Analysis of Population Receptive Field Estimation Technique in Neuroimaging

For obtaining visual field maps, new research suggests to adopt a model-driven approach to estimate neuronal population receptive fields (pRFs) which can be theoretically tested.

We introduce novel computational techniques to analyze and simulate fMRI experiment designs for pRF estimation in the human visual cortex. Utilizing the technique, we find optimal experiment and model parameters in addition to evaluating the models’ assumptions by finding the systematic errors.

We first obtain a pRF model based on measurements of pRF sizes in the human V1 region. Then we simulate BOLD responses by downsampling the stimulus using the assumed pRF model. After a log-polar retinotopic mapping, we apply the assumed HRF function with added noise to obtain BOLD signals of the voxels in the primary visual cortex. Finally, we compare the true and estimated parameters for optimization and failure analysis.

For instance, we show that the pRF estimation method gives lower precisions when underlying HRF is non-linear and it gives biased pRF size estimates when the assumed HRF model is non-linear.