NEU/MOL 502A: From Molecules to Systems to Behavior

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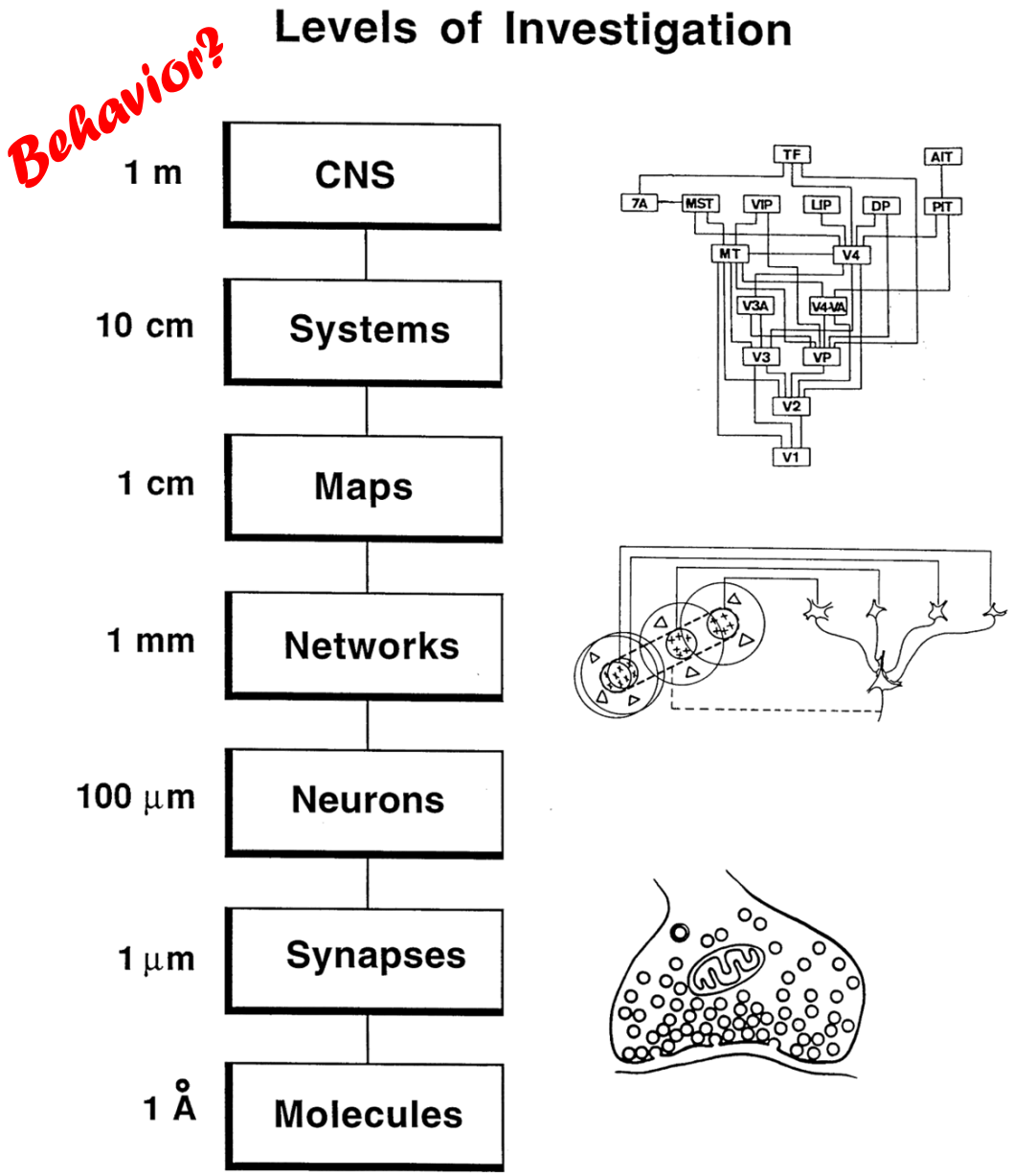
From circuits to behavior…

NEU/MOL 501 focused on the foundation of neuroscience:

1. gross anatomy
2. anatomy and biophysics of neurons
3. molecular basis of learning

NEU/MOL 502 will build on this foundation, reaching towards understanding the circuits and systems that support behavior.



Real world behavior

Your task: make a peanut butter and jelly sandwich.

How would you do this?

Hayhoe et al, JoV 2003

Real world behavior

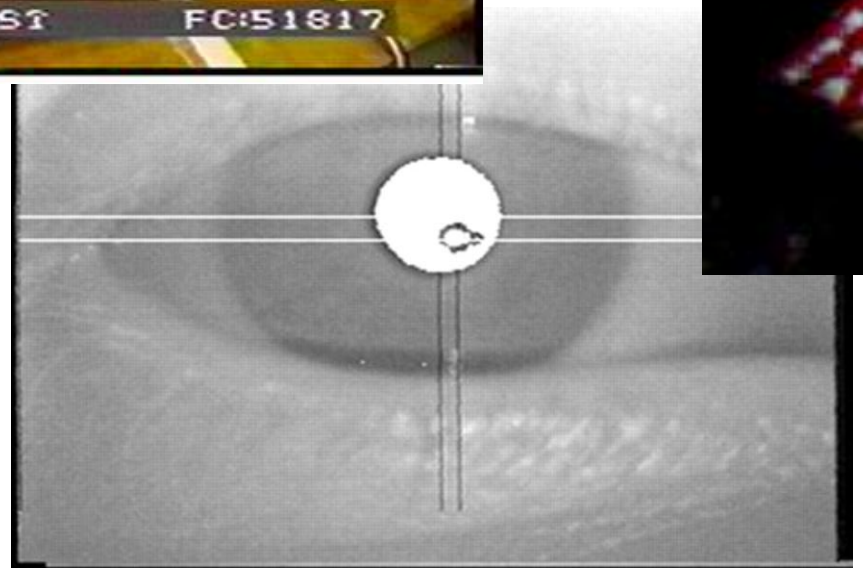
Your task: make a peanut butter and jelly sandwich.

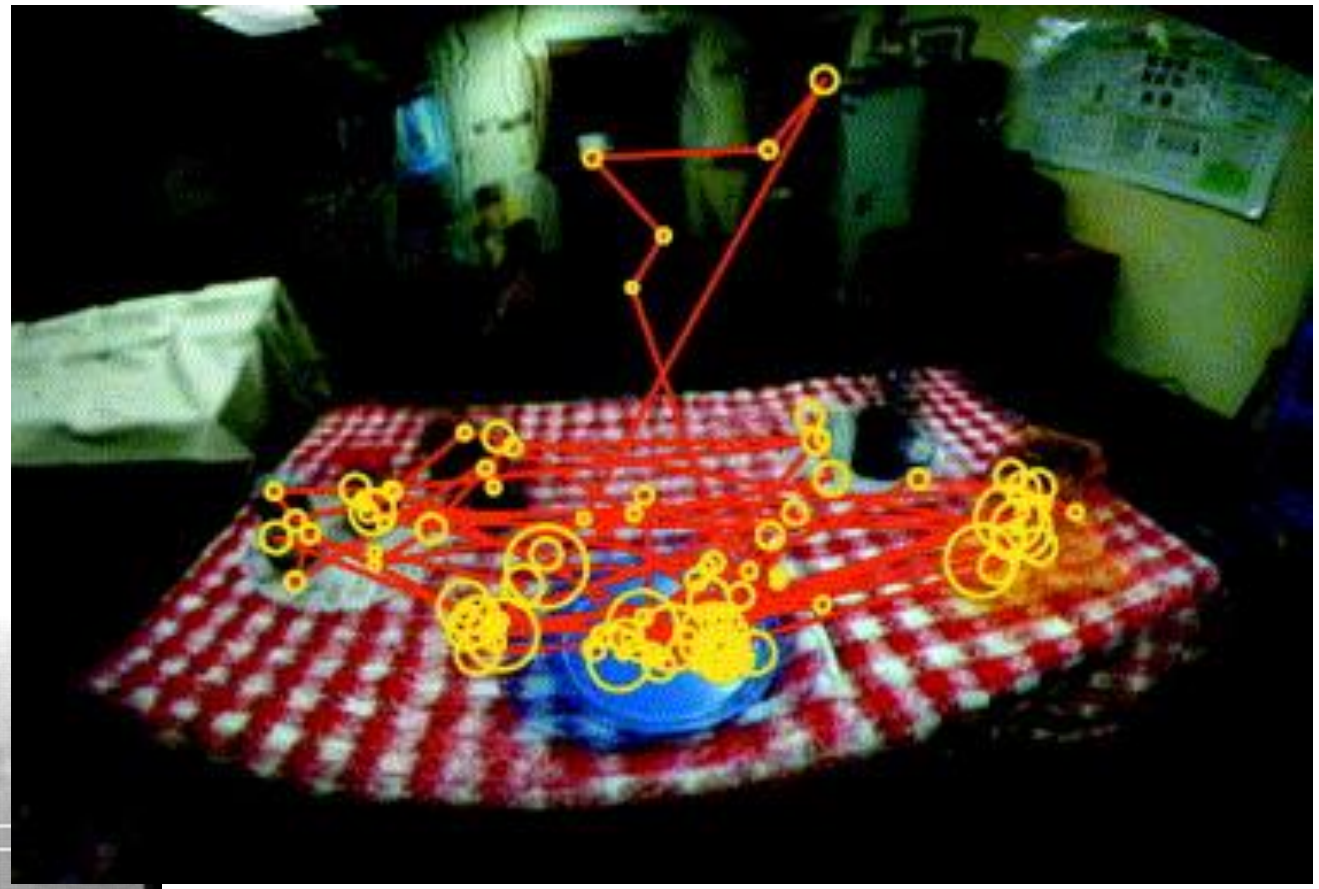
How would you do this?

How can we begin to understand cognition at this level?

Hayhoe et al, JoV 2003

Real world behavior

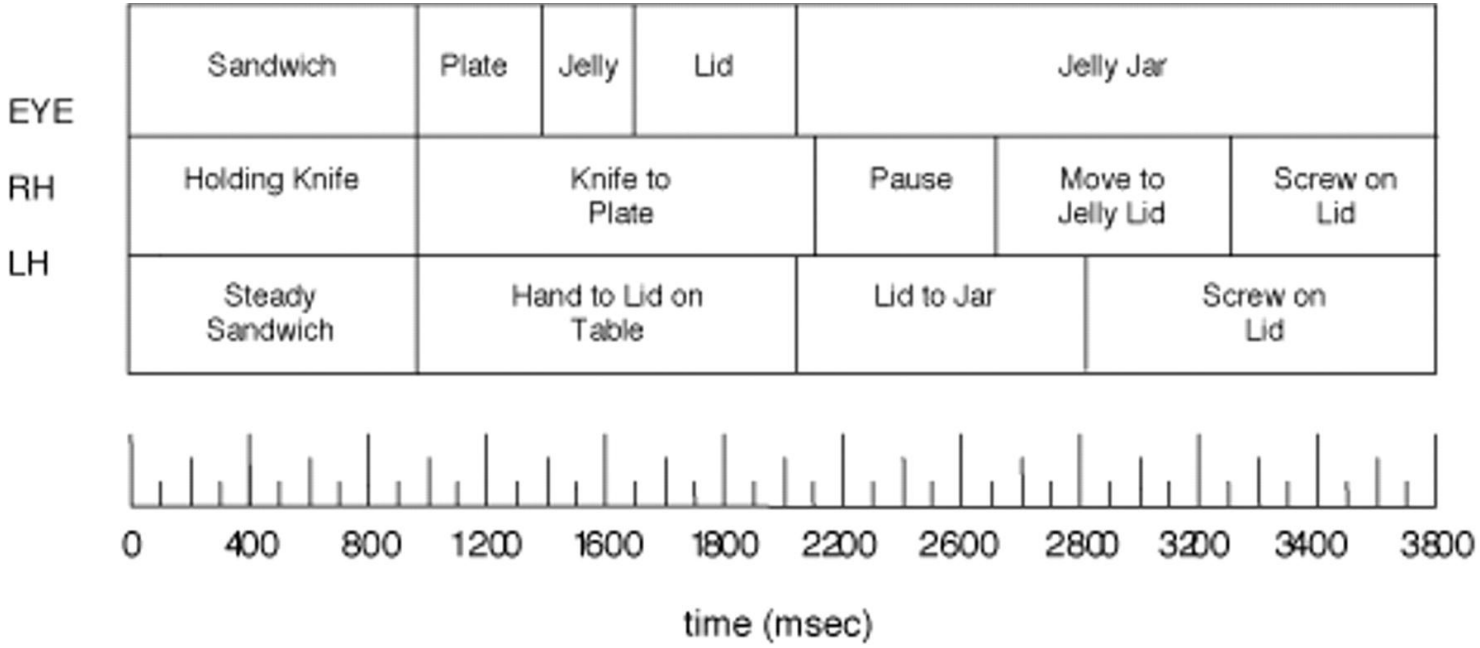


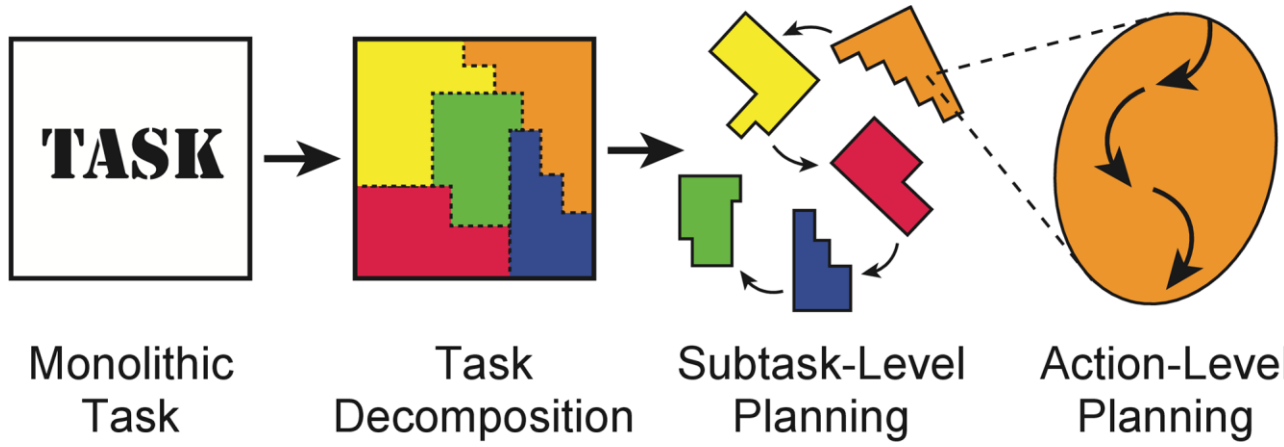


Play Example Movie

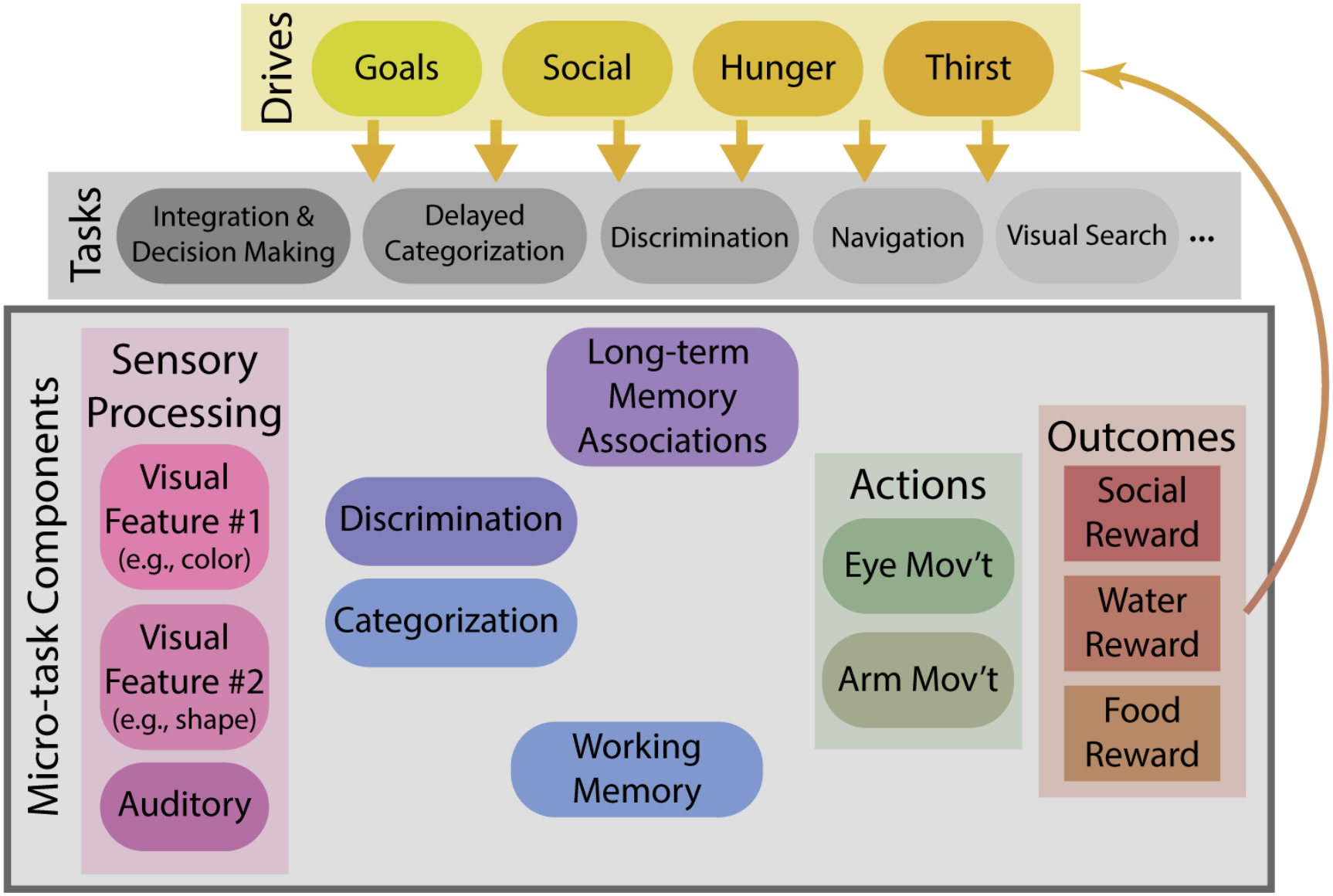
Hayhoe et al, JoV 2003

Cognition in the real world

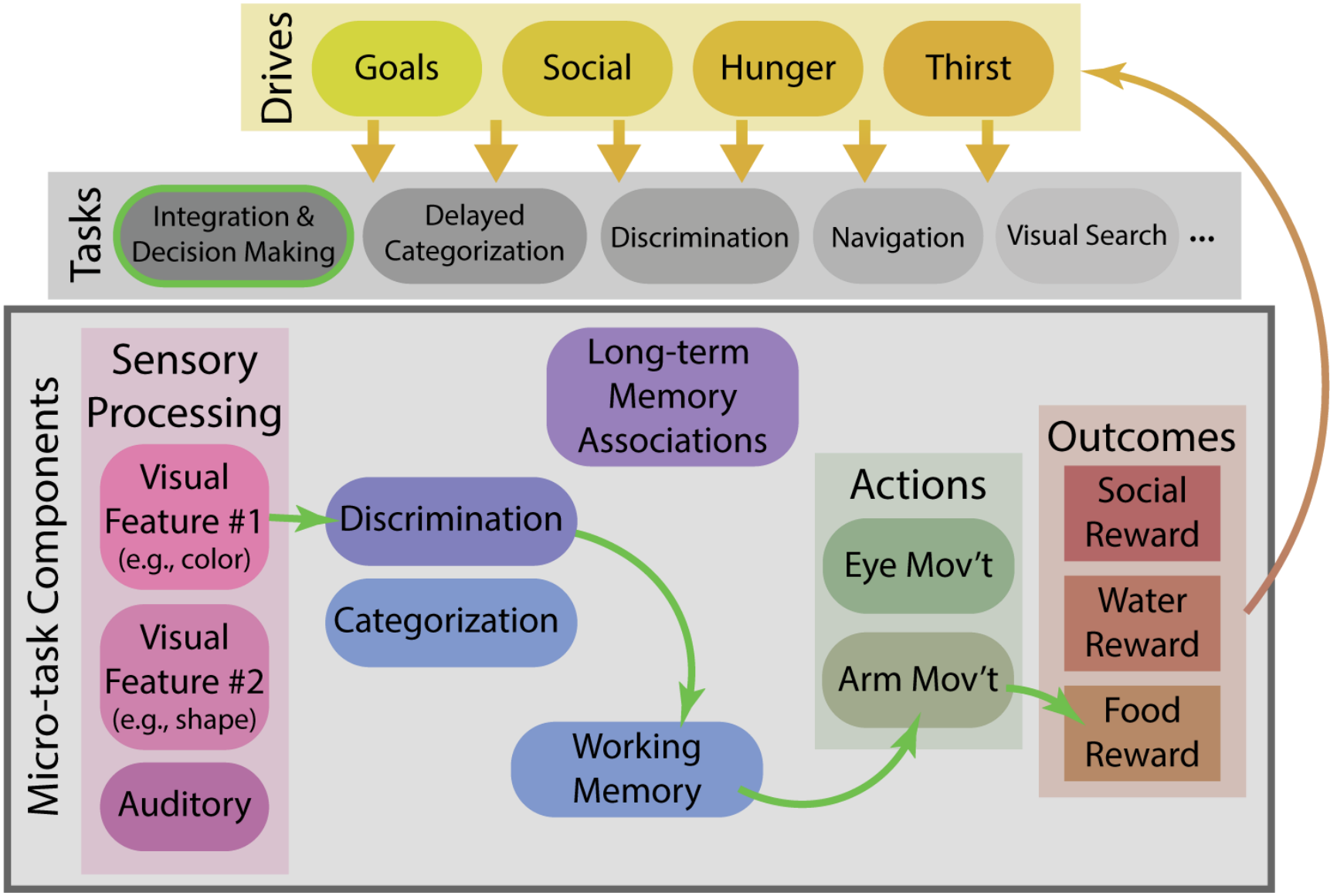




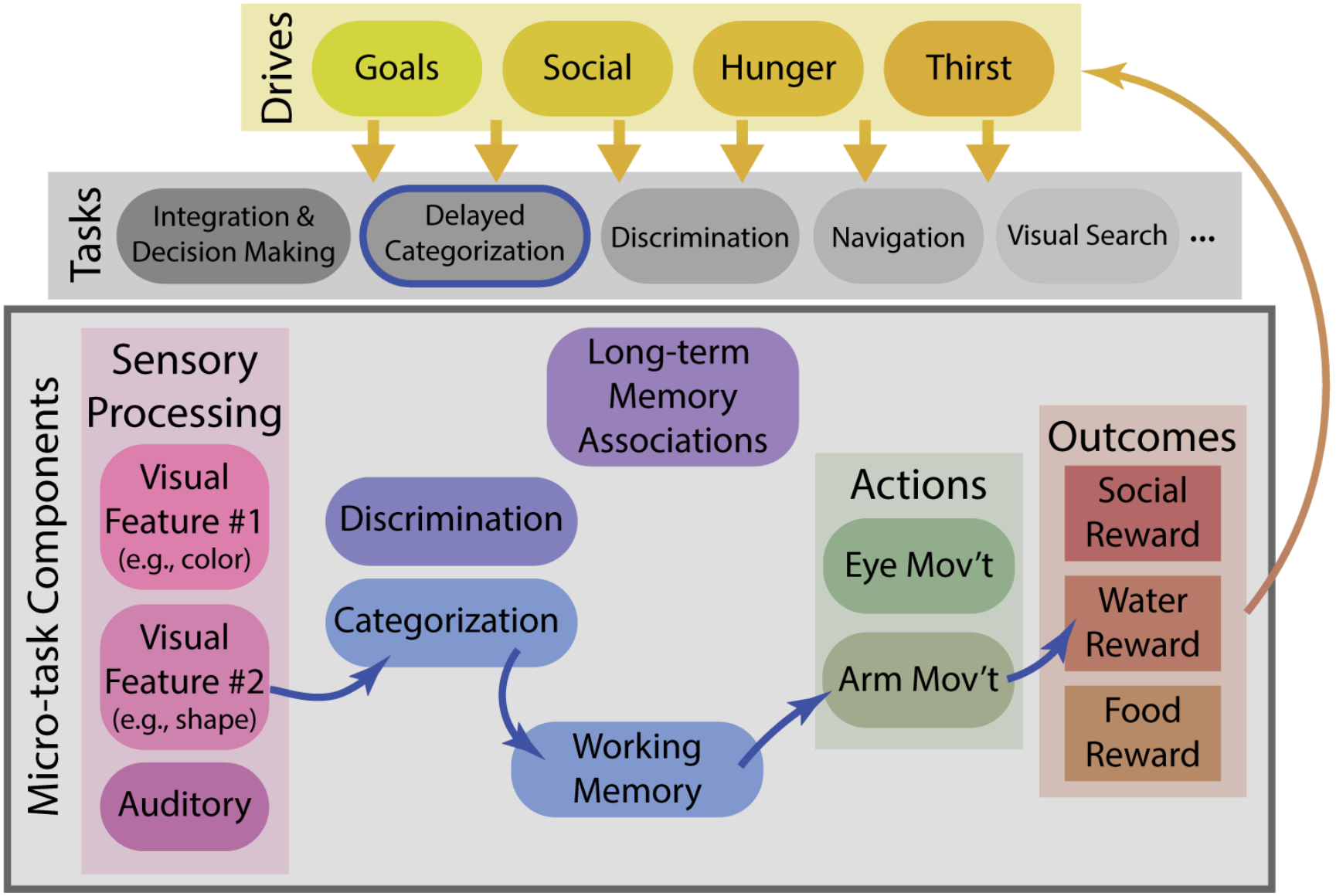
Cognition in the real world



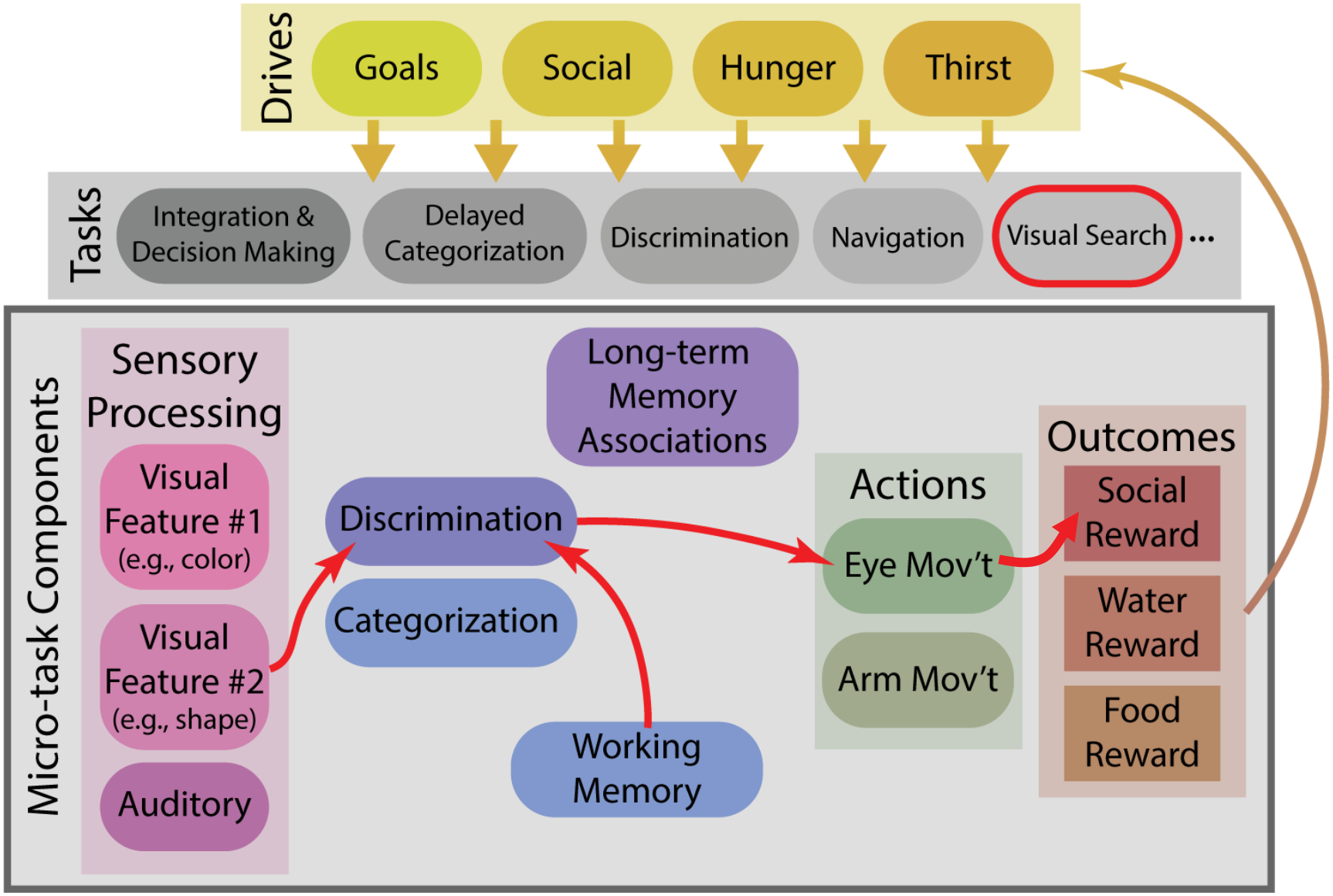
Cognition in the real world



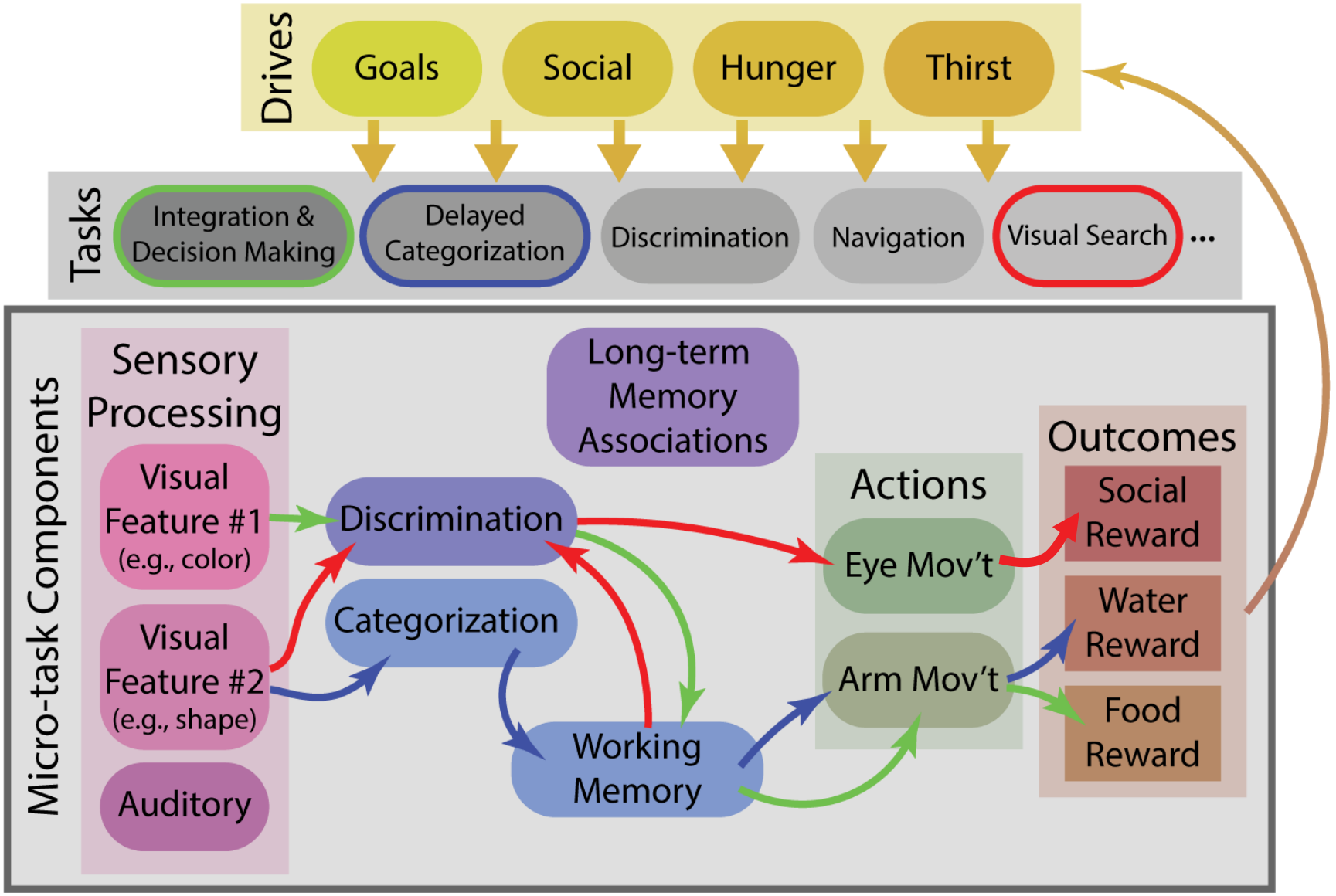
Cognition in the real world



Cognition in the real world



Cognition in the real world



Syllabus

1. **Introduction and History of Cognitive Neuroscience and Methods**
2. **Perception and Inference**
    1. Visual System + Constraint Satisfaction
    2. Associative Learning & Topography
    3. Efficient Coding
    4. Statistical Learning and Predictions
3. **Decision Making**
4. **Learning and Action**
    1. Cerebellum and Error-driven learning
    2. Reinforcement Learning
    3. Model-Free/Model-based Learning
    4. Dopamine + Basal Ganglia
    5. Motor System and Motor Cortex
    6. Explore/Exploit and the LC/NE System
    7. Distributed Representations + Semantics
    8. Bayes in the Age of Intelligent Machines
5. **Short-term and Long-term Memory and Sleep**
    1. Hippocampus + Navigation
    2. Complementary Learning Systems
    3. Non-monotonic Plasticity
    4. Sleep + Replay
    5. Attention, Control and Prefrontal Cortex
    6. Working Memory
6. **Cognitive Control**
    1. Representational Capacity Limits
    2. Higher-level cognition + Abstraction
    3. Optimization of Control
    4. Oscillations and Coherence
    5. Dynamics and Geometry of Control
    6. Neuroscience of Social Behaviors
7. **Disorders**
    1. Cognitive Neuropsychology
    2. Computational Psychiatry

Class Organization

- This is a pseudo team-taught course (similar to 501). Lectures will be given by PNI faculty with relevant expertise; one goal of this approach is to provide you with exposure to all faculty in the department (use this opportunity!).
- Schedule and syllabus are available online here. (https://princetonuniversity.github.io/NEU-PSY-502/)
- This is how the practical aspects of the course will be organized. The spreadsheet includes links to **PDFs of lectures and readings**.
- Readings will largely be drawn from original texts. But there are also a few foundation readings from textbooks (PDFs provided):
    1. Principles of Neurobiology by Liqun Luo; Garland Science
    2. Principles of Cognitive Neuroscience by Purves, Cabez, Huettel, LaBar, Platt, and Woldorff; Sinauer Associates
    3. Principles of Neural Science, $4^{th}/5^{th}$ Edition by Kandel, Schwartz, and Jessel, McGraw-Hill

Grading

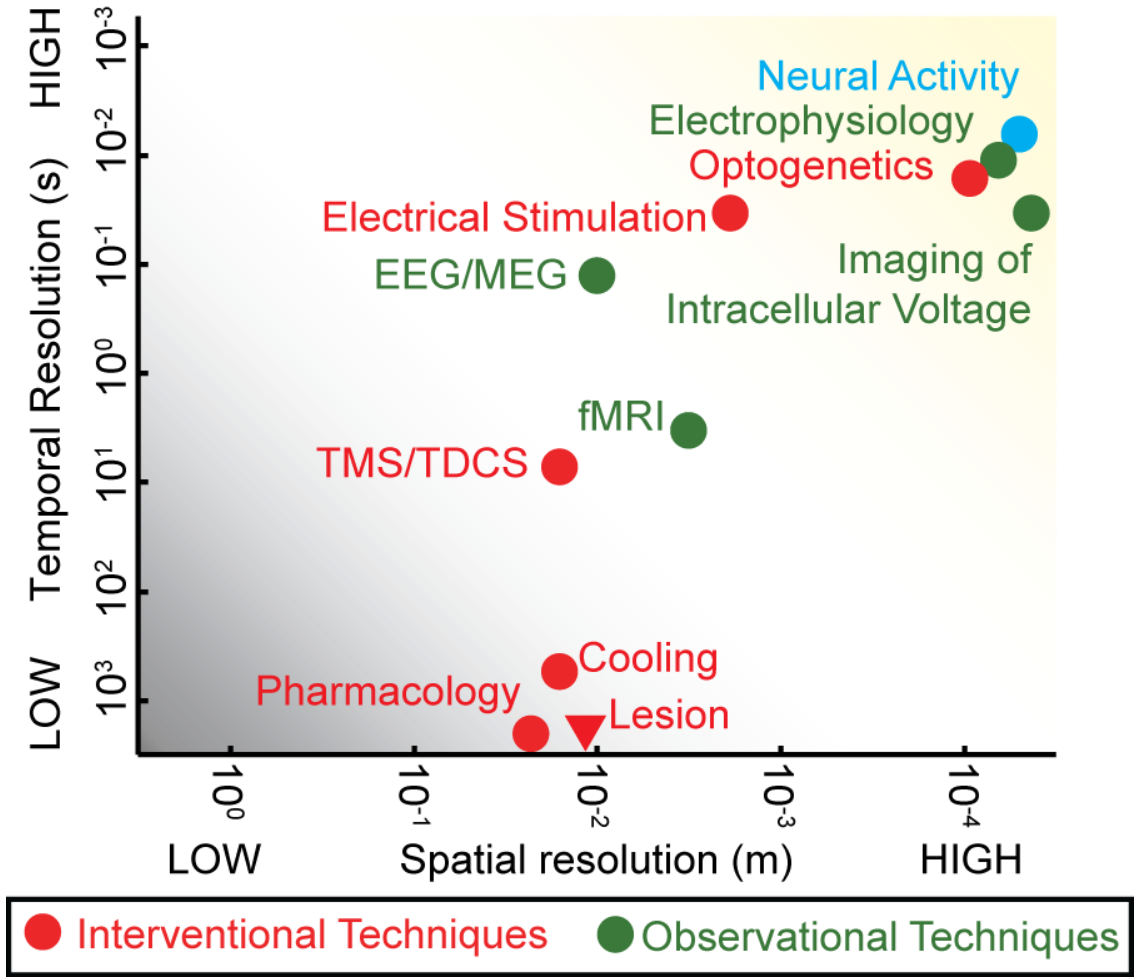
50% **Paper Presentations**

50% **Class participation**

- Students will receive a participation grade based on attending class and participating in the discussion.

History and Methods of Cognitive Neuroscience

Spatial and Temporal Resolution of Observation and Intervention Techniques



Levels of Investigation