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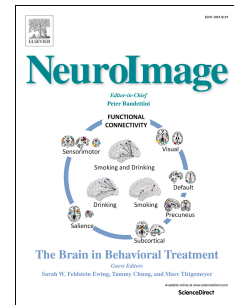
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Estimating the functional dimensionality of neural representations

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Abstract

Recent advances in multivariate fMRI analysis stress the importance of information inherent to voxel patterns. Key to interpreting these patterns is estimating the underlying dimensionality of neural representations. Dimensions may correspond to psychological dimensions, such as length and orientation, or involve other coding schemes. Unfortunately, the noise structure of fMRI data inflates dimensionality estimates and thus makes it difficult to assess the true underlying dimensionality of a pattern. To address this challenge, we developed a novel approach to identify brain regions that carry reliable task-modulated signal and to derive an estimate of the signal's functional dimensionality. We combined singular value decomposition with cross-validation to find the best low-dimensional projection of a pattern of voxel-responses at a single-subject level. Goodness of the low-dimensional reconstruction is measured as Pearson correlation with a test set, which allows to test for significance of the low-dimensional reconstruction across participants. Using hierarchical Bayesian modeling, we derive the best estimate and associated uncertainty of underlying dimensionality across participants. We validated our method on simulated data of varying underlying dimensionality, showing that recovered dimensionalities match closely true dimensionalities. We then applied our method to three published fMRI data sets all involving processing of visual stimuli. The results highlight three possible applications of estimating the functional dimensionality of neural data. Firstly, it can aid

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