Decision-making in rapidly changing environments: linking normative computation and neural implementation

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Abstract

A rich body of work in psychology and neuroscience has shown that a sensible, neurophysiologically plausible strategy for making decisions under uncertainty is to accumulate information over time. An often-overlooked challenge of making such decisions in natural environments is that the state of the world, and thus the correct choice, can change while a decision is being formed. This volatility requires adaptive tuning of the accumulation process to suit the environmental statistics. In this talk, I will present work showing that humans can approximate optimal decision-making remarkably closely in such contexts. I will show that diagnostic signatures of the underlying computations – including a sensitivity of accumulation to both surprise and uncertainty – are evident in the dynamics of a network of brain regions centered on motor cortex, and are produced by an established biophysical model of decision-making that generates competitive 'attractor' dynamics. Moreover, while fast pupil dilations were also strongly driven by surprise and uncertainty, they were selectively associated with enhanced sensory responses to new information and had little bearing on the motor regions encoding the accumulation process. I will conclude that normative accumulation of information in changing environments can be approximated by large-scale attractor dynamics in decision-related cortical activity, and that this process is subtly fine-tuned by pupil-linked neuromodulatory systems.

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