

## Station 1: Formation of spatial memories

### Part 1: Drawing a scene (Spatial STM)

Set up a random arrangement of several objects (e.g. pen, water bottle, scissors) on the table in front of the students. After a short time for viewing, hide the objects and ask students to write down the order of the objects from memory.

#### Talking Points

- *“What strategies or methods do we use to accomplish this spatial task?”*
- *“When do you have to do something like this in the real world?”*
  - *Ex. Putting things back on a shelf, finding a car in a parking lot*

### Part 2: Drawing a map of school (Spatial LTM)

Ask students to draw a map of the school to the best of their ability. Note the relative orientation of and distance between buildings, and have them add descriptive labels to the map.

#### Talking Points

- *“Did you ever specifically try to form this memory? If not, how did it form?”*
- *“How are the strategies or methods that we use to accomplish this spatial task that are DIFFERENT from the previous task? What does this suggest about the role of memory in these tasks?”*
- *“When do you have to do something like this in the real world?” Ex. Getting to a store from “YOU ARE HERE” on a mall map*

## Station 2: Spatial memory recall and the brain

### Part 1

Show students a video of the London taxi cab driver studies. Pause at appropriate times to talk about the diagrams/fMRI images of the hippocampus, to reinforce the idea that physical changes in the hippocampus underlie the behavior.

#### Talking/Stopping points

- *Spatial memory is done in the hippocampus (~ 0:55). To be more specific, the hippocampus gets denser and bigger in cab drivers than normal people. This is an example of plasticity (i.e., your brain anatomy changing when you learn something)*
  - *Just by looking at the brain, scientists can predict whether someone is/was a cab driver*
- *6 hours of training for 3 years to memorize 25,000 streets! (~1:30)*
- *Why might it be harder for the cab drivers to learn new routes? (~2:20)*

### Part 2

Ask students to navigate with their eyes closed from the classroom to the end of the ramp outside of the portable (where we come in). Walk with the students to make sure they don't hurt themselves.

#### Talking Points

- *How is this similar to what taxi drivers have to do?*
  - *Requires a mental map, with real-time updating of position in the map*
- *How might it be different?*
  - *No visual cues for reminders, requires the mental map to be more detailed*
- *How do you think your hippocampi compared to those of the taxi drivers?*
  - *It's smaller and less dense. Probably.*
- *How do you think GPS and smartphones have affected people's hippocampi??? Debate!*

## Station 3: Animal tests of spatial memory

### Part 1

Show students videos of the Morris water maze, radial arm maze, and Barnes maze (e.g. <http://www.jove.com/science-education/5418/spatial-memory-testing-using-mazes>, but can't download).

### Talking Points

- *What's important about spatial memory?*
- *How might we study it in a lab? Has anyone ever seen cartoons of rats in a maze? (Start video at 2:23 for Morris Water Maze, 5:00 for Barnes maze.)*
- *Why do we do the 'reference' trials that the video mentions?*
  - *Figure out if the rat can cheat, figure out if*
- *Applications*
  - *Is it possible that some people are genetically better at spatial tasks?*
  - *Are specific areas of the brain dedicated to spatial tasks?*
  - *Can chemicals affect spatial processing?*
    - *Alcohol...*

### Part 2

Go through the Money Road Map Test (basically a maze on paper for humans). Explain to them that Mr. Kenan is lost in downtown and takes a very circuitous route to get to the Rockets game. Ask them to pay attention to the route as you trace a prescribed path through the blank grid. Then ask them to help retrace his steps so that he can get back to the Metro - pause at (each) intersection to ask them "Right, Left, or Straight?" (for reference <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0060885> Fig 3)

### Talking points

- Circuitous route: Go north take a left on South Right Street, Go up the hill to Down Avenue, turn left at the corner of Circle Square, Then right on the left of Plane, Take left hand fork at Spooner Road, Then Easy Avenue to Harden Boulevard, Turn back to the left on Right Front Street, Then it's right down there on your left
- What could we test with this technique?
  - AD progression, differences between different groups (cab drivers, boys vs. girls, athletes vs. video game players, etc.)

## Station 4: Spatial memory and aging/AD

### Part 1

Ask students if they know anyone who has AD. Describe the symptoms, especially in terms of spatial memory deficits, in AD. (No need to go into the pathophysiology, other than perhaps that neuronal loss leads to reduction in brain volume).

#### Talking Points

- Does anyone know a person with AD or dementia? What are the symptoms?
  - Short term memory loss, language problems, mood swings, loss of motivation, long term memory loss, loss of bodily function
- What problems do these people have with spatial memory?
  - AD and dementia patients are substantially more likely to get lost, particularly in new environments. 6 in 10 will 'wander', which means becoming disoriented and lost.
  - When spatial navigation goes, it often is the point that patients must be moved into an assisted living situation for safety reasons
- Knowing this, what can we do to help
  - Long term memory for AD patients follows a 'Last in, first out' model. The oldest memories are the last to go.
  - Keeping spaces either simple or very similar to what they have lived in is critical for the wellbeing of patients

### Part 2

Have students play the Monkey Ladder Test online. Ideally, we will have multiple computers set up so that multiple students can play at the same time. Record each student's average score and plot as a bar graph.

#### Talking Points

- How do you think AD patients would fare in this test? Why?
- Ask students to draw in the bar for early and late AD patients.
- Brain exercises like this (along with active living) can be helpful for early stage AD patients. Continuing to use your mind slows (but unfortunately does not stop) mental decline

### Extension (if necessary)

Restoring memories in AD with optogenetics - Tonegawa paper from last week.