Uncertainty, exploration and assessment during decision-making

Gloria Cecchini[1], Michael Depass[2], and Ignasi Cos*[2]

[1]Centre de Recerca Matemàtica de Catalunya (CRM) – Espagne
[2]Universitat de Barcelona – Espagne

Résumé

Uncertainty is an intrinsic condition of behavior in the natural realm. However, what could be a significant drive for behavioural exploration in some, could equally act in the converse fashion, or even freeze behaviour entirely. How uncertainty is processed by the brain to influence the learning of specific decision strategies, and how related cognitive processes influence our perception and interaction with the environment remains a matter of vivid discussion. Previous evidence shows that specific oculomotor dynamics accompany stimuli exploration and co-vary with inner confidence. Consistent with this, alternative oculomotor movements between options have been viewed as part of a metacognitive process aimed at coping with uncertainty during assessment. Here we investigate how these sources of uncertainty relate with the learning of strategies of reward seeking behavior across several trials by analysis of oculomotor patterns. Also, we probe the relationship of pupil dilation and mental effort expenditure during the learning of such strategies as a function of reported confidence. Our results show that the participants reporting low to middle confidence gradually define a strategy with increasing accuracy. This is accompanied by increased of pupil dilation during the early learning only. Furthermore, the harder the choice the slower their responses and the larger the number of alternative saccades between stimuli. The participants reporting the highest confidence performed the poorest and never improving their strategy. Indeed, our results show that the participant's responses co-vary with the environment's uncertainty, strongly suggesting that humans possess a quantitative sense of confidence in their inferences about their strategy and about their relationship with the environment, which transpires through oculomotor control. However, a moderate level of confidence is necessary for a speediest option exploration and ultimate learning.
Reference:
Cognitive mechanisms of learning in sequential decision-making under uncertainty: an experimental and theoretical approach. Front. Beh. Neurosci. (2024) Vol 18

*Intervenant