Session 081 - Neural Networks for Executive Functioning

Add To Itinerary

81.06 / DDD11 - Neurophysiological mechanisms for representing abstract components of mental states

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Presenter at Poster
Sat, Nov. 12, 2016, 2:00 PM - 3:00 PM

Authors

***J. MUNUERA**[1], M. RIGOTTI[3], S. FUSI[1], C. D. SALZMAN[1,2,4];
[1]Neurosci., [2]Psychiatry, Columbia Univ., New York, NY; [3]IBM T.J. Watson Res. Ctr., Yorktown Heights, NY; [4]Psychiatry, NYPSI, New York, NY

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Abstract

Contingencies between stimuli, actions, and reinforcement outcomes often differ dependent upon the situation. Serial reversal-learning is a behavioural task that can be used to explore the mechanisms underlying such context-dependent adjustments in action selection and reinforcement anticipation. In serial reversal-learning, two or more stimuli reverse their contingencies multiple times within an experimental session. Upon a reversal, agents may update independently their understanding of contingencies of each stimulus-response-outcome association, or they may learn to grasp that within a block of trials, the set of associations for all stimuli defines a task set. Knowledge of task sets allow a computationally more efficient strategy of exploiting knowledge that the association of one stimulus has changed to infer that contingencies have also switched for the other stimuli within a task set (i.e. by applying inference, a strategy recently demonstrated to be invoked by monkeys, see Saez et al., 2015). This strategy requires the formation and utilization of neural representations of task sets. We investigated the mechanisms that can underlie the formation of representations of task sets. In each of two contexts, rhesus monkeys learned to associate each of 4 images (conditioned stimuli, CSs) to an operant action (hold or release a button) and an unconditioned stimulus (US - either a drop of juice or its absence). Each context was thereby defined by the set of operant and reinforcement contingencies for the CSs, i.e. the task set. Within each context, we manipulated the temporal statistics of events such that particular trial types tended to occur in temporal proximity to each other, creating two sub-contexts. Switches between sub-contexts did not change contingencies so learning about sub-contexts could not be driven by error signals. Instead, learning about sub-contexts relied on the formation of a link between the current trial and the previous trial, a link that could be formed through a Hebbian mechanism if different interconnected neurons represent the current and most recent trial, respectively. We recorded single neuron activity in the amygdala, OFC, and ACC to determine if neural signals merely reflect a memory trace of previous trials, or if they reflect the formation of neural representations of sub-context and context. In all 3 brain areas, the neural representations reflected the linked sets of trials that form sub-contexts and contexts by virtue of the temporal statistics of events. This could underlie a process of abstraction that creates novel, abstract mental states reflecting task sets, a process vital for flexible cognitive behaviour.