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Model Components

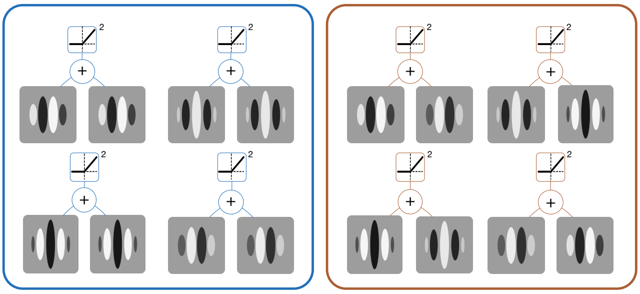

Fig. 1) A depiction of the excitatory **(Left)** and the suppressive **(Right)** pools as direct extension to the binocular Energy model (Ohzawa, DeAngelis, Freeman, 1990). Each pool sums the responses of 4 simple-cell components. The two pools are combined in different ways as described in **Fig. 2**. Each simple cell component have binocular receptive field with fixed phase disparity (0 or 180). The linear filter output is half-wave rectified and squared.

Disparity Decoding

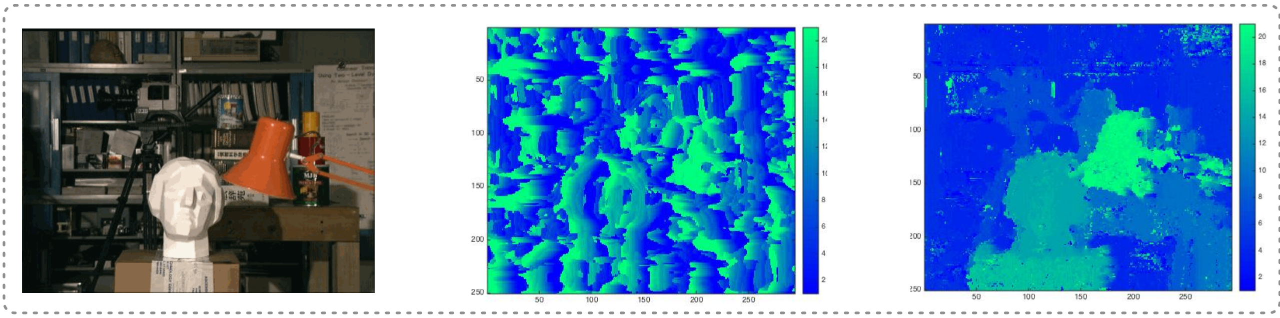

Fig. 2) Examples of disparity decoding from a natural stereo image pair using different model settings. Each model returns a map of model cell responses (binocular complex cells) tuned to a range of spatial frequencies and orientations. The disparity decoder then sums the responses over orientations and spatial frequencies and returns the value of disparity with maximal summed response. **Left)** Original image (Left image shown). ((Nakamura et al., 1996) **Middle)** Disparity map from the subtractive inhibition model (Tanabe, Haefner, Cumming, 2011). Accuracy showed marginal improvement over the original stereo energy model. **Right)** Same map generated from the contrast normalization model (Tanabe, Haefner, Cumming, 2011; Rust et al., 2005) . Comparable performance as can obtained from the model described in divisive suppression model with strong suppressive power. From the mathematical viewpoint, the suppressive signals represent the mismatch between left and right eye image patches whereas excitatory signals represent the overall feature strength. The results confirms our belief that the excitatory signal, if not properly discounted by further processing stages, creates detrimental bias.

Simulations of Electrophysiology

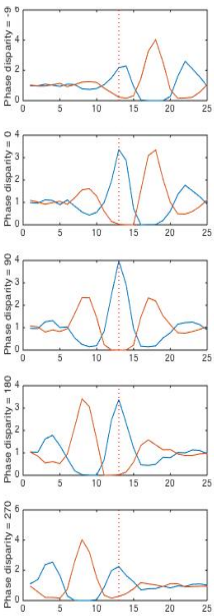

Fig. 3) The 'iso-disparity' group. The five tuning curves represent the group of cells with different combinations of position and phase disparities such that the peak of their tuning curves lie on the same disparity (dotted vertical line). The blue curves represent the disparity tuning to correlated random stimuli whereas the red line represents the tuning to anti-correlated stimuli. We found that an excitatory interaction between these units coupled with proper normalization results in significant relative attenuation of the amplitude of tuning curve to anti-correlated stimuli. We also found that such a mechanism mildly improves disparity decoding, adding to the list of possible roles that a variety of phase disparity-tuned units might play.

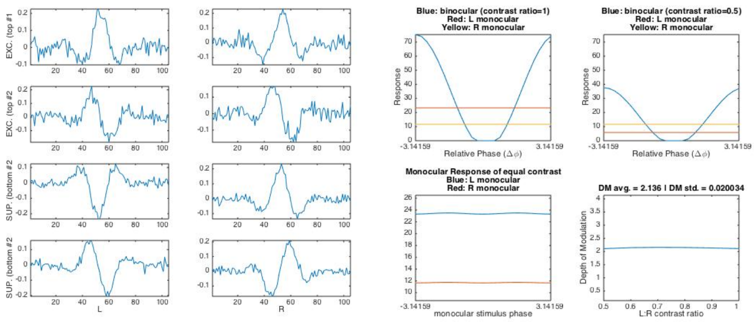

Fig. 4) (Left) Spike-triggered covariance analysis of a model cell. (divisive suppression model shown). The top two rows represent the eigenvectors with the highest eigenvalues and the bottom two rows represent those with the lowest eigenvalues. Both the excitatory and the suppressive components are fully recovered for all models that combine both pools. **(Right)** Simulation of ocular dominance (lower left figure) and depth of modulation (lower right) across disparity (Ohzawa, Freeman, 1990). The classical energy model produced better fit to overall tuning curves (upper two figures) than any model with suppressive input, suggesting that either the neurophysiological data of the original study was taken by the cells without suppressive components or additional mechanism for adapting baseline response exists.