

## **Choice and Deliberation in a Complex Planning Game in Monkeys**



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## Overview

- What neural mechanisms underlie complex planning?
- We trained a monkey to play a board game, Four-in-a-Row, against a computer opponent
- Monkey 3 behavior is well-predicted by a heuristic model
- Some neurons in DMPFC, DLPFC, and Caudate respond to heuristic features





Goal: be the first to place four pieces in a row

## 43% 11,000+win rate vs CPU games Trials 10000-Total states of Unique states Number 5000-0 23 3 15 19 Number of Pieces on the Board

Gameplay

Heuristic model best predicts monkey moves

> **Heuristic Model** Tree Search

Model shows sensible ordering of heuristic weights

4IAR

20

10

Weight (a.u.)

Dist Center X-

## Neurons

Single neurons in Caudate show anticipation of opponent heuristics





4-in-a-row 3-in-a-row double threat **3-in-a-row connected** 3-in-a-row disconnected 2-in-a-row connected 2-in-a-row disconnected Block 4-in-a-row Block 3-in-a-row



Model

Our model, trained only to predict moves, also predicts gaze



Several neurons in DMPFC, DLPFC, and Caudate respond to heuristic features



DMPFC (n=1093) DLPFC (n=1230) Caudate (n=939)





Model



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[4] Huang, J., Velarde, I., Ma, W. J., & Baldassano, C. (2023). Schema-based predictive eye movements support sequential memory encoding. Elife.