INTRODUCTION

The ability of our visual system to discriminate and recognize complex three-dimensional (3D) shapes from images necessitates that we use mechanisms of inference using information from a multitude of depth cues. One depth cue is binocular disparity and recent evidence suggests that neuronal interactions in primary visual cortex (V1) can help resolve local ambiguities about absolute disparity. Area V2 is one of the earliest regions that have neurons that respond selectively to relative disparity information. Signals from these neurons could represent some of the preliminary components of more complex 3D shapes. We hypothesized that interactions among V2 neurons could help resolve local ambiguities about relative disparity information. The interactions could resolve which disparity regions belong to the same surface to reveal 3D component shapes. To test our hypothesis, we chronically implanted 32 moveable electrodes into V2 of a rhesus macaque. We measured the facilitative and suppressive interactions among the population of neurons while presenting contextual stereoscopic stimuli outside of the classical receptive field and simultaneously manipulating the uncertainty about disparity within the classical receptive field. We found that interactions depended on the likelihood of whether the stimuli inside and outside of the classical receptive field were part of the same continuous surface. This suggests that neuronal interactions in V2 play an important role in the early stages of 3D shape inference.

NEUROPHYSIOLOGICAL METHODS

Recordings were made with a chronically implanted Gray Matter 32-channel microdrive system and chamber into V1/V2 of an awake, behaving macaque performing a simple fixation task. Tungsten-in-glass electrodes were independently moved and spikes were sorted offline with principal components analysis and manually set time-voltage thresholds. A 2.5 x 2.5-degree frontal parallel surface was presented to the center of the receptive field for each neuron while a 2.5 x 5.17-degree surround was presented at 7 possible relative disparities and disparity gradients. The motivation was to compare the effect of surround stimulation depending on surface continuity and shape. An eighth control condition was presented to make sure the surround was not within the receptive field. Surfaces were rendered using dynamic random dot stereograms with a black and white dot density of 25% and a dot pattern refresh rate of 12 Hz. All conditions were presented 60 times and at 3-5 different absolute disparities (gray).

CONCLUSIONS

• Surround suppression is stronger in disparity-tuned V2 neurons when the surround surface is continuous with the surface of the receptive field stimulus.
• The surround modulation depends on the global curvature of the surface in the surround and is not accounted for by simple iso-disparity suppression.
• The surround effect depends on the disparity tuning of the neurons and could be reversed when RF stimulus is of non-preferred disparity.