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OPINION

Foraging for foundations in decision neuroscience: insights from ethology

Dean Mobbs, Pete C. Trimmer, Daniel T. Blumstein & Peter Dayan

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Dean Mobbs

Professor of Cognitive Neuroscience; Allen V. C. Davis and Lenabelle Davis Leadership Chair, Caltech Brain Imaging Center; Director, Caltech Brain Imaging Center

B.S., University of Birmingham, 1999; Ph.D., University College London, 2008. Assistant Professor, Caltech, 2016-20; Professor, 2020-; Chen Scholar, 2019-21; Davis Leadership Chair, 2021-; Director, 2021-.

Office: 319 Baxter Hall

Mail Code: MC 228-77

Phone: 626-395-4028

Administrative Assistant:
Mary A. Martin
Email: mmartin@caltech.edu

Dean Mobbs is interested in the intersection of behavioral ecology, economics, emotion, and social psychology. By understanding the neural, computational, and behavioral dynamics of human social and emotional experiences, his lab develops theoretical models that merge those fields. Using brain-imaging, computational modeling and novel behavioral techniques, his lab is probing the neurobiological systems responsible for fear and anxiety, revealing how people learn to control their fears, and how anxiety and psychiatric disorders disrupt those processes. His research also focuses on the interplay between social interaction, protection, and emotion—how fear can depend on whether you're alone or in a group (e.g. fear dilution).

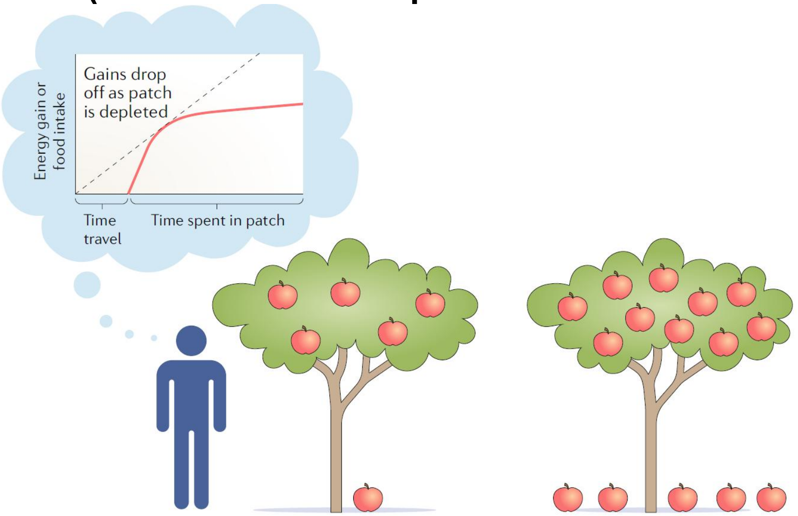
- Ethology studies how behavior may vary adaptively in response to environmental variation.
    - foraging, predator avoidance, reduction of competition…
    - optimal escape theory, foraging theory…
    - frameworks of Huxley, Mayr and Tinbergen
    - proximate and ultimate causes of animal decisions

- Decision neuroscience has built accounts of the proximate causes of behavior.
    - building and understanding process models, such as models of inference and learning
    - whether these tasks are ethologically credible and comprehensive or not

- We lay out a blueprint for a closer integration of ethological and behavioral ecological approaches with work on the neural basis of decision-making.
    - energy-based decision, competitive foraging and foraging under the risk of predation

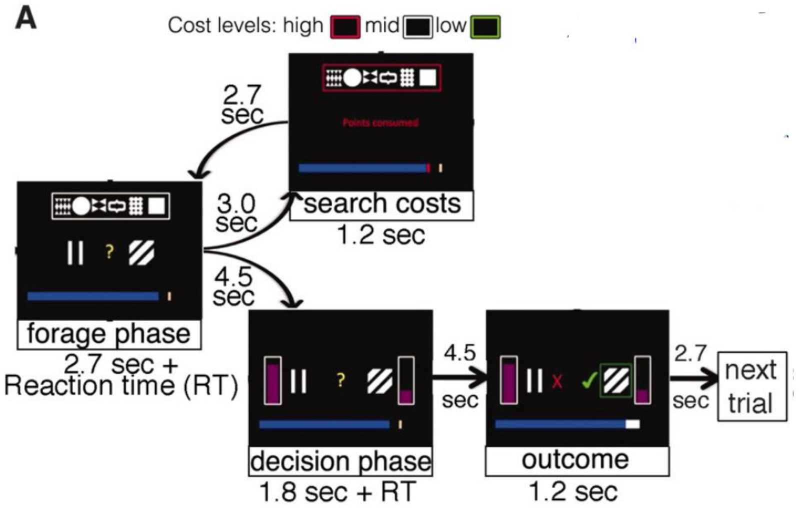
- Foraging (energy-based decision)
  - Net rate maximization
  - Optimize the difference between the benefits and the costs per unit time.
  - Dorsal anterior cingulate cortex (dACC) is involved in the cost–benefit analysis of control-demanding situations and that it is engaged in energizing behavior.

  - The marginal value theorem (resources deplete over time as they are exploited)



  - MVT performed better than TD-Learning (16).
  - The dACC neurons increased its firing rate as a function of juice and travel time (13).
  - MVT can be generalized to intangible resources like attention, social information and memory (53-55).

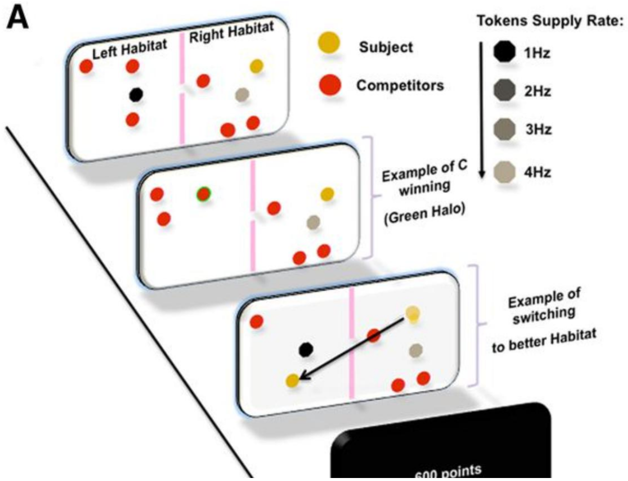
- Foraging (energy-based decision)
  - Exploration versus exploitation



  - The dACC encoded both the average value of the foraging environment and the costs of foraging.

  - State dependence
  - Individuals are not constrained by energy or homeostatic challenges.

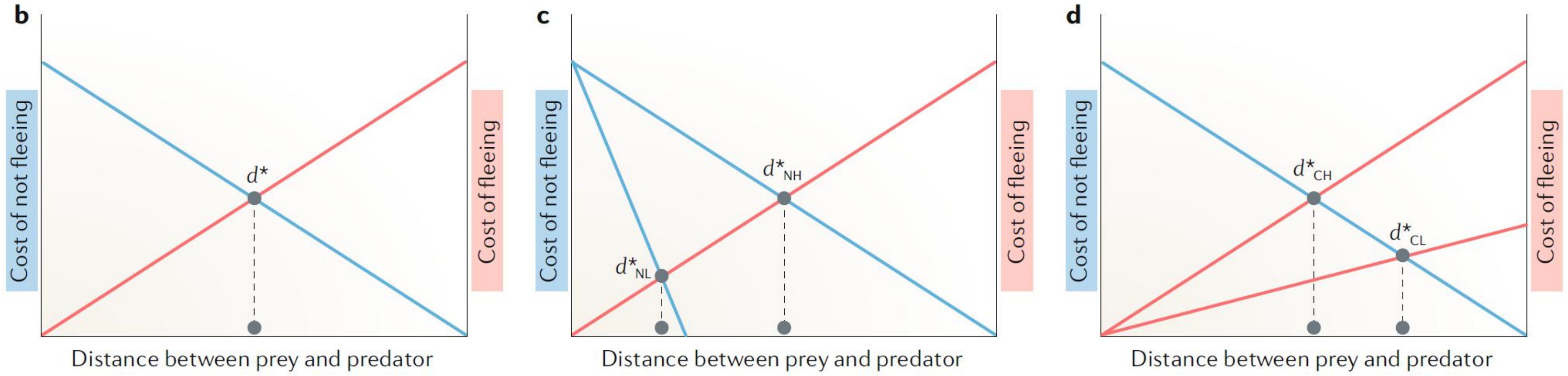
- Competitive Foraging
  - Ideal free distribution
  - Perfect information about patch quality and competition density
  - Move freely among patches without time delay



  - The dACC, the supplementary motor area and the insula involves with switching, while staying was associated with striatum and mPFC.

- Foraging under predation risk
  - Common currency
  - The choice that maximizes reproductive value can be identified as the normative expectation under natural selection.

  - Escape theory
  - Prey make economic decisions in terms of the cost–benefit ratio of remaining compared with fleeing.



- Foraging under predation risk
  - Neural basis of escape
  - The vmPFC was preferentially active when the virtual predator was distant, but this activity switched to the midbrain periaqueductal grey (PAG) as the threat moved closer.