Cognition Without Cortex: Rapid Learning, Generalization, and Long-term Memory in Acortical Mice

Jieyu Zheng, Zeynep Turan, Katelyn Sadorf, and Markus Meister, ***California Institute of Technology***

Jieyu is looking for postdocs starting Fall 2026. Scan the QR code:
https://jieyusz.github.io

ACORTICAL MICE

1. THE MOTIVE

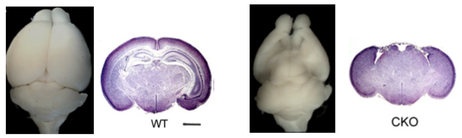
Is rodent neocortex and hippocampus strictly required for cognition?
We study whether acortical mice preserve:

- Rapid learning (latent learning, few-shot learning)
- Long-term memory of routes and turns
- Generalization across different maps

2. THE ACORTICAL MICE

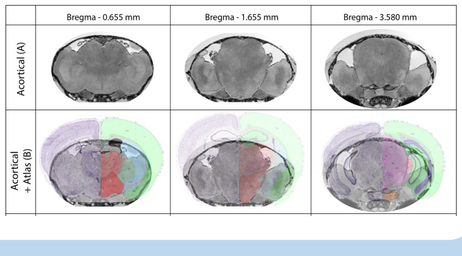
A mutant born without neocortex and hippocampus:

- Dorsal cortex knockout
  No primary sensory or motor cortex
- Undisturbed development of subcortical structures
- Vision through superior colliculus
- Olfaction through piriform cortex



C57BL6/J Wildtype **Emx1-Cre+ x Pals1 flox/flox**

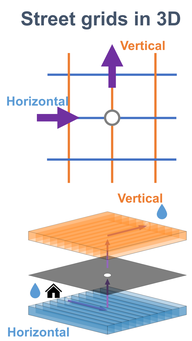
Kim et al Walsh, Neuron 2010



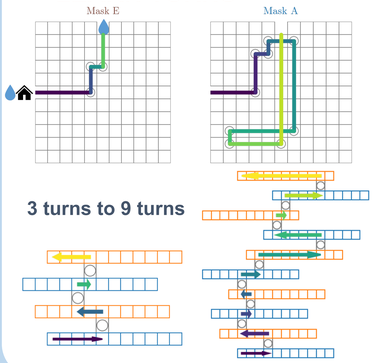
MANHATTAN MAZE

1. DESIGN PRINCIPLES

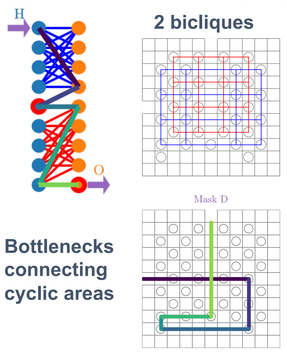
Tablet for video



2. ACYCLIC GRAPHS – LEARN TURNS



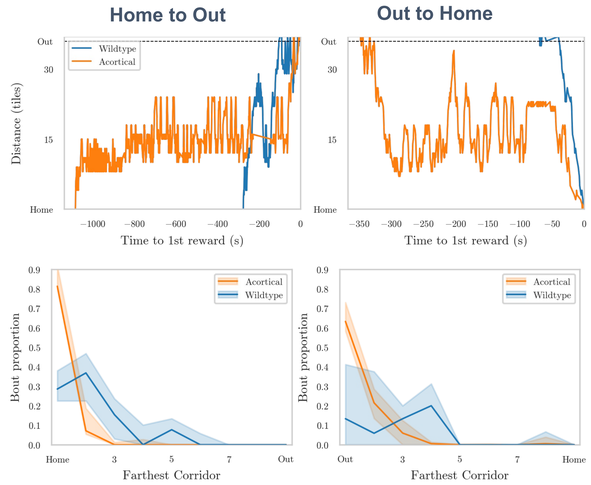
3. CYCLIC GRAPHS – LEARN BOTTLENECKS



Bottlenecks connecting cyclic areas

RAPID LEARNING

1. INEFFICIENT EXPLORATION

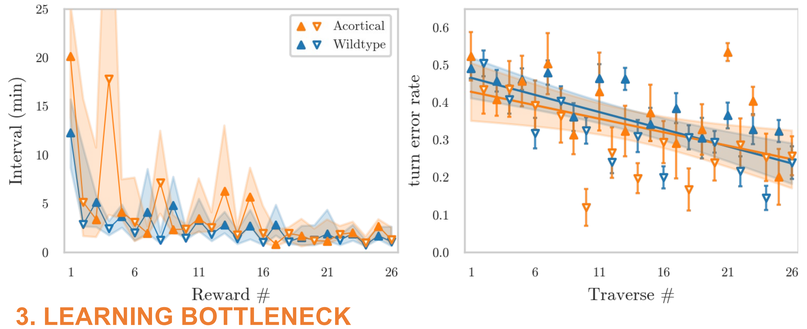


Acortical mice took 3x more time to reach the first reward compared to wildtype mice, due to repetitive scans of the same corridor.

Most of their bouts were repetitive sorties near the starting points. (n=5 mice)

2. FEW-SHOT LEARNING

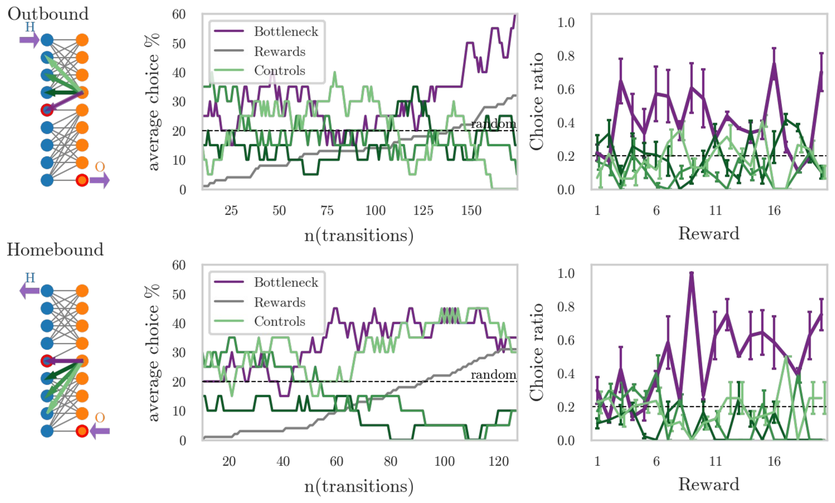
Like wildtype mice, acortical mice (n=10) shortened their traverses in Mask A within just 20 rewards. Their turn error rates also decreased in a similar trend.



First 20 rewards each day

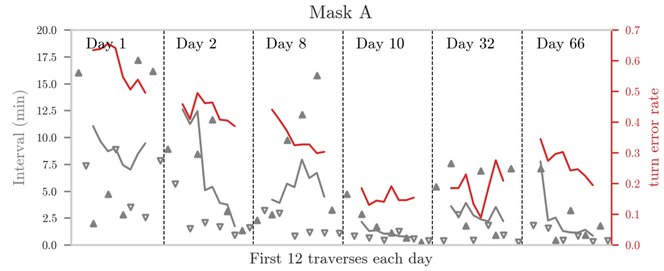
3. LEARNING BOTTLENECK

Choices of the bottleneck over control nodes increased over rewards (n=7).



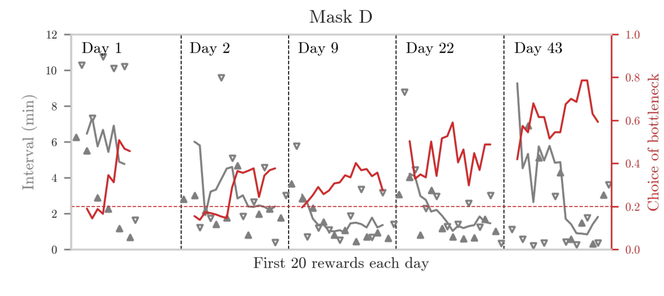
LONG-TERM MEMORY

1. MEMORY OF TURNS



An acortical mouse memorized the turns of the same map over two months.

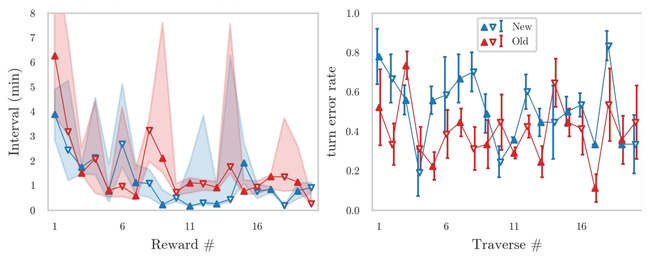
2. MEMORY OF BOTTLENECKS



Another mouse remembered the cyclic map over a month and consistently chose the bottlenecks.

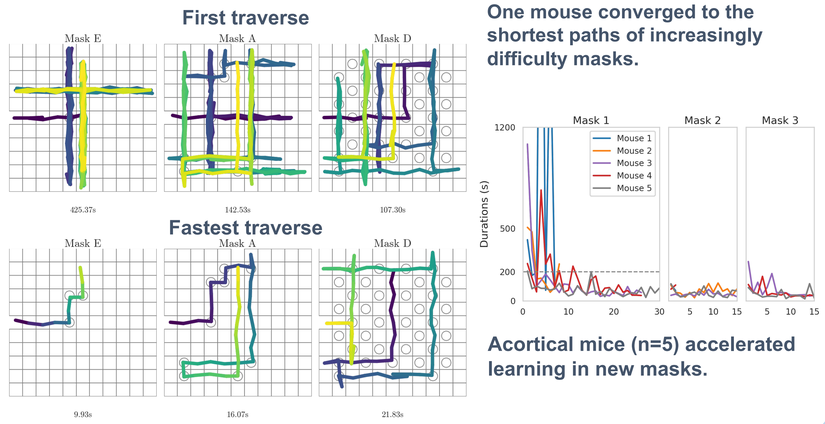
GENERALIZATION

1. SAME DIFFICULTY



Acortical mice (n=5) could learn the new mask with different turns faster than the old mask.

2. INCREASING DIFFICULTY



One mouse converged to the shortest paths of increasingly difficulty masks.

Acortical mice (n=5) accelerated learning in new masks.

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