A Novel Method for fMRI analysis: Inferring Neural Mechanisms from Voxel Tuning

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Presentation Abstract Summary Recent fMRI analysis methods produce voxel tuning functions (VTFs) that relate the value of stimulus features (e.g., orientation) to the intensity of BOLD. Modulation of VTFs by differing brain states (e.g., viewing stimuli at low vs. high contrast) has been taken to reflect changes in the shape of neural tuning functions (NTFs) of feature-selective neurons within the voxels. However, mapping a VTF back to NTFs is an ill-posed inverse problem: there are two unknown distributions (the shape and the response magnitude of underlying NTFs) but only one observed distribution (the BOLD signal across values of the stimulus feature). We tackled this inverse problem by using BOLD response profiles from two brain states and solving for modulations in the profile. We collected BOLD from V1 in subjects viewing oriented gratings at low vs. high contrast. We fitted alternative models of NTF modulation by stimulus contrast (additive shift, multiplicative gain, bandwidth sharpening). Although the VTF expressed an additive shift from low to high contrast, the best-fitting models indicated that this shift was driven by multiplicative gain in the NTFs, in line with electrophysiological data. Thus, the method recovers 'ground truth,' linking monkey neurophysiological data on NTFs to human fMRI data on VTFs.

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