Connecting scene statistics to probabilistic population codes and tuning properties of V1 neurons

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Populations of V1 neurons recorded from three macaque monkeys were analyzed to evaluate the relationship between the distribution of the disparity tuning properties and the scene statistics of depth distribution relative to fixation depth. We found that there are more neurons preferring disparities with a higher probability of occurrence in the natural environment, and fewer neurons preferring disparities with a lower probability of occurrence. The tuning curves of neurons selective to the more probable disparities tend to be sharper than those for less probable disparities. Both the distribution of preferred disparities and the distribution of relative scene depth can be fit with similar Laplacian distributions, but with an asymmetry favoring near disparities. This finding is consistent with the hypothesis that neurons are performing optimal sampling of the natural environment based on the information maximization principle. These tuning properties manifest in a probabilistic population code at the V1 level to explicitly represent the statistical priors of natural scenes for depth inference.