Variability of V1 Population Responses to Natural Images Reflects Probabilistic Inference

Submission ID 3000169

Submission Type Poster

Topic Neuroscience

Status Submitted

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SUBMISSION DETAILS

Presentation Type Oral Presentation

Presentation Abstract Summary The visual cortex processes its inputs through the variable and coordinated activity of neuronal populations. Population variability has been studied intensely with artificial stimuli, but its structure and functional role in natural vision remain largely unexplored. To address these issues, we recorded simultaneously from tens of neurons in macaque primary visual cortex (V1) while presenting natural images of different sizes. Stimulation of the receptive field surround reduced response variability and covariability on average, but the strength of the effect varied across images. To understand these observations, we extended a model of image statistics that accounts for single-neuron selectivity on natural images (Coen-Cagli et al 2015), and we assumed neurons represent a posterior distribution over local image features (Orban et al 2016). In our model, surround stimulation stabilizes population responses by reducing uncertainty. Such reduction however is modulated by segmentation cues, computed via Bayesian inference about the statistical dependence between neighboring image regions. As predicted by the model, weaker evidence for statistical dependence between regions reduced the effects of surround stimulation on population variability. Our results suggest the structure of population activity in V1 is modulated by the statistical properties of natural images, consistent with a probabilistic representation of image features.

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Keywords

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Population coding
Natural image statistics
Uncertainty
Response Variability
Visual Cortex