



Navigating Uncertainty: Neural Mechanisms of Probabilistic Foraging in Mongolian Gerbils

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Abstract

This thesis investigates the neural underpinnings of decision-making in uncertain environments, using Mongolian gerbils as a rodent model. Specifically, it examines the role of the anterior frontal cortex—a key region in human decision-making—in managing attentional resources during an exploration-exploitation dilemma. The study employed a probabilistic foraging task alongside chronic laminar recordings in gerbil's frontal region A (FrA). This approach allowed an in-depth study of the FrA's mesoscale activity as the gerbils made decisions in environments simulating real-world uncertainties.

Our findings revealed that gerbils engage in sophisticated, inference-based decision-making strategies rather than following rigid foraging rules. Current Source Density (CSD) profiles within the FrA indicated a complex cognitive integration of past experiences with immediate action-outcome assessments, through encoding of reward anticipation and evaluation. Importantly, an increase in pre-decisional neural activity in the FrA, specifically observed just before the animals decide to explore, underscores its role in exploratory behaviour. Additionally, layer-specific analysis in the FrA showed enhanced engagement of supragranular layers during the crucial transition from exploitation to exploration, hinting at a layer-dependent mechanism within FrA that enables adapting adequate foraging strategies. Overall, these results contribute to our understanding of decision-making in uncertain environments, emphasizing the rodent anterior frontal cortex's role in attentional resource management for adaptive decision making.

Exploring these neural mechanisms within the exploration-exploitation dilemma—a critical aspect of cognitive functioning in uncertain environments— not only enriches our understanding of decision-making in rodents but also serves as a crucial model for investigating analogous processes in more complex beings, including humans. Such insights have the potential to inspire new approaches for treating decision-making disorders and enhancing cognitive adaptability across a spectrum of neurological and psychiatric conditions.

Keywords: Decision-making, exploration-exploitation dilemma, Mongolian gerbils, probabilistic foraging, frontal region A, chronic laminar recordings.