A global dopaminergic learning rate enables adaptive foraging across many options

Laura Grima*[1], Yipei Guo[2], Lakshmi Narayan[1], Ann Hermundstad[1], and Josh Dudman[1]

[1]Janelia Research Campus [Ashburn] – États-Unis
[2]Institute of High Performance Computing – Singapour

Résumé

In nature animals must effectively allocate their choices across many concurrently available resources when deciding where to forage. However, lab-based studies of decision-making traditionally reduce the problem to two discrete and well-learned options. It is therefore less understood how animals learn to execute two core components of foraging decisions: whether to stay or leave a currently chosen option, and where to go next if departing. Here we developed a paradigm in which naive, water restricted mice were free to sample from six options arranged around the walls of a large (_˜2.5m) arena that were rewarded at a range of deterministic intervals. Within tens of minutes mice rapidly diverged from random behaviour and began to exhibit robust matching, visiting options in proportion to their relative history of reward. This behaviour was sensitive to the distance between options such that animals were able to achieve near optimal rates of return when taking into account the spatial configuration of the environment. To develop a mechanistic description of this learning, we constructed an RL model inspired by foraging theory and found that a dynamic learning rate was necessary for capturing key features of mouse behaviour with high precision, including its higher order transition structure. Finally, concurrent fibre photometry recordings revealed that dopamine in the nucleus accumbens core (NAcC) but not dorsomedial striatum (DMS) reflects learning rate within this context. Altogether our results reveal that in large spatial environments, mice are able to rapidly and effectively learn about and exploit many options through use of a dynamic learning rate, supported by ventral striatal dopamine.

*Intervenant