figure and ground independent of luminance contrast. To investigate the functional role of the antagonistic structure, we developed a model based on the estimated STA, and evaluated its consistency in FG judgement across a variety of natural image patches (i.e., correctness in FG classification). The veridical FG labels for the natural patches were obtained from human psychophysical experiments. The consistency of the model across stimuli was compared with the neural consistency computed from the recorded cells. The consistency of the model exhibited a significant correlation with the neural consistency. Although the model is primarily based on a linear STA, its performance showed an agreement with the neural consistency, suggesting the importance of the antagonistic structure responsive to figure and ground for the robust FG determination in natural images.

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