Chapter 6: Hippocampal Function In Cognition

From *Mechanisms of Memory*, second edition
By J. David Sweatt, Ph.D.
Grid Cell
The Hippocampus Serves a Role in Multimodal Information Processing and Memory Consolidation
Functions of the Hippocampus

- Cognitive Processing:
  - Space
  - Timing
  - Relationships

- Memory Consolidation
Hippocampal Connectivity in the CNS
Theta Pattern in Hippocampal EEG
Functions of the Hippocampus

- Cognitive Processing:
  - Space
  - Time
  - Relationships
MRI of Hippocampus

fMRI in Virtual Maze Navigation

Morphometry of London Taxi Drivers

Right Posterior Hippocampal Volume Correlates with Time Spent Driving

Hippocampal Output Pathway & Intrinsic Circuit

A

Entorhinal Cortex

Dentate Gyrus

CA3

CA1

Subiculum/Entorhinal Cortex

Amygdala, Cortex

Lateral Septum

B

CA1 Axon

GABAergic Interneuron

Norepinephrine

Acetylcholine

Serotonin

Schaffer Collaterals

CA1 Outputs

C

Entorhinal Cortex

Schaffer Collaterals

CA3

CA1

Norepinephrine

Acetylcholine

Serotonin

Schaffer Collaterals
Hippocampal Output Pathway & Intrinsic Circuit

A

Entorhinal Cortex

\[\downarrow\] Perforant Pathway

Dentate Gyrus

\[\downarrow\] Mossy Fibers

CA3

\[\downarrow\] Schaffer Collaterals

CA1

Subiculum/Entorhinal Cortex

Lateral Septum

Amygdala, Cortex

B

Entorhinal Cortex, CA1 Outputs

C

GABAergic Interneuron

Norepinephrine

Acetylcholine

Serotonin

CA1 Axon

Schaffer Collaterals
Comparative Views

Figure 3
Place Cell Firing Patterns
Types of Rodent Mazes

- Lashley Maze
- 4 Arm Radial (Plus) Maze
- 8 Arm Radial Maze
- Triangle Maze
- “T” Maze
- “Y” Maze
Direction Selectivity in Place Cell Firing
Types of Rodent Mazes

Lashley Maze

4 Arm Radial (Plus) Maze

8 Arm Radial Maze

Triangle Maze

“T” Maze

“Y” Maze
Rotation of Visual Cues

Figure 7

Rotation of Visual Cues 90°
Place Cells Fire in Corresponding Location
Experience-Dependent Changes in Place Cell Firing

Figure 9
Functions of the Hippocampus

- Cognitive Processing:
  - Space
  - Timing
  - Relationships
Eye-Blink Conditioning in Rabbits

Corneal Air Puff Elicits Eyeblink Response

Corneal Air Puff Given with Tone

Tone Given Alone Elicits Eyeblink Response
Increased Hippocampal Neuron Firing during Trace Eyeblink Conditioning
Increased Connectivity in Pyramidal Neurons with Eye-blink Conditioning

Figure 11
Functions of the Hippocampus

• Cognitive Processing:
  Space
  Time
  Relationships
4-arm Radial Maze with Local and Distal Cues
Double Rotation 4-arm Maze Experiment
Continuous Odor-guided Non-Matching to Sample

Test 1: Odor A

Test 2: Odor B
Nonmatch = Food Reward

Test 3: Odor B
Match = No Reward
Task Related Firing Patterns of Hippocampal Pyramidal Neurons

- **Panel a**: Graphs showing firing rate (Hz) for different trial types (M, NM) across positions (P1 to P9). Error bars indicate variability.

- **Panel b**: Similar to Panel a, but with graphs for different positions (P1 to P9) across trial types (M, NM).

- **Panel c**: Graphs showing firing rate (Hz) for different trial types (M, NM) across odours (O1 to O9). Error bars indicate variability.

- **Panel d**: Graphs showing firing rate (Hz) for different odours (O1 to O9) across time (s), with examples of firing patterns for positions (P1 to P9).
Functions of the Hippocampus

- Cognitive Processing:
  - Space
  - Time
  - Relationships
Arc and Cellular Reactivation

Blue Box 2
Grid Cells in the Entorhinal Cortex
Functions of the Hippocampus

- Cognitive Processing: Space, Time, Relationships
- Memory Consolidation
Human Studies
MRI of HM’s Brain lesions

Surgeon’s Estimate of H.M.’s lesions

Revised Estimate based on MRI
Functions of the Hippocampus

- Cognitive Processing:
  - Space
  - Timing
  - Relationships

- Memory Consolidation