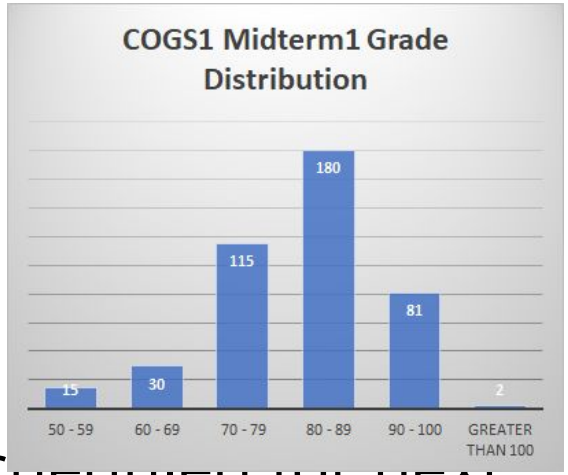
COGS 1: Spring 2019

Section **D**, Week 5

Professor Boyle	*mboyle@ucsd.edu*	Friday, 2-4 pm	CSB 130
Lauren	*lcurley@ucsd.edu*	Tuesday, 10-11 am	CSB 225
Lexi D.	*adalenco@ucsd.edu*	Tuesday, 12:30-1:45 pm	Sun God Lounge
Elena	*edreisba@ucsd.edu*	Thursday, 1-2 pm	CSB 114
Adrian	*ajm033@ucsd.edu*	Wednesday, 5-6 pm	CSB 114
Audrey	*aberardi@ucsd.edu*	Tuesday, 4-5 pm	CSB 114
Devansh	*d4agarwa@ucsd.edu*	Monday, 4-5 pm	CSB 114
Lori	*rol044@ucsd.edu*	Monday, 10-11 am	CSB 114
Lexi F.	*adfrankl@ucsd.edu*	Thursday, 4-5 pm	CSB 114

Important Information

- **Midterm 1**
  - Grades have been released
  - See your TA if you don't see a grade

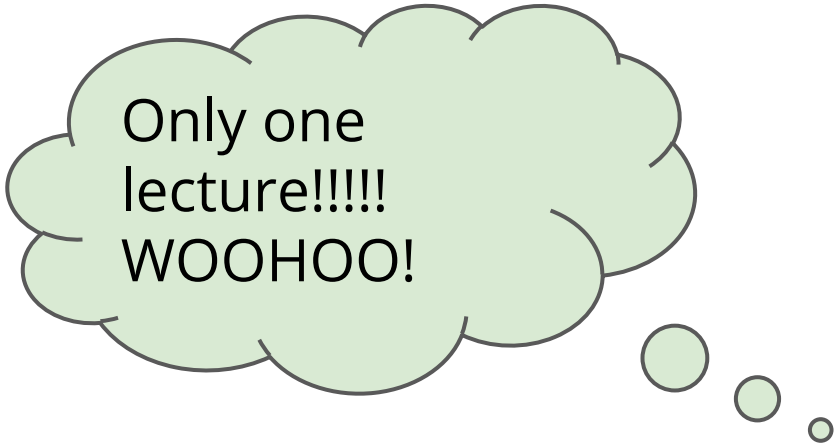


Happy Cend of) Week 5!

- **EC Reading Quiz**
  - We don't currently have an EC quiz scheduled for next week, but keep an eye out for an announcement just in case :)

Last Week's Topics

- Lecture 7 | Dr. Nitz: Mapping Space in the Brain



Lecture 7 | Review Questions (1 of 3)

Vote!!

1. What are the rules for mapping space in the brain?
2. Why are animal models (rats) used to study spatial cognition?
3. What is a cognitive map? How does it facilitate navigation?
4. Understand the function that each of the following type of cells has
    a. Place cells
    b. Grid cells
    c. Head direction cells
    d. Goal direction cells
    e. “Axis-tuned” neurons
5. In what animals and what brain region have (i) place cells, (ii) grid cells, and (iii) goal direction cells been found by researchers?

Reading | Review Questions (2 of 3)

Vote!!

6. When do the “goal-direction cells” fire? Examples?
7. What is the evidence for the statement: “ goals in the bat hippocampus are not merely sensory-based, but memory-based”?
8. What are the characteristics of “axis-tuned” neurons?
9. What is characteristic of encoding in the hippocampus?
10. Who are the Mosers? What is their contribution to understanding spatial navigation from a neuroscience perspective?

Reading | Review Questions (3 of 3)

Vote!!

11. What are the strategies animals use to navigate?
12. What are the cognitive maps? How do the maps help animals find their way?
13. What is the relationship between CA1 and entorhinal cortex? What are the differences?
14. Understand the sequence of the discovery of the different cell types that help animals to navigate. How do these cells coordinate to facilitate spatial navigation?

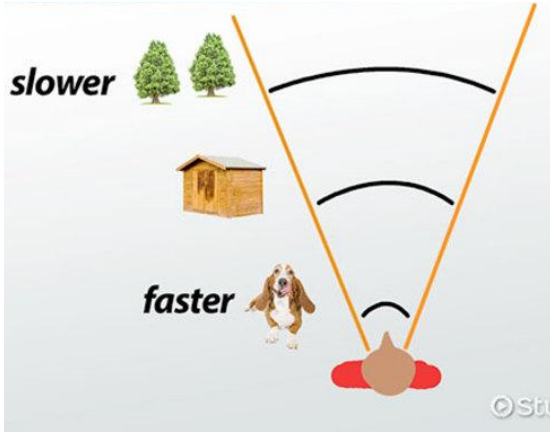
1. What are the rules for mapping space in the brain?

Depth Perception

KEY IDEA: Use of visual cues to "decode" important features of the environment

- Motion Parallax
- Texture Gradient
- Occlusion
- Retinal Disparity

(enables stereopsis)

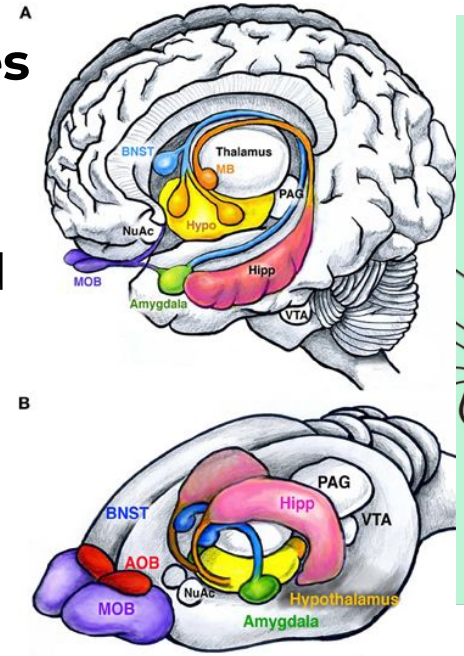


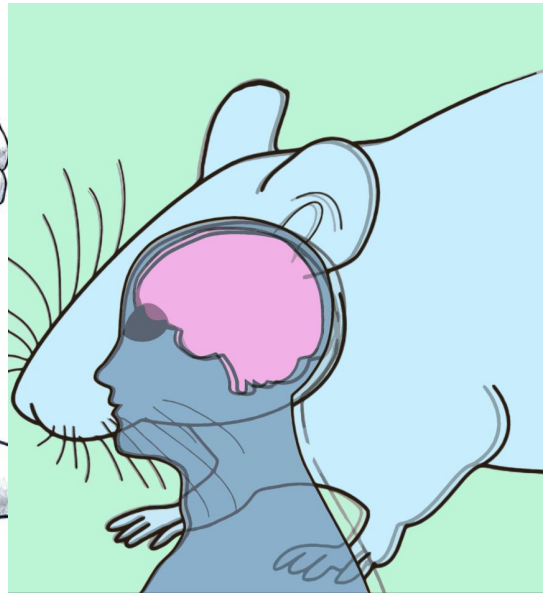
All Ques.

2. Why are animal models (rats) used to study spatial cognition?

Advantages of Animal Models

- **Similar navigational strategies**
  - Graph Theory
- **Brain Structure**
  - Cerebellum well-developed
  - Similarly detailed cortical structure





All Ques.

3. What is a cognitive map? How does it facilitate navigation?

Cognitive Maps

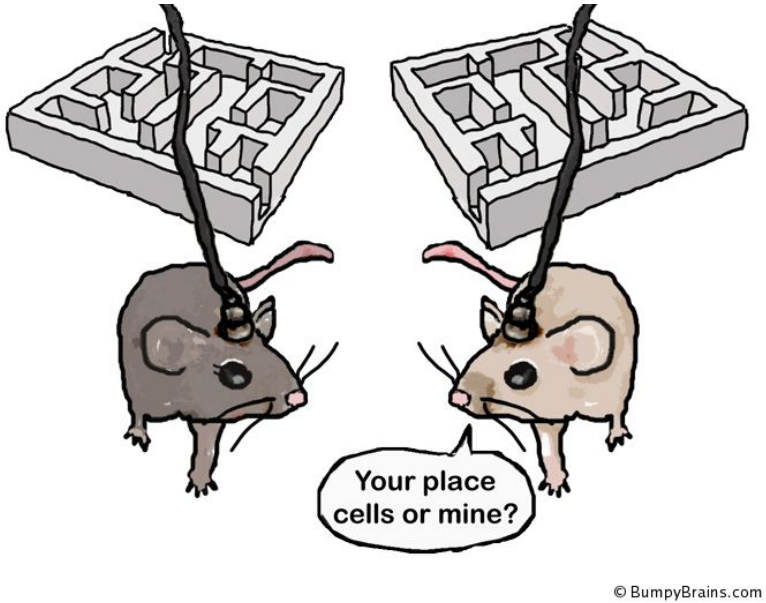
- Mental “map” / construction of the surrounding environment
  - Works in conjunction with memory ⇒ “automate” navigation

All Ques.

4. Function of Place Cells

Place Cells

- Tuned to the position of animal in the environment
- Different neurons → different directions (all directions)
- Rotation of the environment = rotation of the place fields

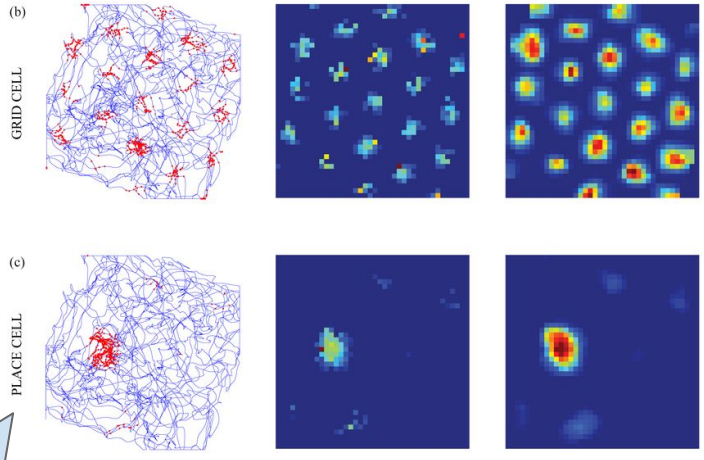


All Ques.

4. Function of Grid Cells

Grid Cells

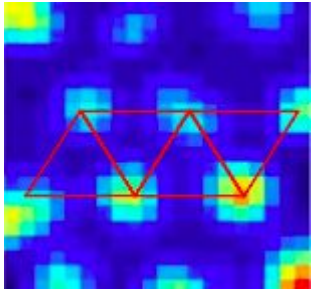
- Cells in **medial entorhinal cortex** (MEC)
- Superimpose “coordinate system” onto environment - - nodes arranged in shape of ‘tessellated’ triangles
- Firing fields ⇒ rotate w/ boundaries of the environment



All Ques.

Place cells vs. grid cells - what differences do you notice?

‘Tessellated’ triangles

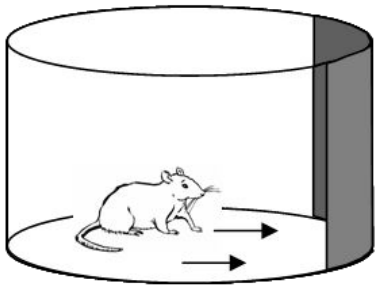


4. Function of Head Direction Cells

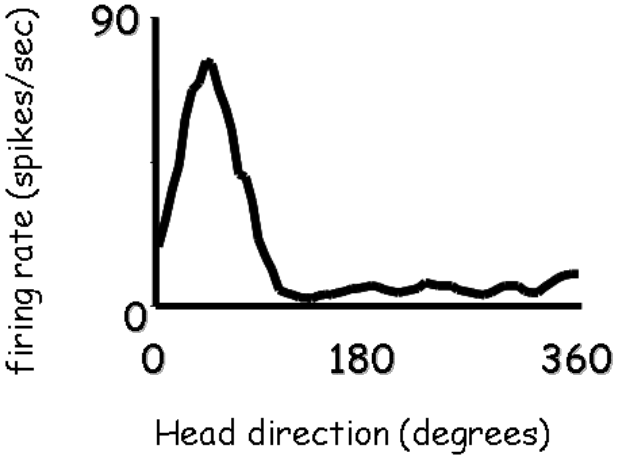
Fire when the animals head is pointing in a particular direction.

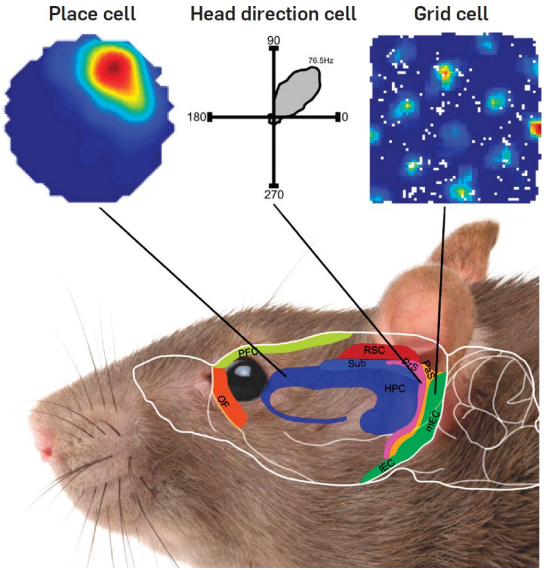
E.g: in where the animal is moving.

Different neurons → different preferred directions (all directions are represented)



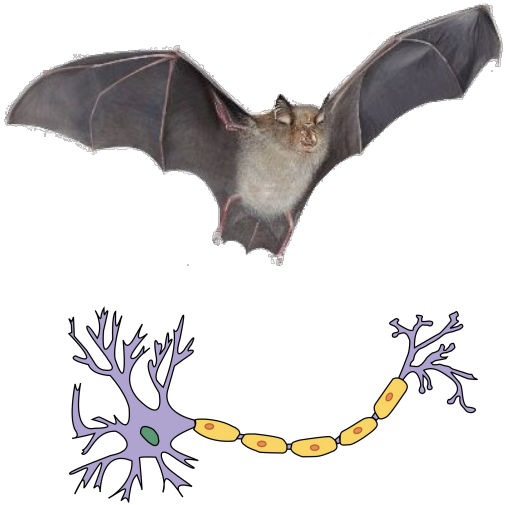
All Ques.



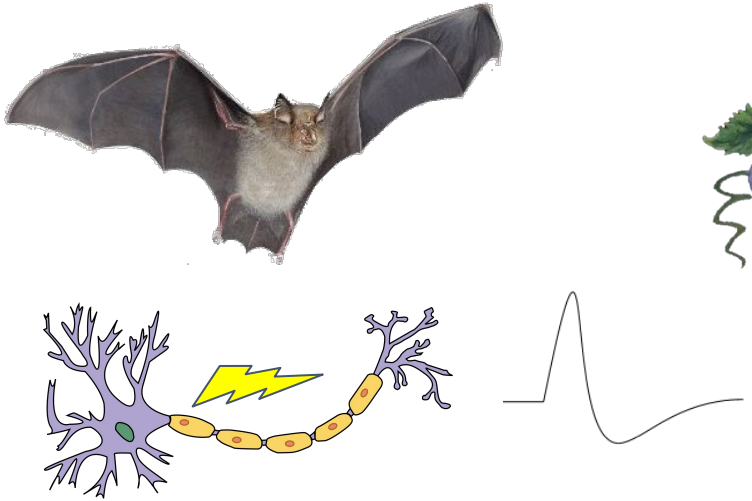


4. Function of Goal Direction Cells

Goal direction cells represent the goal and fire when the animal is close to it



Goal is far away;
Goal direction cell doesn't fire

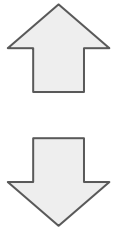


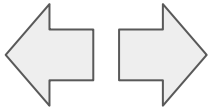
Goal is nearby;
Goal direction cell fires

All Ques.

4. Function of “Axis-Tuned” Neurons

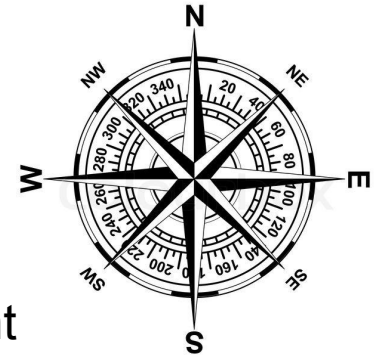
Active in Orientations 180° Apart





Cells fire

Cells are silent



Distinction from head direction cells?

All Ques.

Don’t fire when animal is foraging in open space!

5. In what animals and what brain region have (i) place cells, (ii) grid cells, and (iii) goal direction cells been found by researchers?

	Place cells	Grid cells	Goal Direction cells
Brain area?	**Hippocampus** (O'Keefe & Dostrovsky 1971)	**Entorhinal cortex** (Mosers 2015)	**Hippocampus** (Sarel, Finkelstein, Las, and Ulanovsky 2017)
Animal?			

All Ques.

6. When do the “goal-direction cells” fire?
From “How do brain cells tell us where we are going”

Experiment

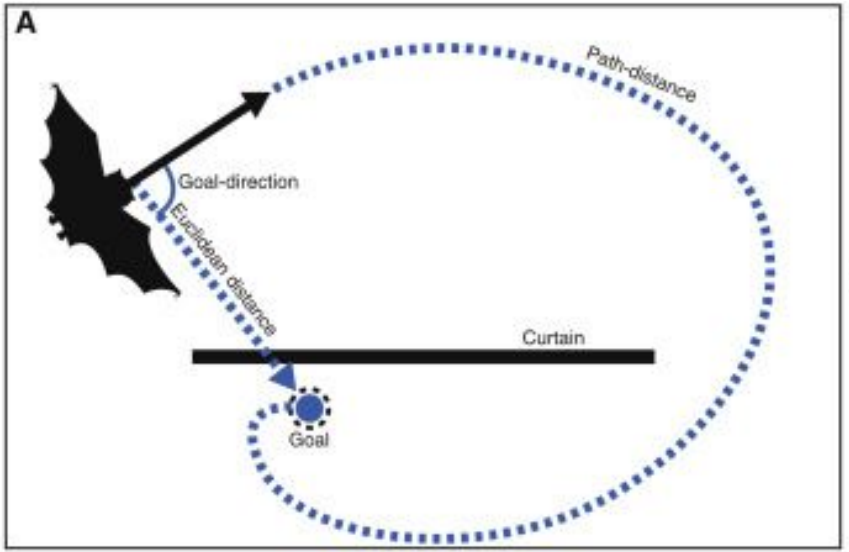
- Egypt fruit bats
- Record hippocampal neurons
- ⅓ → place cells
- 58 neurons → only when the bats were flying directly toward the landing site

All Ques.

7. What is the evidence for the statement, “Goals in the bat hippocampus are not merely sensory-based, but memory-based”?

Evidence:

Goal-direction cells **fired when the landing site was hidden** → (i.e. when there was a lack of any sensory input) → it was concluded that these cells are **memory based**

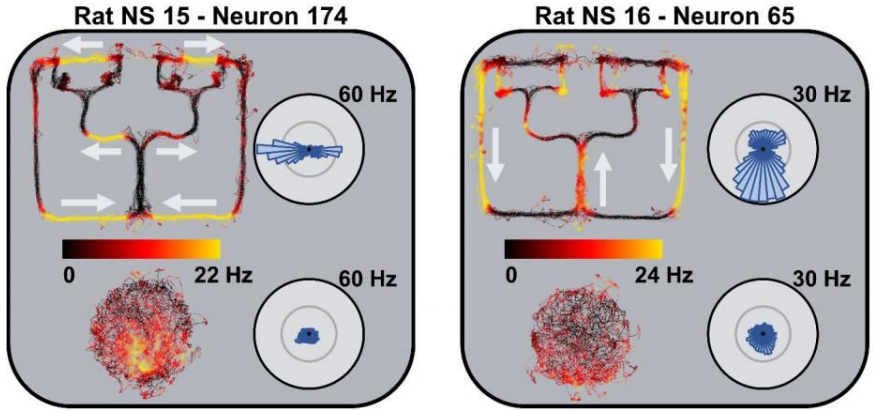


All Ques.

8. What are the characteristics of “axis-tuned” neurons? From “How do brain cells tell us where we are going”

Experiment

- 47 out of 542 were strongly tuned to a specific axis
- E.g. only fire when travel from north to south and south to north



All Ques.

9. What is characteristic of encoding in the hippocampus? From “How do brain cells tell us where we are going”

Related Experiments

- Olson ⇒ **axis-tuned** neurons
- Sarel ⇒ **goal-direction** cells
  - Also, another subpopulation of hippocampal neurons calculate and encode the distance
- Spiers ⇒ **distance** and **route** encoding in hippocampus

All Ques.

10. Who are the Mosers? What is their contribution to understanding spatial navigation from a neuroscience perspective?

May-Britt and Edvard Moser

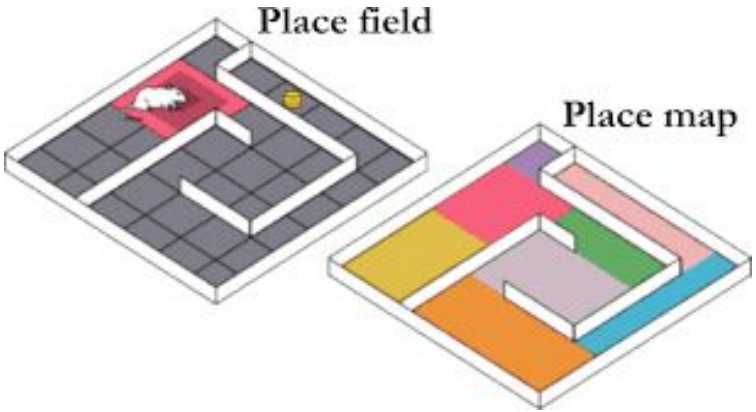
- Discovered grid cells
- Worked in O'Keefe's lab (discoverer of place cells)
- 2014 Nobel Prize in Physiology or Medicine

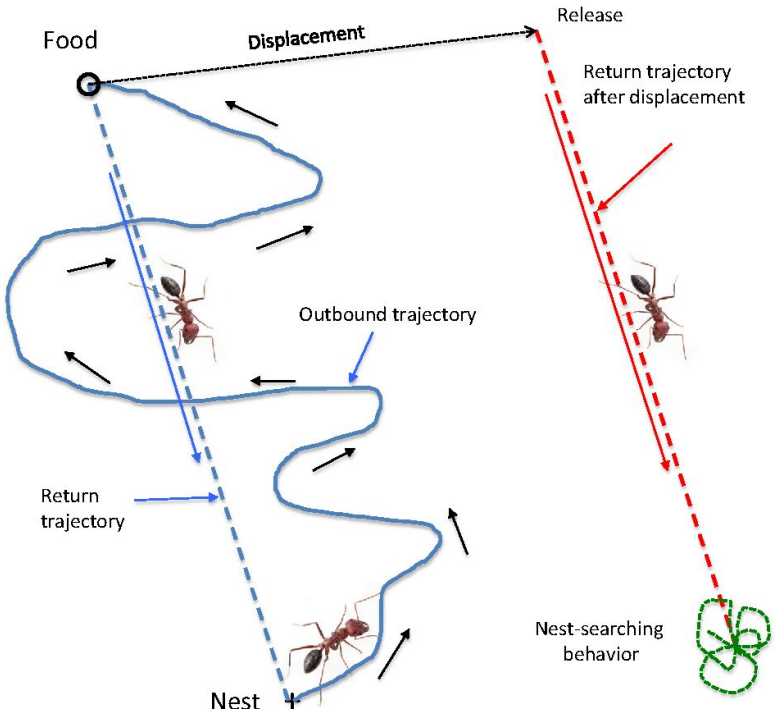
All Ques.

11. What are the strategies animals use to navigate? From “Where am I - Where am I going”

Strategies:

- Roundworm: Olfactory signals (odor gradient)
- Honey bees: path integration
- Mammals: neural maps



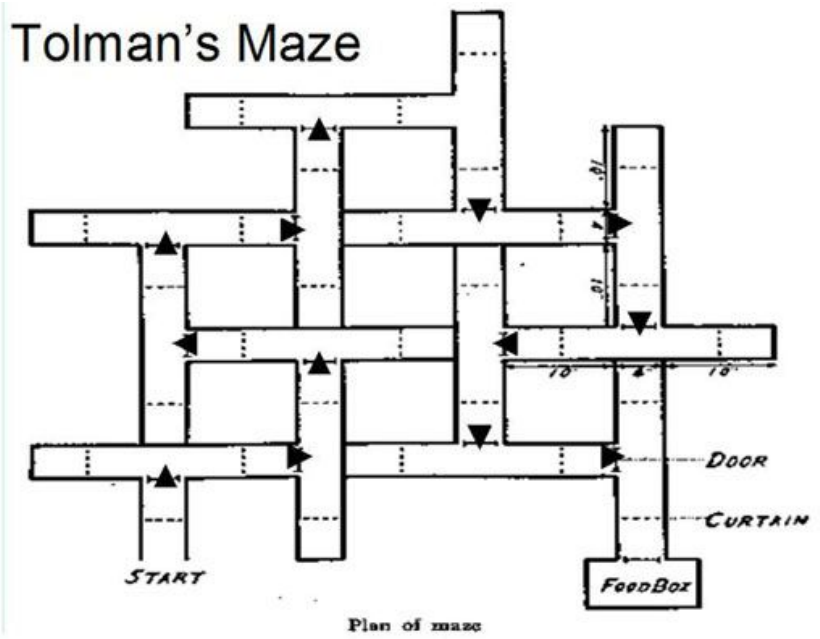


All Ques.

12. What are the cognitive maps? How do the maps help animals find their way? From “Where am I - Where am I going”

Experiment

- Tolman
- Rats took shortcuts or made detours → cognitive maps?
  - Find routes
  - Record info experienced at specific locales



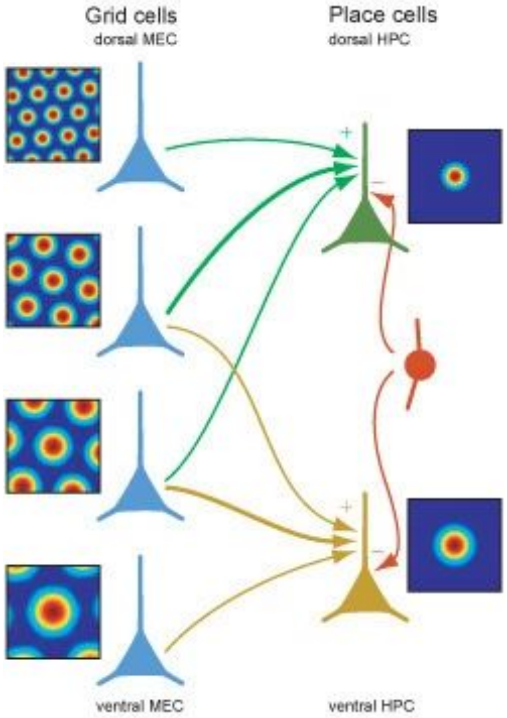
All Ques.

13. What is the relationship between CA1 and entorhinal cortex? What are the differences? From “Where am I - Where am I going”

Experiment

- Place cells → CA1
- Many cells in entorhinal cortex
  - Fire when an animal was at a particular spot in the enclosure (like place cells)
  - Fire at many locations a rodent visited (unlike place cells)

All Ques.



14. Understand the sequence of the discovery of the different cell types that help animals to navigate. How do these cells coordinate to facilitate spatial navigation?

1. *Tolman* → cognitive maps
2. *O'Keefe* → place cells in CA1
3. *Ranck and Taube* → head direction cells
4. *Mosers* → grid cells
    a. Entorhinal cortex
    b. Hexagonal pattern of firing
    c. Size of hexagon ↑ moving toward ventral part
5. *Mosers* → speed cells
    a. Firing rates increase in proportion to the speed of movement

All Ques.

Quiz Time!

- No talking, signaling, or communicating of any kind.
- Put away your books, notes, computers, phones, etc.
- Pen or pencil is okay (just make sure it's a black pen and you press hard with a pencil).
- Write your name in the "Name" box, write and circle in your PID, and sign the academic integrity agreement.
- Bubble in this section
- Please have your student ID out when you turn in your quiz!

Write and circle in your PID

Write down your name here

UC SAN DIEGO – DEPARTME OF COGNITIVE SCIENCE

STUDENT PID NUMBER								
A/U								
[0]	0	0	0	0	0	0	0	0
[1]	1	1	1	1	1	1	1	1
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Last NAME, First NAME
COURSE NUMBER
COGS 1
SPRING 2019
Dr. Mary ET Boyle
Quiz A
April 9-12, 2019
Quiz VERSION

A	B	C	D	E	F	G	H
■	B	C	D	E	F	G	H

Section you are taking this quiz:
Please Bubble only one!
[1] 1 Monday @ 9 Lexi D.
[2] 2 Monday @ 4 Elena
[3] 3 Wednesday @ 2 Adrian
[4] 4 Wednesday @ 3 Audrey
[5] 5 Wednesday @ 5 Devansh
[6] 6 Friday @ 11 Lori
[7] 7 Friday @ 12 Elena
[8] 8 Friday @ 1 Lexi F.

Bubble in the current section

Quiz will not be graded without Academic Integrity Signature.

ACADEMIC INTEGRITY

By taking this quiz, you agree that you will follow ALL UCSD ACADEMIC INTEGRITY policies.
It is YOUR responsibility to know and understand all of the policies.
Failure to follow all UCSD Academic Integrity policies could result in expulsion from UCSD.
DO NOT DISCUSS THIS QUIZ CONTENTS WITH FELLOW STUDENTS!!!

Signature Date

Your **signature above certifies** that you *will follow* and that you know that you will suffer the consequence for ANY academic integrity violation.

Sign and date here

YOUR ANSWERS GO HERE

	[A]	[B]	[C]	[D]	[E]
1	A	B	C	D	E
2	A	B	C	D	E
3	A	B	C	D	E
4	A	B	C	D	E
5	A	B	C	D	E
6	A	B	C	D	E
7	A	B	C	D	E
8	A	B	C	D	E
9	A	B	C	D	E

Bubble in the answers