MODULE 24

Storage: Retaining Information in the Brain

MODULE OVERVIEW

Module 24 explores the second of the three steps in the memory process—storage. Storage is the purely passive mechanism by which information is maintained in memory. This module also discusses how memory is represented physically in the brain, noting that we actually have two memory systems operating in tandem.

NOTE: Answer guidelines for all Module 24 questions begin on page 215.

MODULE REVIEW

First, skim this section, noting headings and boldface items. After you have read the section, review each objective by completing the sentences and answering the questions that follow it. In some cases, Study Tips explain how best to learn a difficult concept and Applications help you to know how well you understand the material. As you proceed, evaluate your performance by consulting the answers beginning on page 215. Do not continue with the next section until you understand each answer. If you need to, review or reread the section in the textbook before continuing.

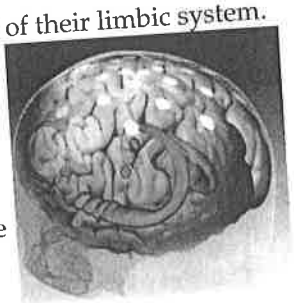
Retaining Information in the Brain

Objective 24-1: Describe the capacity and location of our long-term memories.

1. In contrast to short-term memory—and contrary to popular belief—the capacity of permanent memory is essentially limitless.
2. Psychologist Karl Lashley attempted to locate memory by cutting out pieces of rats' cortexes after they had learned a maze. He found that no matter where he cut, the rats remembered (remembered/forgot) the maze.

Objective 24-2: Describe the role of the frontal lobes and hippocampus in memory storage.

3. Many brain regions send input to your frontal lobes for working memory processing.
4. Amnesia patients typically have suffered damage to the hippocampus of their limbic system. This brain structure is important in the processing and storage of explicit memories. Damage on the left side of this structure impairs verbal memory; damage on the right side impairs memory for visual designs and locations. The rear part of this structure processes spacial memory.



5. The hippocampus seems to function as a zone where the brain temporarily (temporarily/permanently) stores the elements of a memory. However, memories (do/do not) migrate for storage elsewhere. The hippocampus is active during deep sleep, as memories are processed and filed for later retrieval. Sensory cortex areas also receive information from the outside

world and send it to the hippocampus and to other parts of the temporal lobes.

APPLICATIONS:

6. Brad, who suffered accidental damage to the left side of his hippocampus, has trouble remembering
   a. visual designs.
   b. locations.
   c. all nonverbal information.
   d. verbal information.

7. After suffering damage to the hippocampus, a person would probably
   a. lose memory for skills such as bicycle riding.
   b. be incapable of being classically conditioned.
   c. lose the ability to store new facts.
   d. experience all of these changes.

Objective 24-3: Describe the role of the cerebellum and basal ganglia in our memory processing.

8. The cerebellum is important in the processing of implicit memories. Humans and laboratory animals with a damaged cerebellum are incapable of simple eyeblink conditioning.

9. Deep brain structures called the basal ganglia, which are also involved in motor movement, facilitate formation of procedural memories for skills.

10. The dual explicit-implicit memory system helps explain infantile amnesia. We do not have explicit memories of our first three years for two reasons: explicit memory requires the use of words that nonspeaking children (have/have not) learned and the hippocampus is one of the last brain structures to mature.

The Amygdala, Emotions, and Memory

Objective 24-4: Discuss how emotions affect our memory processing.

11. Emotions trigger stress hormones that influence (influence/do not influence) memory formation by making more glucose available to fuel brain activity.

12. Stress hormones provoke the amygdala to initiate a memory trace in the temporal lobes and basal ganglia to boost activity in the brain's memory-forming areas.

13. Memories for surprising, significant moments that are especially clear are called flashbulb memories. Like other memories, these memories can (can/cannot) err.

APPLICATION:

14. Which of the following is the best example of a flashbulb memory?
   a. suddenly remembering to buy bread while standing in the checkout line at the grocery store
   b. recalling the name of someone from high school while looking at his or her yearbook snapshot
   c. remembering to make an important phone call
   d. remembering what you were doing on September 11, 2001, when terrorists crashed planes into the World Trade Center towers

Synaptic Changes

Objective 24-5: Explain how changes at the synapse level affect our memory processing.

15. Eric Kandel and James Schwartz have found that when learning occurs in the sea slug *Aplysia*, the neurotransmitter serotonin is released in greater amounts, making synapses more efficient.

16. After learning has occurred, a sending neuron needs less (more/less) prompting to release its neurotransmitter, and the number of receptor sites it stimulates may increase. This phenomenon, called long-term potentiation, may be the neural basis for learning and memory. Blocking this process with a specific drug, or by genetic engineering that causes the absence of an enzyme, interferes with learning. Rats given a drug that enhances LTP will learn a maze faster (faster/more slowly).

17. After LTP has occurred, an electric current passed through the brain will not (will/will not) disrupt old memories and will (will/will not) wipe out recent experiences.

18. To enhance memory, one approach focuses on drugs that boost the LTP-enhancing neurotransmitter glutamate. Another approach involves developing drugs that boost production of CREB, a protein that also enhances the LTP process.

PROGRESS TEST

Multiple-Choice Questions

Circle your answers to the following questions and check them with the answers on page 216. If your answer is incorrect, read the explanation for why it is incorrect and then consult the text.

1. Kandel and Schwartz have found that when learning occurs, more of the neurotransmitter _____ is released into synapses.
   a. ACh
   b. dopamine
   c. serotonin
   d. noradrenaline

2. Studies demonstrate that learning causes permanent neural changes in the _____ of animals' neurons.
   a. myelin
   b. cell bodies
   c. synapses
   d. all of these parts

3. The basal ganglia of the brain play a critical role in the formation of
   a. iconic memory.
   b. echoic memory.
   c. procedural memory.
   d. explicit memory.

4. Which area of the brain is most important in the processing of implicit memories?
   a. hippocampus
   b. cerebellum
   c. hypothalamus
   d. amygdala

5. Lashley's studies, in which rats learned a maze and then had various parts of their brains surgically removed, showed that the memory
   a. was lost when surgery took place within 1 hour of learning.
   b. was lost when surgery took place within 24 hours of learning.
   c. was lost when any region of the brain was removed.
   d. remained no matter which area of the brain was tampered with.

6. *Long-term potentiation* refers to
   a. the disruptive influence of old memories on the formation of new memories.
   b. the disruptive influence of recent memories on the retrieval of old memories.
   c. our tendency to recall experiences that are consistent with our current mood.
   d. the increased efficiency of synaptic transmission between certain neurons following learning.

TERMS AND CONCEPTS TO REMEMBER

Using your own words, on a separate piece of paper write a brief definition or explanation of each of the following terms.

1. explicit memory
2. hippocampus
3. implicit memory
4. flashbulb memory
5. long-term potentiation

ANSWERS

Module Review

Retaining Information in the Brain

1. unlimited (limitless)
2. Karl Lashley; cortexes; remembered
3. frontal
4. hippocampus; explicit; verbal; visual; spatial
5. temporarily; do; deep; hippocampus; temporal
6. **d.** is the answer.
   a., b., & c. Damage to the right side, not the left side, of the hippocampus would cause these types of memory deficits.
7. **c.** is the answer. The hippocampus is involved in processing new facts for storage.
   a., b., & d. Studies of amnesia victims with hippocampal damage show that neither classical conditioning nor skill memory are impaired, indicating that these aspects of memory are controlled by other regions of the brain.