Firing rate of V1 neurons predicts perception of ambiguous three-dimensional objects

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We studied single unit responses of V1 superficial layer neurons in a perceptual task. A rhesus monkey was trained to hold fixation during presentations of ambiguous and unambiguous (3D) structure-from-motion objects, and was required to report his perception in an alternative forced choice task. We estimated the probability with which the firing rate of a given V1 neuron allows an ideal observer to predict the monkey's perceptual choice. Neuronal responses to zero-disparity (ambiguous) objects were sorted according to the perceptual choices and the type of object on the preceding trial. The choice probability was determined for each neuron (Britten et al., 1996). Based on the sample of 159 neurons, 40% of the cells showed a significant but relatively late perceptual bias ($p<0.01$) starting at ~400 ms after the stimulus onset. Analysis of the sequence of trials revealed that perception and neuronal responses during ambiguous trials were affected by the preceding non-ambiguous trials in a time dependent fashion. In a separate experiment, by varying the inter-trial-interval (ITI) between unambiguous and ambiguous object trials, we found that an ITI < 1s caused the perception to switch, while following an ITI > 1s the perception remained the same. Consistent with the perceptual stabilization following long ITIs, neurons recorded during ambiguous trials (separated by long ITIs) revealed a short latency persistent firing rate increase if the preceding trial was congruent with the preferred direction/disparity of the neuron. Thus, the relative firing rate during ambiguous trials was predictive to the monkey's choice. These results suggest that a subpopulation of V1 neurons contribute to generating a perceptual bias deriving from two sources: a short latency anticipatory bias induced by the previous exposure and a long latency perceptual bias representing a corroborative feedback from higher visual cortical areas (MT/MST). (Supported by NEI and J.G. Boswell Professorship)