Independent and distributed coding of task-set decision rules within ventrolateral prefrontal cortex

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Goal-driven behavior relies on the neural coding and representation of task-set information. Task sets can be specified not only by task-relevant perceptual dimensions and motor responses, but also by the decision rules that govern how different combinations of stimuli lead to different responses. In the current study, the neural representation of decision rules was examined within the context of a novel experimental paradigm in which participants (N=14) performed tasks in response to visually presented word-pairs while undergoing functional MRI (fMRI) scanning. In each task, the participant made a semantic judgment, applied a decision rule to the results of the judgment, and responded by pressing a button. There were four different semantic judgments, four decision rules, and four motor response rules, which were combined factorially to produce 64 unique tasks. Two of the decision rules were simple (requiring attention to the semantic value of only one member of the word-pair), while two were complex (requiring integration of semantic values for each pair). We asked whether a neural code for the decision rules could be identified that was consistent across the semantic judgment and button response contexts. Candidate regions coding for decision rules were identified using a standard GLM contrast that distinguished complex vs. simple task rules. In the second-stage these regions were interrogated using a multivariate pattern analysis (MVPA) approach, testing for voxel clusters that reliably distinguished between either the two complex rules or two simple rules. Within the left ventrolateral prefrontal cortex (VLPFC), a double dissociation was observed such that anterior VLPFC was selectively sensitive to the complex rules and posterior VLPFC was selectively sensitive to simple rules. Critically, standard GLM analyses did not distinguish these regions or their coding sensitivity, suggesting that the representational scheme is multivariate and locally distributed. The results suggest that decision rule information is represented as an independent dimension of task representation, and may be coded along an anterior-posterior gradient within VLPFC.