Dynamic trial-by-trial re-coding of task-set representations in frontoparietal cortex mediates behavioral flexibility

How our flexible behavior was supported by the dynamic (re)coding in fronto parietal was explored by the research group led by Prof. Chen Antao (**陈安涛**) from the Faculty of Psychology, Southwest University with the collaboration of Prof. Tobias Egner from Duke University. The study was supported by the National Natural Science Foundation of China, and was recently published in *Journal of Neuroscience* (2017, 0935-17).

"Cognitive control" describes a set of processes that allow individuals to coordinate thoughts and actions in accordance with internal goals. A key component of cognitive control is the capacity to flexibly configure, and switch between "task-sets", rule representations that define currently relevant stimulus attributes and how they map onto responses. Previous functional magnetic resonance imaging (fMRI) studies employing multivoxel pattern analysis (MVPA) have shown that a currently relevant task-set can be decoded from activity patterns in frontoparietal cortex, but how these regions support the dynamic transformation of task-sets from trial to trial is not clear.

The study combined a cued task-switching protocol with human (both sexes) fMRI, and harnessed representational similarity analysis (RSA) to facilitate a novel assessment of trial-by-trial changes in neural task-set representations. We first used MVPA to define task-sensitive frontoparietal and visual regions. We then exploited RSA to track the between and even within trial pattern similarities and correlated these pattern similarities with behavioral performance for switch and repeat trials, respectively.

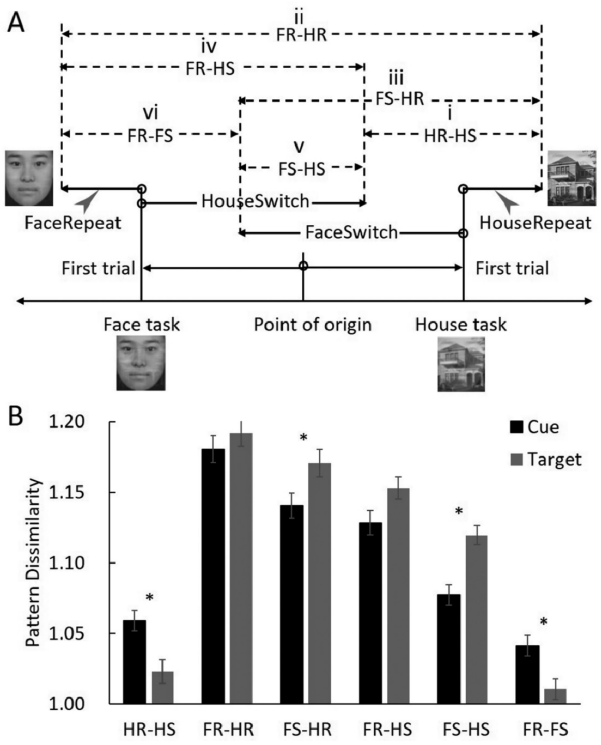

Figure Predicted (A) and observed (B) patterns of ROI-based representational dissimilarities.

Results showed that neural task-set representations on switch trials are less stably encoded than on repeat trials. We also found that the neural representational pattern dissimilarity across consecutive trials is greater for switch than for repeat trials, and that the degree of this pattern dissimilarity predicts behavior. Moreover, the overall neural pattern of representational dissimilarities followed from the simple assumption that repeating sets result in stronger neural task representations than switching sets. Finally, when moving from cue to target phase within a trial, the pattern dissimilarities tracked the transformation from previous-trial task representations to the currently relevant set.

These results provide neural evidence for the longstanding assumptions of an effortful task-set reconfiguration process hampered by task-set inertia, and they demonstrate that frontoparietal and stimulus processing regions support "dynamic adaptive coding", flexibly representing changing task-sets in a trial-by-trial fashion.