Value computations and decision-making: converging evidence from single neurons and discrete lesions of the frontal cortex

Dr. Steve Kennerley

Institute of Neurology, University College London

Decision-making frameworks highlight a number of important computations that may be necessary for guiding optimal behavior. The brain needs to represent what alternatives are available and to compute the variables that will enable efficient choice between alternatives, such as the costs and benefits associated with each alternative. Once the choice has been made the brain must compute the value of the obtained outcome and generate a prediction error if the actual outcome deviates from the predicted outcome. These signals could serve to modify and maintain the values associated with different alternatives, thereby ensuring that future choices are optimal and adaptive. Here I will discuss recent research from our lab suggesting that single neurons in different frontal cortex regions - in particular the anterior cingulate cortex (ACC), lateral prefrontal cortex (LPFC) and orbital frontal cortex (OFC) - encode different types of value signals which support different aspects of goal-directed behavior. Moreover, I will argue that the value representations encoded by neurons in these regions are necessary signals for reinforcement learning and optimal decision-making, as discrete lesions of ACC or OFC cause severe (but dissociable) learning and decision-making impairments.

Unlike DA activity which consistently increases as expected probability increases, as choice value increased an approximately equal number of frontal neurons increased their firing rate (114/218, 52%) as decreased their firing rate.

Because PE activity exhibited by DA neurons tends to be very phasic (<500ms in duration), we examined neuronal selectivity for PE in sliding bins of 200ms, originating at either picture or outcome onset and moving in steps of 10ms until the end of each 1000ms epoch.