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Primates solve risky decision-making problems via spatial computations

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Abstract

What are the neural mechanisms underlying risky decision making? How do the implementation details of these mechanisms impact observable behaviour? Here we hypothesise that non-human primates (NHPs) are re-using circuits for spatial navigation to solve decision making problems. This is motivated by recent findings of grid coding of probability and magnitude in NHP frontal cortex (Bongioanni et al., 2021; Veselic et al., 2025). Grid cells are an optimal code for space (Dorrell et al., 2023; Fiete et al., 2008; Sorscher et al., 2023) but this form of representation is not normatively optimal for risky-decision making. However, this might be a small price for efficiency: by embedding problems in space, NHPs can recycle spatial solutions to quickly solve new problems. First, we show that this spatial framework can replicate classical prospect theoretic findings (Kahneman & Tversky, 1979). Then, we show that the framework also predicts unique biases in the behaviour of NHPs, which we find in two NHP datasets. Finally, we find that a spatial model best fits individual subjects' behaviour in both NHP and human data. In total, we provide a mechanistic implementation for risky decision making, which accurately predicts systematic biases. This proposal makes novel predictions in terms of both behaviour and neuronal activity. **Keywords:** Decision making; prospect theory; grid cells; frontal cortex; computational modelling; resource rationality.

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