# Evidence of cooperative and competitive mechanisms for stereo computation in macaque V1

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Computational models of stereopsis (e.g., Marr and Poggio 1976) require cooperation among neurons of similar disparity tuning and competition among neurons of different disparity tuning. Cooperation and competition help to resolve ambiguity during stereo matching. We tested for evidence of such network behavior by simultaneously recording from multiple spatially distributed disparity-tuned neurons in V1 of awake, alert macaques responding to different depths rendered in dynamic random dot stereograms. We studied the dynamics of both local (same electrode & <1 mm) and long-range (≥1 mm) effective connections using cross-correlation. The likelihood and strength of long-range connections between pairs of neurons depended on similarities in their disparity and orientation tuning. Effective connectivity varied systematically with disparity, resulting in a correlation-based disparity tuning curve. Significant local connectivity was found among neurons with very similar disparity tuning, as well as among neurons with antagonistic disparity tuning. We found that correlation-based tuning curves in the later part of responses were much sharper than firing-rate based disparity tuning curves in the same time window. Both correlation-based and firing-rate based disparity tuning evolved over time. Firing rate-based disparity tuning was initially very broad and became sharper over time. There were two waves of effective connectivity. The first wave was observed at non-preferred disparities where firing rates were lowest, suggesting that the two neurons might be receiving common inhibition from other neurons tuned to those disparities. The second wave was observed in the later part of responses and was sharply localized at the optimal disparity shared by the neuron pairs, suggesting cooperation or mutual facilitation between the two neurons. These findings are consistent with cooperative and competitive interactions suggested by Marr and Poggio's model. The sequence of events suggests that competitive interaction might first remove gross mismatches, and then cooperation further refines depth estimates.

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