Introduction

Prefrontal cortex (PFC) is thought to focus on goal-relevant information. Specifically, medial PFC has been shown to code for latent structures of experience in cognitive maps1,2,3.

Category learning models formalize this process through feature-based attentional tuning and knowledge clustering4,5,6.

This theoretical convergence suggests mPFC may perform data reduction, compressing task-irrelevant features and emphasizing goal-relevant information structures.

Research Questions

• Does mPFC perform goal-sensitive data reduction during learning?
• Are individual differences in learning ability and attentional tuning predicted by mPFC neural compression?

Methods

fMRI category learning tasks (1.7-mm isotropic voxels, 2s TR, whole brain) 22 participants learned three classic categorization tasks6 4 fMRI runs per task, 32 trials per run, 128 trials total per task Learning tasks of varying complexity

Low one dimension

Medium two dimensions

High three dimensions

Feedback-based learning trials

Low complexity

High complexity

Low compression

High compression

Learning-related neural compression

Medial PFC representational compression during learning

Neural PCA searchlight

Neural compression predicts individual differences in learning ability

Variability in learning ability

Computational modeling of learning

SUSTAIN

Greater mPFC compression associated with more optimal task-specific feature attention

Conclusions

• mPFC representations are shaped by experience through goal-sensitive dimensionality reduction
• mPFC compression consistent with mechanisms of SUSTAIN learning model4,5, providing quantitative account of mPFC’s role in concept formation7
• Dimensionality reduction through selective attention may underlie many mPFC functions (e.g., cognitive maps, latent causal models, schemas, value coding)

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References