**Instructor’s Manual**

to accompany

*Cognition,* First Edition

Chun • Most

**Chapter 7**

***Memory Systems***

**CHAPTER OUTLINE**

7.1 Memory Systems

* Think for Yourself 7.1: *Amnesia in the Movies*
* Explicit Memory
* Think for Yourself 7.2: *Alzheimer’s Disease*
* Implicit Memory
* See for Yourself 7.1: *Mirror-Reversed Words*

7.2 Memory Encoding, Storage, and Retrieval

* See for Yourself 7.2: *A Simple Memory Test*
* Distinguishing Long-Term Memory from Short-Term Memory
* Distributed Representation and Reactivation of Memories
* The Hippocampal System Associates Information to Form New Memories
* The Neural Mechanisms of Encoding
* Storage and Consolidation in the Brain
* Think for Yourself 7.3: *The Importance of Sleep*
* Neural Retrieval and Reactivation
* Think for Yourself 7.4: *Population Coding Increases Brain Capacity*
* Think for Yourself 7.5: *Stress and Memory*

7.3 Spatial Memory

* Cognitive Maps
* Spatial Frameworks

**LEARNING OBJECTIVES**

7.1 Discuss the roles of different types of memory systems, including explicit and implicit memory, in human memory function.

7.2 Describe how the brain distinguishes long-term versus short-term memory, and how it encodes, stores, and retrieves memories.

7.3 Discuss how spatial memory functions and its role in navigation.

**DISCOVERY LABS**

**The Brown–Peterson Paradigm**

In this experiment, students explore how storing even a small amount of information is difficult if they are unable to rehearse it. Participants are shown a series of consonants before solving a series of math problems. Afterward, they are asked to recall the three consonants.

Approximate completion time: 30 minutes.

**Serial Position Effect**

Students explore the notion that individuals use maintenance rehearsal for material they need to keep in short-term memory, and that following sufficient rehearsal, that material becomes part of long-term memory. Participants are shown a series of words and then must try to recall as many of the words as they can in the order they were seen.

Approximate completion time: 25 minutes.

**LECTURE TOPICS and CLASS DISCUSSION QUESTIONS**

1. Describe a movie with a character that suffers from memory loss. What kind of memory disorder was portrayed? Was it an accurate portrayal of the disorder?

2. Ask students to imagine living a day in the life of amnesic patients such as H.M. or Clive Wearing and discuss the implications of their disorders. You can also demonstrate this by role playing with students in a mock interview setting.

3. Who are some famous people who suffer from memory disorders such as amnesia or Alzheimer’s disease? How did their diagnosis affect their work and lives?

4. What is the difference between explicit and implicit memory? How about the difference between episodic and semantic memory? Give examples to illustrate your answer.

5. Ask students how much sleep they usually get and how much sleep they need to function well. Tie this into the discussion of sleep and memory.

6. What are the differences between anterograde and retrograde amnesia? What other types of memory disorders are there? How does this differ from dementia and Alzheimer’s disease?

7. What is the role of the hippocampus in storage of memory? Where are memories stored in the brain?

8. How is spatial memory important in our daily lives? Why do you think there is a correlation between spatial memory and STEM achievement?

**CLASSROOM ACTIVITIES**

1. Have students work in groups to write a short story about a character that suffers from anterograde or retrograde amnesia.

2. Play a video clip of an amnesia patient and ask students what kind of memory disorder or deficit the patient exhibits.

3. Ask a volunteer to assume the identity of an amnesic patient, such as H.M., and carry out a short conversation with a partner.

4. Give students a list of words to remember, then ask them to recall the list and examine whether they observe the serial position curve. Explain primacy and recency effects using the results.

5. Play a video of a scene and ask students to describe it using allocentric and egocentric spatial frameworks.

**SUGGESTED VIDEOS**

[Seeking Human Memory Sources](https://youtu.be/hPa7op84R30)(Patient H.M.)

This video shows the research that was conducted with amnesic patient H.M. when he was alive and after his death. H.M. suffered from anterograde amnesia due to an experimental brain surgery when he was 27 years old.

[What Happens when you Remove the Hippocampus?](https://www.youtube.com/watch?v=KkaXNvzE4pk) (TEDEd)

A cartoon illustration of H.M.’s life as a scientific contributor to memory research.

[The Man with The Seven Second Memory](https://youtu.be/k_P7Y0-wgos)(Patient Clive Wearing)

This is a documentary about amnesic patient Clive Wearing, who suffers from anterograde amnesia and partial retrograde amnesia due to encephalitis that led to brain damage.

[Patient K.C.](https://youtube.com/playlist?list=PLzLhVs1Z4UhDzQ68BskT8W9U6C2lP8TJ0) (Episodic amnesia)

This playlist of videos shows the original interviews conducted with patient K.C., who suffers from a loss of episodic memory due to a motorcycle accident.

[Serial Position Curve video](https://youtu.be/bFcemMf_SAw) (by Dr. Christie Chung)

This is a short video explaining the serial position curve and the underlying reasons for the primacy and recency effects.

[Types of Long-Term Memory](https://youtu.be/B2yGunJBDdo) (by Dr. Christie Chung)

This video introduces the different types of long-term memory and clearly demonstrates the differences between explicit versus implicit and episodic versus semantic memory.

[Inside Alzheimer’s Disease](https://youtu.be/zTd0-A5yDZI) (Nature Neuroscience)

This video explains the neurological changes that occur in Alzheimer’s disease.

[How Sleep helps Children Remember New Words](https://www.pbs.org/wgbh/nova/video/sleep-children-learn-remember-new-words/) (PBS)

This video shows how sleep helps children remember made-up words.

[Spatial Navigation](https://www.youtube.com/watch?v=94HekWSIqLM) (Neil Burgess)

Dr. Neil Burgess explains the neural basis of spatial navigation (place cells, head direction cells, and grid cells).

**SUGGESTED ONLINE RESOURCES**

[Alzheimer’s Disease Fact Sheet](http://www.nia.nih.gov/alzheimers/publication/alzheimers-disease-fact-sheet) *(*National Institute on Aging)

This website gives a comprehensive overview of Alzheimer’s disease and its symptoms.

[American Family Physician resources on dementia](https://www.aafp.org/afp/topicModules/viewTopicModule.htm?topicModuleId=5)

This page contains resources on dementia and memory disorders such as Alzheimer’s disease.

[Alzheimer's Association](https://www.alz.org/alzheimers-dementia/memory-loss-concerns?utm_source=google&utm_medium=paidsearch&utm_campaign=google_strategic_search&gclid=CjwKCAjwr_uCBhAFEiwAX8YJgfFVknwOaJgM4NZXsfqy937ioJjWW46q1MgxKhE5I9WC0VxxPoL5dhoCfFQQAvD_BwE)

Resources and checklists for people experiencing memory loss.

[United Brain Association](https://unitedbrainassociation.org/brain-resources/amnesia/)

An online resource for people looking for explanations of amnesia and associated symptoms.

[Memory Movies](https://www.ranker.com/list/best-movies-about-memory/ranker-film)

A list of movies (ranked) about memory.

[Lumosity Brain Games](https://www.lumosity.com/en/)

Daily exercises for your brain.

[Neurobics](http://www.keepyourbrainalive.com/)

Aerobics for the brain!

**ANSWERS TO CHECKPOINT QUESTIONS (from the textbook)**

**CHECKPOINT 7.1**

1. What is the distinction between explicit memory and implicit memory?

*Answer*: Explicit memory refers to memory that we can consciously and deliberately recall (e.g., what you had for breakfast this morning). Implicit memory includes more unconscious, non-declarative processes, such as procedural learning, priming, and emotional conditioning. A good example would be our ability to learn how to ride a bike over time, but one may find it difficult to put into words how each step of learning occurred.

2. Give some examples of episodic memory versus semantic memory.

*Answer*: Examples of episodic memory include what you did last weekend, what you had for dinner last night, and events that occurred during your high school graduation ceremony. Examples of semantic memory include the capital city of France, vocabulary, knowledge about the world, and what you learned in kindergarten and elementary school.

3. What is procedural learning? Give an example.

*Answer*: Procedural learning is a type of implicit memory through which you acquire skills and knowledge over time without conscious awareness of each step. A good example would be learning how to play a musical instrument or tie shoelaces.

4. What is priming? How can you distinguish between associative priming and perceptual priming?

*Answer*: Priming is a type of implicit memory through which reaction to a certain stimulus becomes faster or takes less cognitive effort due to prior exposure to the same or similar stimulus. Associative priming refers to priming that involves meaning or semanticity (e.g., reaction to the word pair nurse/doctor would be faster than bread/ doctor because the first pair contains words that are more semantically related than the second pair). Perceptual priming refers to faster reaction time due to the similarity between the prime and target stimuli, (e.g., ship/shop).

5. Describe an example of statistical learning or contextual cuing.

*Answer*: Statistical learning refers to humans’ ability to decode language faster due to the everyday learning of probability of how English words are constructed. For example, when reading a sentence such as “Cognitivepsychologyisfun,” people are much more likely to parse the sentence in a meaningful way and understand it to say “Cognitive psychology is fun” rather than any other way.

**CHECKPOINT 7.2**

1. How do you test for the serial position curve, and what explains the primacy effect and the recency effect?

*Answer*: You can use a serial-free recall test of a list of items to test for the serial position curve (i.e., the order of the presentation list is important for accurate recall performance). The primacy effect explains participants’ better recall of items in the beginning of the list, which is due to more time spent on rehearsing the beginning items that increased the likelihood of those items being transferred into long-term memory. The recency effect is the better recall of items that are at the end of a stimulus list, because those items are still being processed in short-term, working memory and can be easily accessed.

2. What is reactivation in memory?

*Answer*: Reactivation means that during retrieval of a memory, cognitive and perceptual experiences show patterns of activity similar to when one first encountered the event. For example, when thinking about a person you know, the face area of your brain will be reactivated. Likewise, the place area will be activated when you remember the last place you visited on a vacation.

3. Describe the roles of the hippocampal system and the neocortex in forming a complementary memory system.

*Answer*: The hippocampal system (hippocampus + medial temporal lobe) is activated when an event is first experienced and remembered. This system connects with the relevant cortical regions to create an integrated cognitive experience. Over time and practice, cortical regions become more active during the retrieval process as these memories are now strengthened and stored permanently. The hippocampal system is activated in the retrieval process early on but becomes less active as the neocortex becomes more active over time. These two systems form a complementary memory system to allow experiences to be remembered quickly but also stored for long-term use.

4. How does the subsequent memory paradigm work, and what does it tell us about how the brain encodes and retrieves memories?

*Answer*: The subsequent memory paradigm suggests that the brain activity pattern associated with items that are remembered on a memory test involves many more brain regions than items that are not remembered. These regions are the prefrontal cortex, parietal cortex, the hippocampal system, and cortical regions specific to the content of the information being encoded (e.g., face area for encoding faces). This finding suggests that these regions are critical for encoding of memory.

**CHECKPOINT 7.3**

1. What is the function of spatial memory?

*Answer*: Spatial memory helps us navigate the world that we live in and allows us to understand our location in relation to other objects or people.

2. Describe cognitive map theory.

*Answer*: The cognitive map theory suggests that the hippocampus creates a mental map of our environment, which helps us make memories related to spatial information and navigate the world we live in. It is also useful in episodic memory, as these memories are often linked to spatial and temporal context.

3. Explain what place cells and grid cells are, and what role they play in spatial navigation and memory.

*Answer*: Place cells fire when an individual is in a certain location and grid cells are responsible for tracking of one’s position during movement. Place cells and grid cells work together to track one’s location and movement, much like the icon that represents your car on a GPS display.

4. Give examples distinguishing an egocentric spatial framework from an allocentric spatial framework.

*Answer*: Imagine a traditional classroom with a professor facing a class of 50 students, with a lectern in front of her and a projector screen behind her. From an egocentric framework of the professor, the lectern and the class are both in front of her, while the blackboard is behind her. However, from an allocentric spatial framework, the lectern will be referenced as in between the projector and the class of students.