Dorsomedial prefrontal cortex and dorsal raphe nucleus represent controllability estimation in human

Yanhe Liu*[1], Lisa Spiering[1], Jan Grohn[1], and Matthew Rushworth[1]

[1]Department of Experimental Psychology, University of Oxford – Royaume-Uni

Résumé

Controllability is a fundamental feature of behaviour. In a changing environment, an agent should track whether its actions really exert any influence on the environment. However, it remains unclear how controllability estimations are represented and updated in the brain. Human participants estimated whether a simple task environment was controllable or not. Their estimates varied as a function of the environment's true controllability. We outline a model of how participants derived these estimates. We provide evidence that they update their estimates of controllability by comparing the real reward rate experienced with their expectation of reward rate. We show that they assign credit for an outcome to either themselves or to fluctuations in the environments by maintaining their estimation of controllability, monitoring their confidence in their choices whenever they make decisions, and by monitoring the outcomes they receive. 7T fMRI showed that dorsomedial prefrontal cortex (dmPFC) activity reflected both confidence and environment controllability, and outcome attribution. Activity in dorsal raphe nucleus (DRN) tracked change in controllability estimation. Interactions between the two regions were related to the formation of a controllability estimate. Individual variation in activity patterns was related to individual variation in controllability estimation. Meanwhile, the reward prediction error signals in DRN, midbrain dopamine region, and dorsal striatum were modulated by participants' estimations of controllability. We hypothesize that a DRN-dmPFC circuit tracks controllability and that changes in its activity pattern impact on other aspects of reward and reward prediction error signalling elsewhere in the brain.

*Intervenant