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# Sparse coding model captures V1 population response statistics to natural movies

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Local populations of sensory cortical cells exhibit a diverse range of activity patterns. However, classical approaches have neither fully accounted for nor characterized this heterogeneity, especially in response to natural stimuli. First, classical single cell recordings suffered from sampling bias and favored highly responsive cells [1]. Second, common approaches considered mostly the average activity over different cell classes, without a full description of the statistical distribution over the entire population [2]. Recent studies started to address these issues [3,4]. In this study, we make further inroads by recording simultaneous single unit activities across cortical layers in cat V1 in response to natural movies using a silicon polytrode, and comparing the population statistics to the predictions from a dynamical system implementation of the sparse coding model [5,6], with a linear-nonlinear model as control.

We analyzed data sets from two recording sessions in anaesthetized cats viewing natural movies. To quantitatively measure the difference between model predictions and the recording, we used the earth mover's distance [7] to quantify the dissimilarities between the distributions of the recorded response and those predicted by sparse coding and linear-nonlinear model. We show that: (1) The population firing rate distribution is close to exponential in both the recorded data and the sparse coding model in response to natural movies; (2) The response correlation between unit activities is small regardless of the size of receptive field overlap, when using a binning window synced to the movie frame. A similar relationship between the response correlation and receptive field overlap is observed in the sparse coding model; (3) A linear-nonlinear model could predict the exponential firing rate distribution, but not the correlation structure.

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