MEMORY

A Five-Day Unit Lesson Plan for High School Psychology Teachers

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TOPSS

Developed and Produced by the Teachers of Psychology in Secondary Schools (TOPSS) of the American Psychological Association, November 2013.

MEMORY

A Five-Unit Lesson Plan for High School Psychology Teachers

This unit is aligned to the following content and performance standards of the *National Standards for High School Psychology Curricula* (APA, 2011):

COGNITION DOMAIN STANDARD AREA: MEMORY

CONTENT STANDARDS

After concluding this unit, students understand:

1. Encoding of memory
2. Storage of memory
3. Retrieval of memory

CONTENT STANDARDS WITH PERFORMANCE STANDARDS

CONTENT STANDARD 1: Encoding of memory

Students are able to (performance standards):
1.1 Identify factors that influence encoding
1.2 Characterize the difference between shallow (surface) and deep (elaborate) processing
1.3 Discuss strategies for improving the encoding of memory

CONTENT STANDARD 2: Storage of memory

Students are able to (performance standards):
2.1 Describe the differences between working memory and long-term memory
2.2 Identify and explain biological processes related to how memory is stored
2.3 Discuss types of memory and memory disorders (e.g., amnesias, dementias)
2.4 Discuss strategies for improving the storage of memories

CONTENT STANDARD 3: Retrieval of memory

Students are able to (performance standards):
3.1 Analyze the importance of retrieval cues in memory
3.2 Explain the role that interference plays in retrieval
3.3 Discuss the factors influencing how memories are retrieved
3.4 Explain how memories can be malleable
3.5 Discuss strategies for improving the retrieval of memories

TOPSS thanks Julie A. Penley, PhD, of El Paso Community College, and Kristin A. Ritchey, PhD, of Ball State University for their reviews of this lesson plan.

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This project was supported by a grant from the American Psychological Foundation.

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INTRODUCTION

Welcome to *Memory,* one of the units students find most applicable to the academic and personal spheres of their daily lives as the information in this unit can enhance their abilities to study and learn in general. Memory is often defined as application of learning over time. How does memory work? How much do we remember? How can we recall more? How can we better remember to do tasks in the future? In addition to answering these relevant questions, this unit lesson plan will present research on the accuracy of memories, how memories can change, implications for eyewitness testimony, and more. It will focus on the set of systems that allow us to encode, store, and retrieve information. It will present classic experiments of researchers such as Ebbinghaus, Sperling, and Loftus. The unit is intended to enhance your textbook, providing both content and critical thinking activities and exercises to facilitate remembering about memory.

The understanding and application of the information in this unit directly serve to enhance student study skills. Exercises and activities have been selected to provide a deeper understanding of specific topics and generate long-term retention of concepts, while directly applying the concepts in the activity. Students generally engage easily with this material, as they immediately and directly see the implications in their lives for information such as understanding why cramming isn't effective and why certain things or mnemonics (e.g., ROY G. BIV) are remembered for years.

Throughout the unit, students and teachers can add real-world examples using tools such as semantic encoding, self-referent thinking, and effortful processing. Applications of the content can allow students to engage in more efficient and effective study time. Students are often interested in learning about memory, especially as it relates to their academic as well as social world.

CONTENT OUTLINE

LESSON 1

Overview of the multisystem model of memory

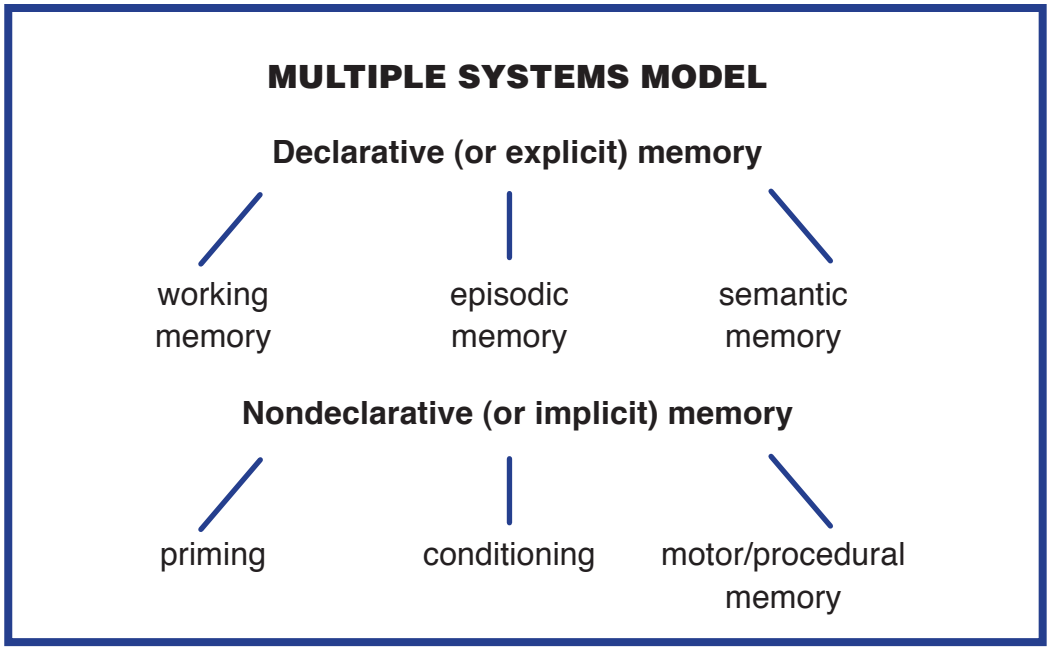
GO TO ACTIVITY 1.1

Pervasive Role of Memory in Everyday Life

Until recently, memory has been compared to a computer and defined by an information-processing model in which information goes through three discrete stages: encoding, storage, and retrieval. Additionally, Atkinson and Shiffrin (1968) posited that information goes through three stages: sensory, short-term memory, and long-term memory. Today, researchers have integrated this model with findings from cognitive neuroscience to include the idea that memory has been found to be created by a collection of systems, working interdependently. There is no one portion of the brain solely responsible for all memory, though there are certain regions related to specific memory subsystems.

I. The multiple systems model posits that memory is not a single, unitary system that relies on one neuroanatomical circuit; rather memory is made up of multiple memory systems that can work independently of one another.

The systems include **declarative memory** and **nondeclarative memory.** Each of these has several subsystems (described in the lessons that follow):



II. Declarative memory

A. **Declarative memory** or **explicit memory** is a memory system that is controlled consciously, intentionally, and flexibly. Declarative memory generally involves some effort and intention, and we can employ memory strategies such as mnemonics to recall information.

1. It is mediated by the hippocampus and frontal lobes, and, thus, damage to these areas may compromise declarative memory. For example, people with damage to the hippocampus have difficulty forming new long-term declarative memories, while those with frontal lobe damage may experience deficits in working memory.

2. Explicit memory is measured with explicit memory tests, such as recall and recognition, in which an individual is fully aware that he or she is being tested.

3. It generally declines with age.

B. Examples include recalling the name of an old friend, remembering a list of items to pick up at the store, remembering information for a test, learning a phone number, and recalling your ATM password.

III. Declarative memory subsystems

A. **Working memory** is a short-term memory system that allows us to store and process limited amounts of information of an imme-

diate sense. Working memory lasts anywhere from 2 to 18 seconds.

Working memory is used for mental calculations, such as figuring a tip; retaining information briefly, such as when dialing a phone number; and processing incoming information, such as when listening to a newscast. It also allows us to temporarily process information we have previously learned in a class and access it to learn and associate new information.

B. **Episodic memory** is a long-term memory system that stores information about specific events or episodes related to one's own life.

   1. Episodic memory is used to recall past events, such as a movie you saw last week, the dinner you ate last night, the name of the book your friend recommended, or a birthday party you attended.

   2. In the laboratory, psychologists study episodic memory by exposing participants to material and then testing the participants' memory of it. For example, in the first part of an experiment, participants could be shown pictures of 20 simple objects and then asked to name the pictures (e.g., dog, table, shoe). After a delay, for part two of the experiment, participants could be asked to recall all the pictures they had seen in the first part of the experiment, or they could be tested on their recognition of the items they had seen. For example, participants can be presented with 20 pictures (10 old pictures and 10 new pictures) and asked to circle the objects they had seen in the first part of the experiment. Note that both the recall and recognition tests ask participants to consciously remember what had been presented earlier.

C. **Semantic memory** is a long-term memory system that stores general knowledge.

   Examples of what semantic memory stores are vocabulary or facts such as 2+2 = 4 and Michigan is a state in the United States.

IV. Nondeclarative memory

A. **Nondeclarative memory** or **implicit memory** is a memory system that influences our current perceptions and behavior without our knowledge, awareness, or intention. Nondeclarative memory

is not used intentionally and involves no effort. It is assessed with an implicit memory test in which the individual is unaware she or he is taking a memory test.

1. It is mediated by cortical areas, the cerebellum, and the basal ganglia. Just as damage to the hippocampus and frontal lobes can compromise performance on declarative memory tasks, so, too, can damage to the visual cortical area impair visual priming. Damage to the cerebellum and basal ganglia can impair classical conditioning and procedural memory.

2. It was first discovered in work with people who had anterograde amnesia (an inability to form new, long-term declarative memories) and seemingly could not form new memories.

3. It is assessed with implicit measures such as priming, in which participants do not know their memory is being tested. Generally, these measures test for the effects of prior exposure on behavior without asking for conscious recollection.

    a. For example, the first part of an experiment could be identical to the episodic memory experiment described above. That is, you could show participants pictures of 20 simple objects and have the participants label the pictures (e.g., dog, table, shoe). After a delay, for part two of the experiment, you could tell participants they will now perform a speeded naming task in which their task is to name pictures as quickly as possible. You could then present a number of new pictures (e.g., one of a cat) and a number of old pictures (e.g., one of a dog) and measure participants' speed in naming the pictures. You will find effects of repetition priming (see in Section V), that is, old items will be named more quickly than new items.

    b. Another way to say this is that the prior exposure and naming of pictures enhances (in this case, speeds up) later processing of those items. Note that you are not asking participants to remember the pictures that occurred in the first part of the experiment—that kind of test would be a declarative or explicit memory test (see previous section).

4. Nondeclarative memory is used synonymously with implicit memory.

5. It remains relatively stable with normal aging.

6. Examples of nondeclarative memory include riding a bike,

driving a stick-shift car, using the same verbal patterns as friends (e.g., saying "like" repeatedly), and classical conditioning.

V. Nondeclarative memory subsystems

A. **Priming** is an automatic or unconscious process that can enhance the speed and accuracy of a response as a result of past experience. Different cues (see examples below) prompt the retrieval of memory. Memories are stored as a series of connections that can be activated by different kinds of cues; there is not any single location in the brain associated with a specific memory trace. Priming helps trigger associated concepts or memories, making the retrieval process more efficient.

1. An example of priming is **repetition priming**: You are faster reading the word "pretzel" aloud when you have just recently read it.

2. Another example is **semantic priming**: You are faster and more likely to say the word "nurse" when you have just recently read the word "doctor."

B. **Procedural memory** is the memory for the process involved in completing a task (e.g., motor memory) after the task is well learned and has become automatic.

Examples include playing the piano, typing, hitting a tennis ball.

C. **Classical conditioning** is memory for associations formed between two stimuli.

An example of classical conditioning is Pavlov's classic experiment with dogs: Just before presenting a dog with food, the researcher rang a bell. Soon, the animal learned the bell indicated food was imminent and would salivate at the sound of the bell. Humans can also become conditioned to the sound of a ring tone consistently paired with a specific caller.

VI. Evidence for multiple memory systems

A. There are people who have damage to the hippocampal/medial-temporal regions of the brain who show a pattern of anterograde amnesia, an inability to form new, long-term declarative memories.

1. These people often have a fully functioning working memory and can demonstrate all forms of nondeclarative memory.

2. Scientists and medical specialists have found no evidence to suggest these people have the ability to form new episodic memories, and yet they showed normal nondeclarative or implicit memory. So, if shown a list such as the one described in the episodic memory section above, they have very poor or no conscious recollection of that list. Yet, they exhibit normal implicit memory when tested for that (e.g., priming).

3. Famous people with amnesia include Henry Molaison (H.M.) and Clive Wearing.

4. Other people show impairments in episodic, but not semantic memory. Individuals with Alzheimer's dementia show impairments in both episodic and semantic memory.

B. Behavioral data: Dissociations across tasks

1. Dissociations are findings showing that a variable affects one component of the memory system in a particular way but has no effect on another component of the memory system.

   a. The existence of dissociations suggests these memory processes are mediated by different brain systems.

   b. For example, there are factors that improve explicit memory but do not improve implicit memory. In a study by Jacoby (1983), individuals who generated words during a study (e.g., provided an antonym for hot: _____) remembered those words better on a later explicit recall test than individuals who simply read those words. On an implicit priming test, however, individuals who generated words during study were not faster to read those words in a later implicit naming test than individuals who read those words. In fact, the opposite was true.

2. Factors that affect episodic tests do not always influence semantic tests in the same way. Older adults generally show significant impairment in episodic memory tests such as recall, but often show no impairment (and sometimes better performance) on semantic memory tests such as vocabulary or world knowledge.

GO TO ACTIVITY 1.2
Categorizing Types of Memory

LESSON 2:

Sensory memory and working memory

I. Sensory memory

The **sensory register** is a memory system that works for a very brief period of time that stores a record of information received by receptor cells until the information is selected for further processing or discarded.

A. The sensory memory register is specific to individual senses:

1. Iconic memory for visual information

2. Echoic memory for auditory information

B. Duration is very brief:

1. 150-500 msec for visual information

2. 1-2 sec for auditory information

C. The capacity of the sensory register is believed to be large.

D. Information in store is meaningless unless it is selected for further processing by being attended to in an effortful way.

E. The general purpose of the sensory information stores seems to be to keep information around, albeit briefly, for further processing. Processing information takes time, and it's helpful to have an initial store that maintains the presented information beyond its physical duration.

II. Evidence of a visual sensory register

A. Original research was conducted by George Sperling (1960).

1. Whole report versus partial report method:

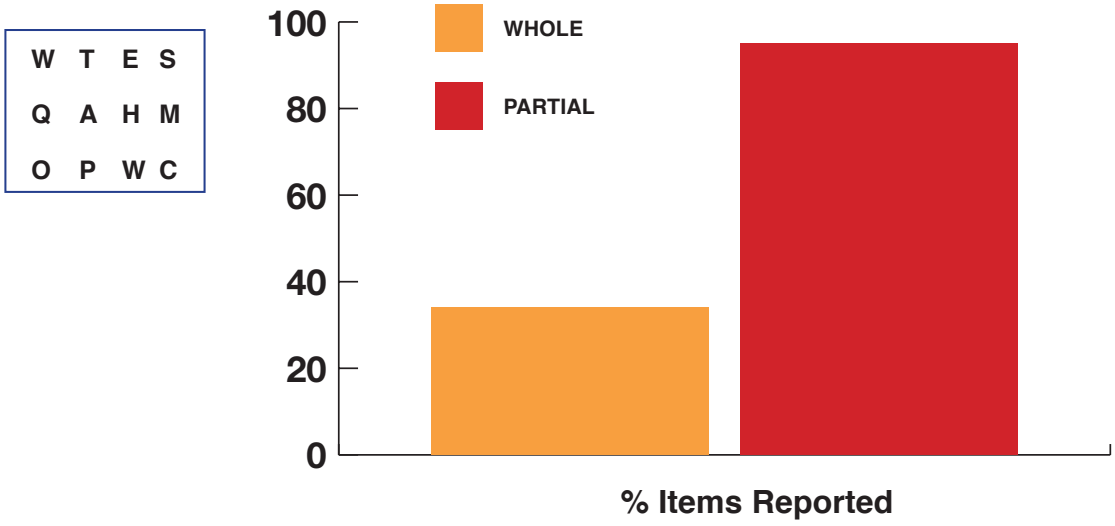
a. Participants viewed a 3 by 4 matrix of letters (see next page) and were asked to report either the entire matrix (whole report) or cued with a tone to report one random line (partial report).

b. Critically, participants did not know which line they would report until after the matrix had disappeared. When re-

quired to report the whole matrix, participants could recall only three or four items.

c. When required to report one random line, participants could report nearly all the items in that line, regardless of which line was selected, suggesting that the capacity of the visual sensory register is large but remains present for only a short duration.

WHOLE REPORT VERSUS PARTIAL REPORT METHOD



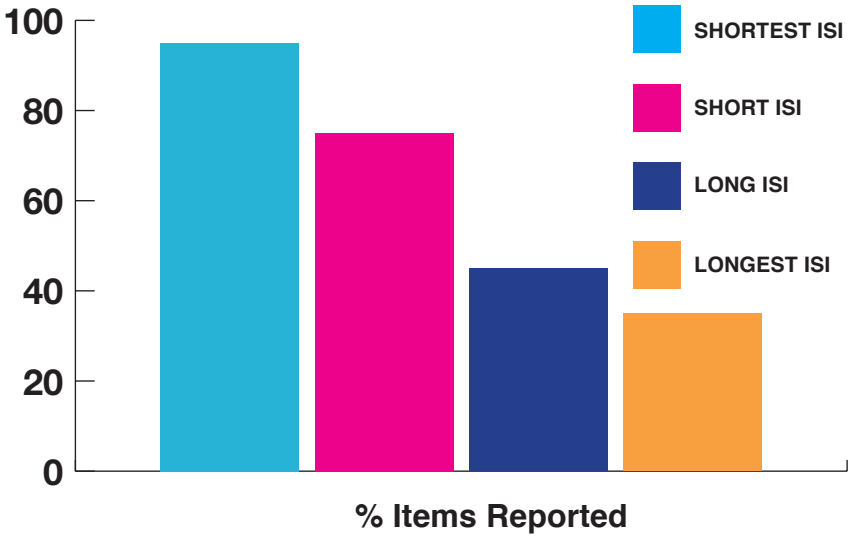
2. Delaying the cue in the partial report method:

   a. Participants who were cued to report a single row of letters immediately after the disappearance of the matrix could report nearly all of the items in the matrix.

   b. However, when investigators lengthened the time between the offset of the matrix and the onset of the cue (that is, they lengthened the inter-stimulus interval, or ISI), participants showed a diminished ability to report items. When the delay, or ISI, reached one second, performance on the partial-report task was no better than that on the full-report task.

   c. The longer the delay, the fewer items participants could recall, suggesting the information in the sensory register gradually decays over time.

DELAYING THE CUE IN THE PARTIAL REPORT METHOD



3. Using a physical cue versus a semantic cue:

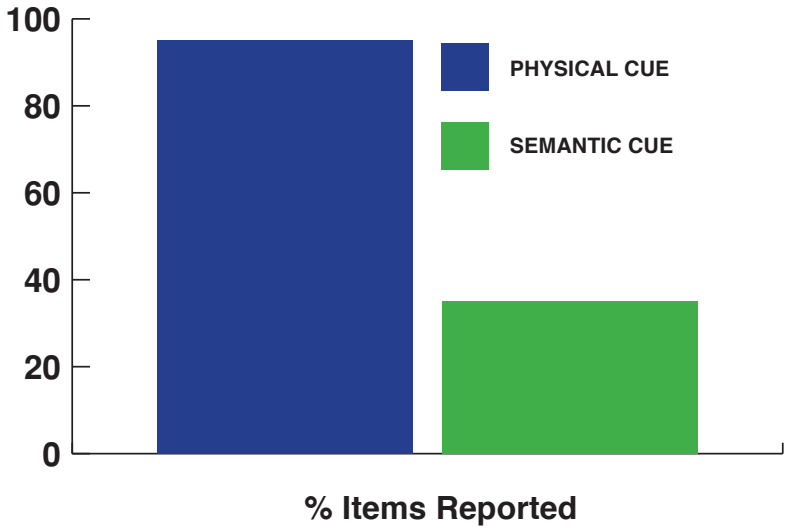
   a. In the original study, participants were trained to link different auditory tones (high, medium, and low) with different lines in the matrix (top, middle, bottom), so they knew to report the top line when they heard a high tone.

   b. With this type of physical cue, participants were very successful in reporting all of the letters in one row.

   c. However, when the cue given to participants required they process the items in the row before responding (e.g., report all the vowels), participants were not successful in reporting the items.

   d. These findings indicate (1) participants hold items in the sensory register in a raw form, and (2) processing the items for meaning takes time. As the sensory register is available for a short time only, the time it takes to process for meaning results in information no longer being available in the sensory register.

PHYSICAL CUE VERSUS SEMANTIC CUE



III. Working memory

Working memory (WM) is a short-term memory system we use to store and process information we are currently thinking about. Whereas the capacity of sensory memory is large (e.g., everything in your visual field is stored in iconic memory, or everything that is sufficiently loud is stored in echoic memory), the capacity of WM is much smaller. Typically, some of the information in iconic memory is selected for further processing in WM. While sensory memory operates preattentively (unconsciously), WM has been defined by some as the current contents of consciousness. It operates like a sketchpad or desktop in the sense that it allows a person to comprehend, retrieve, and manipulate information.

IV. Characteristics of working memory

A. Storage capacity of working memory is small: around 7 plus or minus 2 items. Zip codes, phone numbers, and most passwords are consistent with 7+/-2 items.

1. Original work was done by George Miller (1956) (Magical Number 7 +/- 2).

2. Early studies used a digit-span task (such as asking participants to remember a list of numbers), but more recent studies use a task that requires both storage and processing (reading span, operation span (e.g., performing mathematical calculations)).

GO TO ACTIVITY 2
Operation Span Task (Turner & Engle, 1989)

B. Duration of working memory is limited (about 2-18 seconds).

Original work was conducted by Brown (1958) and Peterson and Peterson (1959) (now called Brown–Peterson paradigm). When people cannot rehearse (practice), information dissipates from working memory in about 18 seconds.

C. Information is typically encoded acoustically (by sound) in working memory.

Early work by Conrad (1964), Wickelgren (1965), and others demonstrated the phonological similarity effect: It is more difficult to remember items that sound alike (e.g., T, C, B, V, E) than items that do not sound alike (e.g., T, L, X).

D. Information can be chunked in working memory to increase capacity.

1. **Chunking** is the organization of items into familiar or manageable units or chunks.

2. Chase and Simon (1973) showed that when people are given 5 seconds to view the arrangement of pieces in a chess game, chess experts remember nearly all the pieces while nonexperts remember on average only 9 of 32 pieces. However, when the chess pieces are randomly arranged on the board, chess experts and nonexperts do not differ in their memory for the pieces. The chess experts remember groupings or chunks of meaningful units; when the pieces lose meaningful groupings, the experts' working memory capacity is similar to that of others.

3. Chase and Ericsson (1982) demonstrated that a male subject who was a runner started with an average memory span for digits (7 plus or minus 2 digits), but with practice and chunking, he could recall up to 80 digits presented to him randomly at a rate of 1 per second. He did this by converting the numbers into running times. Even after his training with numbers, his memory span for letters was average.

4. The practical implication is that when students are learning, they should look for patterns or ways to group information. For example, if a person is trying to remember a friend's email address (CPM1995@email.com), the person will more likely remember the address if he or she sees the three letters as the friend's initials and the numbers as the friend's birth year (as

opposed to trying to memorize seven unrelated characters). The greater a person's experience or background knowledge within a domain, the greater his or her ease in chunking.

V. Baddeley's model of working memory

A. The **phonological loop** is a short-term verbal store that holds verbal material in a buffer. The information can be kept active through subvocal rehearsal.

B. The **visuospatial sketchpad** is a short-term store for visual and spatial material. It is believed to be essential for mental imagery and spatial reasoning.

C. The **episodic buffer** is a temporary store that integrates information from the phonological loop, the visuospatial sketchpad, and long-term memory.

D. The **central executive** is the master component that coordinates activities among the phonological loop, the visuospatial sketchpad, and the episodic buffer. The central executive is believed to allocate attention and direct cognitive efforts. It is believed to be mediated by the frontal lobes of the brain.

VI. Interaction between working memory and long-term memory

A. **Serial position effect** is the effect an item's position on a list has on how well it is recalled. For example, when participants are given a long list of items to remember in an immediate memory task, they tend to remember best the items listed first on the list (primacy effect) and the items listed last on the list (recency effect).

1. The **primacy effect** is the concept that the first items in a list receive a great deal of rehearsal, and are, thus, more likely to be transferred into long-term memory. The primacy effect is diminished when list items are presented at a fast rate. The primacy effect is not affected by a distractor task (a task not related to the task currently taking place) presented after the list is presented.

2. The **recency effect** is the concept that people tend to report the last items of a list first while those items are still in their working memory. The recency effect is not affected by the rate of speed a list is presented. The recency effect can be eliminated if a distractor task is presented immediately after the list is presented and before recall is required.

3. An easy demonstration to do with students is to give them a list of 10 random words and see what percentage of the class remembers each word. Most students will remember the words at the beginning and end of the list.

4. The recency effect is only present when assessed immediately after the task, while the primacy effect tends to be strongest when assessed later. For example, let's say "Dave," who is part of a large group in France, is introduced to the Queen of England. If the Queen is tested immediately after meeting the group, she will remember Dave if he was the *last* one introduced in the group (recency effect). However, if the Queen is not tested until she returns to England, she will likely not remember Dave, who was the last in the group; she would likely only remember Dave if he had been introduced *first* (primacy effect).

B. **Prospective memory** is the memory for tasks to be completed in the future (e.g., sending an email, paying a bill, taking medication).

1. Prospective memory requires working memory because the intended action must enter consciousness at the appropriate time in order to be executed.

    a. Successful retrieval of an intention into working memory does not guarantee that a person will perform it, however.

    b. For example, most of us have failed to include an attachment in an email, even when the sole purpose of the email was to send the attachment. In this case, we retrieved the intention into conscious awareness but then failed to control our attention and maintain the intention in awareness during the writing of the cover note.

    c. It turns out that retrieved intentions are susceptible to disruptions (and particularly so for older adults); thus, the recommendation is to perform an action as soon as you think of it (e.g., to attach the attachment first and then write the cover note).

2. Prospective memory requires long-term memory because a person must not only remember that she or he must complete a task, but also remember what that task is.

LESSON 3

Long-term memory: Encoding

I. The information processing model posits that long-term memory is a system that encodes, stores, and retrieves information (students may understand the metaphor of a computer here).

A. The way information is encoded critically influences later access to that information.

B. A number of factors, described in detail below, influence encoding. These factors include level of processing (shallow or deep) done with an item, timing of practice (massed or spaced), how a person organizes information, a person's reference to the self during learning, distinctiveness of an item, and testing during learning.

II. Levels of processing

The levels-of-processing framework posits that information is processed differently depending upon the instructions and the task and can vary from relatively shallow processing to relatively deep processing. The best retention occurs when processing is elaborative (deep). This concept was first introduced by Craik and Lockhart in 1972 and has been replicated in dozens of experiments.

A. **Shallow processing**

1. **Shallow processing** or **maintenance rehearsal** focuses on the physical features of an item rather than its meaning.
2. Examples of physical features include color, length, font, or sound of an item.
3. Shallow processing can involve the simple repetition of items.
4. For example, we see pennies every day, but may have difficulty recalling the information on the front or back of a penny.
5. Simply repeating an item over and over again for a test will not commit that item to memory for a long period of time.

GO TO ACTIVITY 3.1

Repeated Exposure Versus Deep Processing

B. **Deep processing**

1. **Deep processing** or **elaborative rehearsal** focuses on the meaning of an item and involves forming associations between old and new information, with an effort on making elaborate connections with existing knowledge.

2. Examples include processing that focuses on the pleasantness of an item, the definition of an item, and the item's relationship to other items.

3. When learning new vocabulary, it is best to associate the new item, a vocabulary word, with something you already know well.

4. Recent work by Nairne and colleagues (2010) demonstrates that one effective way to process information to is to relate it to your survival.

5. In preparing for a test, relating course material to information you already know or to something personal in your own life (self-referent) will enhance its retrieval.

GO TO ACTIVITY 3.2
How to Study Actively

III. Timing of practice

A. **Massed practice**

1. **Massed practice** occurs when an individual attempts to learn material all in one setting, with practice crammed into one or two long sessions.

2. Massed practice is not as effective as spaced or distributed practice for long-term retention.

B. **Spaced practice**

1. **Spaced practice,** also referred to as **distributed practice,** involves repeated practice of multiple sessions that are spaced out in time.

2. Spaced practice is far more effective for long-term retention.

3. Baddeley and colleagues (1978) demonstrated that post office workers who practiced typing for an hour each day showed

better retention than those who practiced typing for the same total amount of time, but instead massed their practice (i.e., practiced 2 hours a day).

4. Cepeda, Vul, Rohrer, Wixted, and Pasher (2008) had participants study material (answers to trivia questions) in a massed or spaced fashion and then tested their memory after various delays.

    a. They found that spaced practice (studying and then waiting a while and studying again) almost always improved memory relative to massed practice (studying and then studying again right away), even though the participants in both the spaced- and massed-practice conditions spent the exact same amount of time studying.

    b. For example, with a retention interval of 10 weeks (i.e., memory was tested 70 days after the last study period), the spaced practice group remembered 111% more than the massed practice group.

5. When students are studying, they should be sure to space study sessions over time. If a student plans to study 10 hours for a test, devoting 1 hour each day for 10 days to studying or 2 hours a day for 5 days would be effective. Studying 5 hours each day for the 2 days before the test would not be nearly as effective.

IV. Self-referent encoding

A. When people organize material around their own lives and experiences, they can elaborate on material easily, and they always have access to the cues (the cues are salient to the individual who created them).

B. For example, if you are learning state or country capitals, relating them to your own travels and experience can improve memory. If you associate Michigan with your grandfather who loves Lance crackers, you may find it easier to remember that the capital of Michigan is Lansing. Or if you associate the United Kingdom with your friend Landon, you could remember the capital of the United Kingdom is London.

V. Distinctiveness and organization

A. **Distinctiveness:** Items that are unique or distinct from others are often remembered best. When an item is naturally distinctive, as is a black swan in a lake filled with white swans, it will be remembered better than the other items that are similar to each other. This is known as the **von Restorff effect.** Students can work to make an item distinct by elaborating on it and providing great detail about it, and the benefit will be similar.

B. **Organization:** Organizing information also facilitates memory. If someone has a list of items that includes clothing, sporting equipment, food, and travel destinations all mixed together, organizing those items by category will improve recall. The category heading can be used to prompt recall, and relating the items within a category to each other will allow them to serve as cues for each other. Students could work to impose an organization on course material, and that structure will help guide retrieval during tests.

C. **Subjective organization:** For material that does not have an obvious structure, imposing some personal organizational strategy or structure on the material can enhance retention. Subjective organization involves developing a personal way to categorize and recall information.

GO TO ACTIVITY 3.3
Read the Label **(The use of labels aids comprehension and retention)**

VI. Testing effect

A. Taking a memory test not only assesses what a person knows, but can also enhance later retention.

B. This phenomenon is known as the testing effect or test-enhanced learning. This effect was first demonstrated by Gates (1917) and later expanded by Carrier & Pasher (1992) and Roediger & Karpicke (2006; see also Karpicke & Roediger, 2008).

C. Recent experiments demonstrate that people who study and then are tested on material retain that information more effectively over long durations relative to people who study and then study some more (even though both groups spend the same amount of time with the material).

D. When students study, they should not simply reread their book or even focus on their highlights. They should quiz themselves on the material regularly, so they have a sense of what they know and don't know and practice and strengthen the connections among associated information in their brain.

LESSON 4

Long-term memory: Retrieval

GO TO ACTIVITY 4.1

Constructive Memory/Schemas: The Rumor Chain

I. Rate of forgetting

A. **Retrieval** is the process of getting ("retrieving") information out of memory storage.

B. Forgetting does not occur at a constant rate.

1. Ebbinghaus conducted experiments with nonsense syllabi. In his studies, he demonstrated that most forgetting occurs early. The rate of forgetting slows over time.

2. Bahrick (1984) has confirmed this pattern using more naturalistic materials. Bahrick examined memory for math and foreign language learned in high school and for the names and faces of high school classmates. He assessed forgetting across several decades and demonstrated that most forgetting occurs early, and that some information persists over time. The research shows what you remember after 3 years, you are likely to remember for the rest of your life.

C. **Proactive and retroactive interference**

Interference, which occurs when some information blocks or disrupts the recall of other information, is believed to be a primary source of forgetting. There are two types of interference: retroactive and proactive.

1. **Retroactive interference** occurs when new information blocks or disrupts retrieval of older information. For example, if you are trying to recall an old, obsolete password to an account but can only remember your current password, you are experiencing retroactive interference.

2. **Proactive interference** occurs when old, previously learned memories intrude with the recall of newer memories. For example, imagine your favorite pizza place moves across town and changes phone numbers. If you drive to the old location or call the old phone number, you are experiencing proactive interference.

a. Proactive interference highlights the importance of forgetting in our everyday lives. Failing to forget information that has become obsolete will disrupt and impair memory for current information.

b. For example, thinking about where you parked your car yesterday may lead you to the wrong space today. In a similar vein, it's important to call your current boyfriend by his actual name and not by your previous boyfriend's name.

3. *Note.* These two concepts are frequently confused by students. Teachers may want to reference the idea that "the problem is with the prefix" or use a mnemonic to help students remember the difference between these two terms.

4. The **fan effect** is another example in which remembering too much can cause forgetting.

   a. When we associate a number of memories with one cue, we are slower and less accurate in retrieving any one of those memories than we are if we associate only one memory with a cue.

   b. For example, if we have to remember John's office phone number, his cell phone number, his home phone number, and his wife's phone number, we are less effective in recalling any one of those numbers than if we simply have to remember his cell number.

   c. To reduce interference, students should try associating fewer items with any one cue.

5. **Retrieval-induced forgetting** occurs when we have many memories associated with a cue, and we selectively rehearse only one or two of those memories.

   a. For example, if we know John's work, cell, and home numbers but repeatedly call only his cell, our memory for his other numbers will diminish.

   b. Practicing all the items associated with a single cue will help reduce this interference. For example, if we are going to dial John's cell, we might also rehearse his other phone numbers before we dial his cell.

D. **Encoding specificity and retrieval cues**

1. **Encoding specificity,** a concept introduced by Tulving, states that the most effective cues at retrieval are those that match the cues present at encoding.

2. Tulving (1983) makes the case that much of our forgetting is due to problems in **accessibility** or the failure to retrieve memories that still reside in long-term memory. (This contrasts with forgetting due to problems in **availability**, where the memory is simply no longer stored in the brain.)

3. A particularly frustrating example of a memory failure due to an accessibility problem occurs when we are in a tip-of-the-tongue state. In that case, we are aware we know the information that we are searching for, but we simply cannot access it.

4. More generally, there are many situations in which memories are available in long-term memory; but we have difficulty accessing them (e.g., the name of a well-known actor, some of the details of a vacation we took last year) until we are given a good cue (e.g., the first name of the actor, a photograph of us playing miniature golf while on vacation), which, according to the encoding specificity principle, is a cue that gets us to think about the event like we did when we encoded it.

5. Examples:

    a. Consider the prospective memory task of walking into the kitchen from the bedroom and then forgetting why you were going to the kitchen. A good way to remember your intention is to get back to what you were doing when you formed the intention—that is, to walk back into the bedroom.

    b. Other good examples for high school students include how the smell of suntan lotion can bring back memories of a family beach trip or how a song can instantly bring back memories of summer camp or time spent with friends.

6. **Context effects**

    a. Changing the physical context of the *studying task* from the physical context of the *testing task* can impair memory.

b. In a study by Godden & Baddeley (1975), for example, individuals learned best when they studied and were tested on land or studied and were tested while scuba diving. Those whose studying took place in one location (e.g., on land) and testing took place in a different location (e.g., in water while they were scuba diving) did not perform as well.

c. Later research demonstrated that the change in physical context needs to be fairly dramatic to affect memory. For example, Saufley, Otaka, & Bravaresco (1986) showed that students' test performance did not change when they were tested in the same classroom they learned in or a different classroom.

d. If students need to recall information (for a test, for example) in a new context that differs greatly from the context in which they learned or studied the information, they should try to imagine the learning context before they start recalling.

GO TO ACTIVITY 4.2

The Importance of Cues **(Mantyla cue demonstration)**

7. **State-dependent memory**

a. Memory is best when a person's emotional or physiological state is the same when he/she is being tested as it was when he/she was learning.

b. As with context effects, the change in the person's physiological state needs to be fairly significant to affect memory (e.g., a person's not drinking a caffeinated soda while testing if the person drank one while learning should not affect the person's performance much).

LESSON 5

Memory in everyday life

I. Eyewitness testimony and the malleability of memory

A. Memory does not work like a video recorder: People do not encode or retrieve every aspect of an event perfectly.

B. What a person encodes depends on his or her priorities, his or her past experience, his or her expectations, and the current demands.

C. What people remember about an event can also depend on what happened after the event, their biases and expectations, and reports from others.

D. **Biases at encoding:** When arousal (state of alertness) is high, people tend to narrow their focus to only certain aspects of an event.

1. One example of an encoding bias is weapon focus. In this, victims of a violent crime report great detail about the weapon but not about the perpetrator. People rely heavily on their expectations and prior experience.

2. A second example of encoding bias is own-race bias, in which we are better able to identify individuals from our own race than individuals from a different race.

3. A third example of encoding bias is the reliance on schemas (cognitive frameworks or concepts that help organize and interpret information) as we process an event. Imagine being pulled over for a speeding ticket. After you've received a ticket, a friend asks, "Did the police officer ask you if you knew how fast you were going?" You believe he did, not necessarily because you recall the question, but because you know that is a common question for a traffic violation.

GO TO ACTIVITY 5
An All-Purpose Memory Demonstration

E. Misinformation introduced after learning

1. Elizabeth Loftus and colleagues (e.g., Loftus and Palmer, 1974; Loftus and Pickerell, 1995) demonstrated that misin-

formation introduced after an event can alter our recollection (memory) of the original event.

2. Participants who viewed a car moving through a *yield* sign were subsequently asked how fast the car was going when it went through a *stop* sign. At a later memory test, those who were asked about the stop sign during questioning misremembered seeing a stop sign instead of a yield sign.

F. Misinformation by repeated imaginings and the use of photographs

1. Loftus & Pickerell (1995) and others have demonstrated that asking people to repeatedly imagine childhood events that plausibly occurred (but in reality never happened) can result in false memories for those events. People who thought extensively about events that never happened to them (e.g., getting lost in a mall, knocking over a punch bowl) began to believe they did experience those events.

2. This false memory effect is exaggerated when people see altered photos made to look like they were taken at the event (e.g., seeing a photo of you and your father in a hot air balloon may lead you to believe you once took a balloon ride with your father).

3. The effect can also be exaggerated with real photos. If you are asked to imagine putting slime in your teacher's desk in second grade, you are more likely to remember the event if you're shown a real picture of your second-grade class.

G. Biases at retrieval

1. We rely on expectations and experience when we attempt to retrieve information.

2. For example, when shown a lineup of suspects for a crime, we assume the perpetrator is somewhere in the lineup. Even when the real perpetrator is absent from a lineup, people are far more likely to guess the wrong person than to report they don't see the perpetrator in the lineup. As a result, now many types of line-ups are structured so that victims are presented with one image at a time for a "yes or no" answer.

II. Autobiographical memory

A. **Reminiscence bump:** Rubin and colleagues (1986) have demonstrated that over the course of a lifetime, we seem to have height-

ened memory for personal, cultural, and historical events that occurred during our late adolescence and early adulthood (roughly between the ages of 15 and 30). Investigators have termed this the reminiscence bump.

B. **Permastore:** Bahrick and colleagues demonstrated that although some forgetting occurs immediately after learning, memory can persist for very long periods of time. Although students forgot a significant portion of the names of their high school classmates or the information they learned in Spanish class, some of the material persisted over decades. Bahrick referred to this endurance of memories as permastore.

III. Flashbulb memories

A. "**Flashbulb memory"** is a term used to refer to the recollection of extremely significant personal or historical events.

B. These events are fairly rare and are typically accompanied by great emotion, such as with the terrorist attack on the twin towers on 9/11.

C. Originally called flashbulb memories because they were thought to reflect permanent, accurate memories of profound events, recent research has demonstrated that flashbulb memories are not immune to being forgotten.

D. Although people are often confident in their memory of the details of a flashbulb event, these events are subject to the same distortions and forgetting as any everyday event. Up to 40% of the details for these events are distorted or misremembered.

IV. Prospective memory

A. Since the time of Ebbinghaus, memory researchers have focused mainly on studying explicit retrospective memory or conscious recollection for past events (e.g., free recall, cued recall, and recognition).

1. In recent years there has been increased interest in prospective memory or remembering to perform actions in the future, such as remembering to put the garbage out on Wednesday nights and remembering to include an attachment in an email.

2. Prospective memory has important implications; there are many prospective memory demands in everyday life in both work and non-work settings, and one of the central functions

of human memory is to plan for future actions so we can respond appropriately to upcoming events (Klein, Robertson, & Delton, 2010).

3. What is different about prospective memory? In a typical retrospective memory task, you might be presented with a list of words to learn; then at some point the experimenter puts you in a retrieval mode—that is, the experimenter asks you to search memory and start remembering the list of words that was presented earlier.

4. A critical feature of prospective memory is that the experimenter does not put participants in a retrieval mode at the time remembering is to occur (Einstein & McDaniel, 2005). In remembering to give a friend a message, for example, there is no one there to remind you to check your memory for what you were supposed to do when you encounter the friend. Instead, rather than processing your friend as a friend, you have to somehow switch to seeing your friend as a cue for an action.

5. A central question in the prospective memory literature arena is, how does the cognitive system accomplish remembering when we are not specifically trying to remember at the time?

B. Processes involved in prospective memory

1. **Monitoring:** In some situations, when we form an intention, we initiate monitoring processes, which can sometimes feel like active and conscious monitoring and sometimes occur unconsciously.

2. **Spontaneous retrieval:** In other situations, we are likely to rely on spontaneous retrieval processes. By spontaneous retrieval, we mean the processing of a strong cue at retrieval can cause an intention to be retrieved even when we are not monitoring for that cue (experienced as an intention "popping" into mind).

C. Types of prospective memory tasks

1. In a **time-based** prospective memory task, you plan to do an action at a certain time, such as remembering to call a friend in 10 minutes.

2. In an **event-based** task, you plan to complete an action when you see a specific cue or event, for example, remembering to give your friend a message when you see her.

ACTIVITIES

ACTIVITY 1.1

Pervasive Role of Memory in Everyday Life

Concept
This exercise is intended to raise awareness of our reliance on memory throughout our daily activities and to help students understand that memory takes many forms.

Materials
For this activity, students will need a pen and paper.

BACK TO CONTENT OUTLINE

Instructions
This activity requires 5 to 10 minutes, depending on the length of discussion, and should be conducted at the start of the class period.

Begin by asking students to write down everything they did yesterday that did NOT involve memory. If students appear stumped, assure them that they did engage in a number of activities that did not involve memory. After having students consider this question for 3–4 minutes, ask students to provide some responses.

Students may provide accurate but fairly limited responses (e.g., blinking, burping, seeing, breathing, sleeping, waking up). Affirm these responses and highlight how very limited a human would be if this were all he could accomplish in a day.

Often students will provide responses that do involve memory (e.g., walking, using the bathroom, eating, talking). These responses provide a great opportunity to emphasize the pervasive role of memory in our lives

and to begin a discussion of the different types of memory (e.g., motor or procedural memory for walking, semantic memory for our knowledge of the people in our lives).

Students may fail to recognize the extent to which memory impacts behavior and cognitive functioning. Discuss a very simple task, such as discussing what you want to have for breakfast with a parent or sibling. Explain that without semantic memory, we would have no knowledge of the other person or his or her likes or dislikes. We would also not understand the meaning of breakfast or some of the cultural conventions generally associated with it (e.g., when it is typically eaten, what types of foods are commonly involved, how formal or informal the dress). Without procedural memory, we would have a difficult time using utensils and eating.

ACTIVITY 1.2

Categorizing Different Types of Memory

Developed by
Sheryl Freedman
Walt Whitman High School, Bethesda, MD

Concept
Students can relate activities to the type of memory required for those activities.

Materials
You will need the *Categorizing Different Types of Memory* form as a handout (see next page).

Instructions
Read or distribute copies of the *Categorizing Different Types of Memory* handout.

BACK TO CONTENT OUTLINE

Answer Key

1.	D	Writing your name
2.	A	Words to the Star Spangled Banner or other national anthem
3.	B	Your friend's birthday party from last week
4.	C	Figuring out a tip for a waiter
5.	D	Tying your shoe
6.	F	Flinching after your sibling says "Titanic" when he has repeatedly splashed you with water on previous occasions of saying this word
7.	E	Being fast to recognize the name of a famous artist when you had only recently heard the name in passing
8.	B	What you ate for dinner yesterday
9.	G	Remembering you need to buy a gift for your friend's birthday party tonight
10.	C	Remembering a phone number as you dial it
11.	A	Remembering the parts of the limbic system

continued on page 34

Categorizing Different Types of Memory

For each of the following memory tasks, mark which type of memory is represented:

Types of Memory

A. Semantic memory

B. Episodic memory

C. Working memory

D. Procedural memory

E. Priming

F. Conditioning

G. Prospective

Memory Tasks

1. ____ Writing your name
2. ____ Words to the *Star Spangled Banner* or other national anthem
3. ____ Your friend's birthday party from last week
4. ____ Figuring out a tip for a waiter
5. ____ Tying your shoe
6. ____ Flinching after your sibling says "Titanic" when he has repeatedly splashed you with water on previous occasions of saying this word
7. ____ Being fast to recognize the name of a famous artist when you had only recently heard the name in passing
8. ____ What you ate for dinner yesterday
9. ____ Remembering you need to buy a gift for your friend's birthday party tonight
10. ____ Remembering a phone number as you dial it
11. ____ Remembering the parts of the limbic system

ACTIVITY 2

Operation Span Task

Developed by
Turner & Engle, 1989

Concept

A number of tasks are used to measure working memory capacity, and a common characteristic is that working memory tasks require participants to hold information in memory while processing information, which is what you have to do when you mentally multiply 12 times 17. For example, you might first multiply 10 times 17 and get 170. You then have to hold that product in memory while you multiply 2 x 17 to get 34. You then have to add 170 and 34 to solve the problem.

Instructions

In the Operation Span Task, participants are asked to read aloud and perform a series of operations while they remember words. For example, they might be shown the following on a computer monitor:

*Is 3*3 +4 + 13? (Yes or no) FRUIT*

They have to indicate whether or not the equation is correct and then say the capitalized word aloud. Then that equation disappears, and the participants are shown another equation and word such as:

Is 10/2 +4 = 7? (Yes or no) ROAD

Again, after the participants read the capitalized word aloud, the equation disappears, and the participants are shown another equation and word such as:

Is 12/4 -2 = 5? (Yes or no) GREEN

After a certain number of trials (anywhere from two to seven), participants are asked to recall the words (i.e., FRUIT, ROAD, GREEN). Their working memory capacity is measured by the number of words correctly recalled.

BACK TO CONTENT OUTLINE

Successful performance on the Operation Span Task requires that you hold onto (store) information (i.e., the words) while you process (i.e., perform the arithmetic operations). This ability is related to performance on many important cognitive tasks. Indeed, performance on working memory tasks (like the Operation Span Task) correlates highly with higher-order tasks such as reading comprehension and fluid intelligence (Engle, 2002, *Current Directions in Psychological Science*). Current conceptualizations suggest that working-memory capacity is highly related to the ability to *control attention*—that is, to keep in mind the relevant aspects of a problem and ignore distraction.

References

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science, 11,* 19-23.

Turner, M. L., & Engle, R. W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language, 28,* 127-154.

ACTIVITY 3.1

Repeated Exposure Versus Deep Processing

Concept

This exercise is intended to illustrate the way in which repeated exposure to information without deep processing of that information fails to cement the information in memory.

Materials

One high-quality photo of pennies (see example below) and a way to show the photo (computer, paper, etc.) are needed.

Instructions

This demonstration will take about 5 minutes. First, ask students how many times they believe they would need to hear and see a new concept before they could remember it. Then, have them rate, on a scale of 1 to 10, their confidence in their ability to remember information if they see it 10 times; then 100 times; then 1000 times. Most students will be confident that they could remember something if they have seen it 1000 times.

BACK TO CONTENT OUTLINE

Next, ask students how much experience they have in handling money. Have them estimate the number of times they have seen a dollar bill, a quarter, and a penny. Then, show them the following display of pennies and ask them to identify the real penny.

Point out to students that the chance of recognizing the real penny is 1 out of 6. In most cases, responses fall at chance in this task. The real penny is the first one, in the upper left-hand corner. Highlight the fact that although students have likely seen pennies more than 1000 times, they do not remember them because they do not encode them in a meaningful way. It is not the amount of time spent studying an item, but rather the way that time is spent that is important.

Further Reading

Nickerson, R. S., & Adams, M. J. (July 1979). Long-term memory for a common object. *Cognitive Psychology, 11*(3), 287-307.

ACTIVITY 3.2

How to Study Actively

Developed by
Donald V. DeRosa
University of North Carolina at Greensboro

Concept

This activity focuses on learning and memory, and you can use it in conjunction with a discussion of research methods or experimental design. No prior knowledge of psychology is assumed, and there is no advance preparation required. The activity can be used with any size class as an in-class activity.

The activity demonstrates to students the importance of studying actively and examines techniques that enhance recall. The experiment, based on work by Hyde and Jenkins (1969), is best performed using two groups of students, one for each condition. For classroom purposes, however, one group will do. Using one group avoids the practical difficulties of dividing one class into sections. The effect the experiment demonstrates is so powerful, it will work anyway.

BACK TO CONTENT OUTLINE

Furthermore, you can use the fact that you conducted the experiment "improperly" as the basis for discussion after the experiment is over. Be sure to tell the students this was not the proper way to conduct the experiment and explain why not. Note the first (pleasant/unpleasant) condition should always result in much higher recall than the second ("e") condition. By using one group only and ordering the conditions with the pleasant/unpleasant condition first, you have set things up to work against the effect you are trying to demonstrate. However, please see the note at the end of the next section on how you can do this demonstration by dividing your class into two groups.

Materials

The list of words provided in the instructions section.

Instructions

Introduce the experiment by informing the class that effective study techniques are based on the results of experimental research in human learning. The principles underlying this research should be discussed after the activity.

Read the following instructions to the class: “It is known that people differ in how pleasant they believe different words are. We are going to demonstrate the “pleasantness” value of a list of words. I will read the list and for each one, I want you to rate how pleasant it is on a 10-point scale, from 1, ‘very unpleasant,’ to 10, ‘very pleasant.’ Let 5 be the neutral point—neither pleasant nor unpleasant. For each word, think about the thing it stands for and rate it from1 to 10. Do not write the word down. Although I will be asking you to recall the words later, please give your attention to the rating of the words and pleasant or unpleasant.* Do you have any questions?” Then read the following words at 5-second intervals; use a watch.

coin	**trail**	**deep**	**fish**
skate	**flower**	**bird**	**coat**
church	**clock**	**sample**	**metal**
fork	**bank**	**move**	**travel**
truck	**paint**	**rain**	**grass**
pocket	**time**	**pipe**	**soap**

Ask students to write down as many words as they can recall in any order. Allow 90 seconds for recall, then read the list; ask the students to count how many they recalled.

Read the following instructions: “Now we are going to carry out a demonstration that will illustrate some important facts about how people deal with information. The first step in studying well is to be sure you have adequately ‘gotten the facts.’ To simulate this, I will read a list of words. For each word, decide if it contains the letter ‘e.’ If it does, make a mark on a sheet of paper. If it does not, do nothing. Do not write the word, decide if it has an ‘e’ in it and keep a tally. [You may wish to have a sheet of paper numbered from 1 to 24 for each condition.] Again, although I will later ask you to recall the words, this is not important right now. You should give your full attention to the task of determining if the words contain the letter ‘e.’ Are there any questions? If you are ready, I will begin.” Read the words at 5-second intervals.

* In their original experiment, Hyde and Jenkins did not indicate that a later recall of the words would be required. Theirs was therefore a purely incidental learning task. We have eliminated this because students in a group become somewhat vocal when surprised by the request to recall the words, and sometimes they feel deceived.

shade	**dress**	**count**	**short**
desk	**horse**	**fire**	**motor**
money	**month**	**song**	**story**
pitch	**door**	**bureau**	**coal**
garden	**belt**	**foot**	**dinner**
hammer	**train**	**magic**	**monkey**

Again, ask them to write down as many words as they recall, in any order. Allow 90 seconds for recall, then read the list and ask the students to mark the words they recalled correctly.

Discussion

Now you can explain the purpose of the study. A word whose meaning is processed (as in the first list) should be better remembered than one whose letters are processed. See if this is true by asking for a show of hands: How many students remembered more words from the second list than from the first? Write the number on the board. The phenomenon is very robust, but if you do not get the expected result, try to elicit reasons from your students. Hyde and Jenkins had nearly twice as many words recalled in the "pleasantness" condition as in the "e" condition.

Ask the students to suppose that you had asked them to intentionally remember the words. Would they have done better? Most will say yes, but Hyde and Jenkins found no difference for intentional versus incidental learning in this task. Discuss how the results of research do not always prove "what everyone knows." Then ask what was wrong about the way the demonstration was conducted. Students may note that it would be better to use different groups of subjects. Some may spot the order problem, and you can explain how the lists would be counterbalanced in a real experiment. You should discuss what the experiment says about the value of trying to study by memorizing the text, as opposed to trying to understand it. Point out that the amount of time was the same for each list.

Note. To counterbalance the lists in your classroom, you could distribute instructions before the demonstration prompting half the class to listen to words for "pleasantness/unpleasantness" and half the class to listen to words for the "e." Students should be instructed not to discuss anything with others throughout the demonstration. You could then read a combined list of words and then ask them to write down as many words as they recall, in any order. Allow 90 seconds for recall, then read the list and

ask the students to mark the words they recalled correctly. You could then ask for a show of hands of how many words were correctly recalled. The class should demonstrate different numbers based on their instructions. You can ask students to consider why students recalled different numbers of words, and either the students will guess—or you can reveal—the different instructions. As stated above, you can explain the purpose of the study and discuss what the experiment says about the value of trying to study by memorizing the text, as opposed to trying to understand it.

Reference

Hyde, T. S., & Jenkins, J. J. (1969). Differential effects of incidental tasks on the organization of recall of a list of highly associated words. *Journal of Experimental Psychology, 82,* 472-481.

ACTIVITY 3.3

Read the Label (The use of labels aids comprehension and retention)

From Bransford & Johnson, 1972

Concept

This exercise is intended to illustrate the importance of understanding what you are learning. Previewing the material will facilitate comprehension and organization for more effective retrieval. More generally, students should know that it is important to read, reread, and think about the learning material until it makes sense.

Instructions

This demonstration will take about 10 minutes. First, have students listen to the following paragraph:

> The procedure is quite simple. First, you arrange items into different groups. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities, that is the next step; otherwise, you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. In the short run this may not seem important, but complications can easily arise.

BACK TO CONTENT OUTLINE

Once they have heard the paragraph, have them rate their comprehension of the paragraph, and then try to recall as much of it as possible. Comprehension and recall will be fairly low. Then, have half the class put their heads down. To the remaining students, show this label: WASHING LAUNDRY. Then have all students listen to the passage again. Test everyone again on comprehension and retention. Those given the label will generally understand and remember the information better. Highlight the need for students to read their chapter titles and summaries before they dive in to their textbooks. Previewing the material takes very little time and gives a significant boost to comprehension and retention.

This demonstration highlights the fact that you should preview your course chapters before you start to read. Review the headings in the chapter and the questions at the end of the chapter before you begin.

See also

Klein, M. (1981). Context and memory. In L. T. Benjamin, Jr., & K. D. Lowman (Eds.), *Activities handbook for the teaching of psychology* (Vol. 1, p. 83). Washington, DC: American Psychological Association.

Reference

Bransford, J. D., & Johnson, M. K. (1972). Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior, 11,* 717-726.

ACTIVITY 4.1

Constructive Memory/Schemas: The Rumor Chain

Developed by
Douglas A. Bernstein and Sandra S. Goss
University of Illinois

Concept

This demonstration uses a childhood game, the rumor chain, to illustrate the constructive nature of memory. The demonstration can be presented before or after discussing constructive memory because the power of the phenomenon is great, even when students are sensitized to it.

The rumor chain game provides a simple, enjoyable, and dramatic illustration that the encoding and retrieval of information in long-term memory can be distorted by prior knowledge, especially by our schemas about the world. These schemas include gender-role expectations and other prejudices.

Materials

You will need a story that is short enough to allow retelling several times in class, but detailed enough that students are unlikely to remember all aspects of it. A sample is included in the following section.

BACK TO CONTENT OUTLINE

Instructions

Send three to five students out of the classroom (and out of earshot). Now read aloud a paragraph-length story to a student whose task is to repeat the story as completely as possible to one of the students who is brought back into the classroom. The newcomer's task is to repeat the story to the next student who is readmitted and so on until the last student who hears the story repeats it to the class. Each rendition of the story should be loud enough so that everyone in the class can hear.

Be sure to give instructions to the class to not laugh when errors are made because this may cause the storyteller to notice and attempt to correct mistakes. To facilitate discussion, instruct the class to take notes as each student tells the story, thus tracking the errors made.

Here is a sample story that works well for us:

> A TWA Boeing 747 had just taken off from Miami International Airport for Los Angeles when a passenger near the rear of the aircraft announced that the plane was being taken over by the People's Revolutionary Army for the Liberation of the Oppressed. The hijacker held a .357 magnum to the head of Jack Swanson, a flight attendant, and forced him to open the cockpit door. There, the hijacker confronted the pilot, Jane Randall, and ordered her to change course for Cuba. The pilot radioed the Miami air traffic control center to report the situation but then suddenly hurled the microphone at the hijacker. The hijacker fell backward through the open cockpit door and onto the floor, where angry passengers took over from there. The plane landed in Miami a few minutes later, and the hijacker was arrested.

Discussion

The errors made in each successive telling of the story are usually quite predictable and follow some basic principles of constructive memory.

First, the story gets progressively shorter as some details, such as the name of the revolutionary group and sometimes the flight's origin and destination are left out. This is referred to as *leveling.*

Second, some details—perhaps the caliber of the gun, or especially for women students, the gender of the pilot—are often retained; this is referred to as *sharpening.* Because individuals retain different details, this leads to a discussion of the schemas already in long-term memory that help us retain information in a meaningful fashion and how these schemas differ for different people based on personal experience.

Third, because many elements of the story are encoded semantically (i.e., as the meaning or gist of the story rather than as exact words), they are likely to be altered in line with each teller's schemas. For example, because for many students, even today, pilots are men and flight attendants are women, Jane Randall may end up as the flight attendant and Jack Swanson may become the pilot. Further, the hijacker is almost always referred to as a man, often as an Arab, even though no gender or ethnic information is in the story. You can relate this phenomenon to false assumptions made about the identity of those who blew up the federal building in Oklahoma City in 1995. "The open cockpit door" may evoke an image of an outside door, such that the hijacker is described as falling out of the plane. Finally, the schema of "angry passengers" may cause expansion of the story to include their beating, or even killing, the hijacker.

By asking the class to describe how the story changed with the retelling, you should be able to illustrate a number of the principles listed here. You can then go on to discuss the role of schemas and constructive memory in other phenomena, such as racial prejudice and errors in eyewitness testimony.

Writing Component

Two different writing assignments can follow this demonstration. For the first one, have students write a paper in the form of a letter to a friend or family member describing how memory works. The letter should address the common view of memory as a sort of video recorder, why that view is incorrect, and the importance of constructive memory. Shared examples of constructive memory between the student and the recipient of the letter could be supplied to illustrate constructive memory. For example, siblings often have different memories of the same incident in their childhoods.

Another assignment would be to have students write a paper in the form of a newspaper column on the role of memory in eyewitness testimony or repressed-memory cases. The paper should incorporate the rumor chain demonstration in a discussion of the issues surrounding these controversial topics. Remind students that their audience would be educated, but not necessarily knowledgeable about psychological principles.

Alternative Demonstration

As Smith (2013) portrays, a simple classroom experiment can also show the inaccuracy of eyewitnesses:

> Even when a multitude of people witness the exact same incident, the details they recall will vary vastly. In an experiment done repeatedly in college classrooms, the inaccuracy of eyewitnesses is revealed. Professors for decades have staged a robbery, an assault, or a simple delivery of an item by a delivery company, which takes place during class. The students do not know what is happening until after the experiment concludes. Everyone is asked to write down what he or she witnessed for the campus police. In a classroom of hundreds, no one writes the exact same description. (http://suite101.com/a/reliability-of-eyewitness-testimony-a400121)

Likewise, you may want to invite an unknown adult to walk into the classroom, make a random comment out loud, take something, say something about “where is your teacher?” and leave.* When you reenter, ask your students without talking to write down everything they can re-

* Please be sure the act does not alarm students and fits with school policy.

member about the perpetrator, as a crime has occurred with something stolen from the classroom. First, students can work as individuals, then in groups. Have the groups report their findings. You will find huge errors in judgment, and the groups are more accurate than individuals, but sometimes a strong person can sway the class or a group with the strength of his or her conviction.

References and Recommended Readings

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ACTIVITY 4.2

The Importance of Cues (Mantyla Cue Demonstration)

Materials and Concept

For this demonstration (based on research by Mantyla, 1986), you should ask your students to take out a sheet of paper and number it from 1 to 20. Then tell them you will present them with one word at a time and you want them to write down two things they think of for that word. For example, if the word is *toast*, then they might write down *butter* and *jelly*. If the word is *purse*, they might write *stolen* and *wallet*. Tell them to not perseverate over the associates and simply to write down the first two thoughts that come to mind. You should then present them with 20 words, one at a time, and give them enough time to write down two associates for each word. (You might want to use the following words: *whistle, teenager, cabin, time, before, cheese, stomach, country, barn, jeans, art, tool, moth, glue, spider, glass, shirt, grape, noise*, and *year*.)

Next, tell your students to turn over their sheet and then ask them to recall the 20 words that you said. After a groan or two, they will settle down and try to recall the words. Give them a couple minutes to do so, and you should find they have great difficulty recalling many words. You might ask them to think about why it is difficult to recall these words (e.g., because they didn't anticipate a recall test, they did not organize the material). Then, you should ask them to think about whether their problems in remembering the words are due to problems in availability (the words are no longer available in memory) or to problems in accessibility.

BACK TO CONTENT OUTLINE

Next, ask them to turn over their sheet, look at their list of cues, and see whether they can now recall the words. Give them as much time as they need, and you should find that nearly all students will remember nearly all of the words.

In discussing this demonstration, you should make at least two points. One is that much of our forgetting is due to problems in accessibility. The other is that the best cue for retrieval is what you thought about during learning—that is, the cues that were present at learning.

This demonstration was adapted from an experiment conducted by Mantyla (1986) in which he asked participants to write down three associations for each of 200 items on each of 3 days. They were given 20 seconds to write down the associations for each word. At the end of 3 days, after having processed 600 words, Mantyla asked some of the par-

ticipants to recall the items, and they recalled only about 60 words. When given their own cues, however, they recalled about 552 words—92% of the words! You might be wondering whether this impressive performance reflects good memory when you are given your own cues or the ability to guess the word when shown three associates. Mantyla tested this by giving a new group of participants the associations that other people had written (after having not seen the list) and found only 17% recall in this case. Thus, it appears that presenting you with your own cues stimulates effective retrieval (and not effective guessing). Generally, Mantyla's results demonstrate the power of memory when given your own detailed cues at retrieval.

Reference

Mantyla, T. (1986). Optimizing cue effectiveness: Recall of 500 and 600 incidentally learned words. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 66-71.

ACTIVITY 5

An All-Purpose Memory Demonstration

Concept

This demonstration provides an excellent way of either introducing the topic of memory or summarizing a range of material covered in a memory lecture.

Materials and Instructions

The demonstration requires only that you ask the class to listen as you read, at about one word per second, the following list:

bed, quilt, dark, silence, fatigue, clock, snoring, night, toss, tired, night, artichoke, turn, night, rest, dream

After a brief pause, give the class 30 seconds or so to write down as many of the words as they can recall.

When time is up, ask how many students recall the word "sleep." Many students will say they recall the word "sleep." Such a "recollection" must be *constructive memory*, since this word was **not** on the list. This also helps demonstrate the fallibility of memory.

Now repeat the list in order and ask for a show of hands by those who correctly recalled each word. By plotting on the blackboard the frequency of correct recall, you should be able to produce a reasonable approximation to the classic *serial position curve*. Recall scores should be best at the beginning of the list (*primacy effect*) and at the end of the list (*recency effect*). Words in the middle of the list should have the lowest scores, except for "artichoke" which should be recalled better than its neighbors because of its *semantic distinctiveness*; it has nothing to do with the topic of sleep.

BACK TO CONTENT OUTLINE

The word "night" should also have a particularly high score, not only because of the recency effect but also because its higher frequency on the list allowed for better *rehearsal.*

Finally, count the number of people who correctly recalled both "toss" and "turn." Due to *chunking*, recalling one should evoke the other. (Ask for a show of hands by those who recalled these words in sequence on their lists.)

Further Reading

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 803-814.

CRITICAL THINKING AND DISCUSSION QUESTIONS

CRITICAL THINKING EXERCISES FOR MEMORY

Exercise A

Have students work in groups to develop a response to the following:

> Roger is at a wedding reception where he has been introduced to over 50 guests whom he has never met. He would like to remember as many names as possible. Describe the role that sensory storage, short-term memory, and long-term memory play for Roger in this situation. Analyze what is happening in terms of the three stages of the information processing model of memory: encoding, storage, and retrieval. Finally, identify strategies Roger might use to improve his ability to remember names.

Exercise B

Have students imagine they are members of a jury and have listened to an eyewitness to the crime. His information is taken very seriously by the other members of the jury. Explain to them why eyewitness memory may not be as reliable as they believe it to be.

Exercise C

Adapted by Nancy Diehl, PhD, Hong Kong International School

The purpose of this exercise is to help students actively use memory principles as applied to academic learning. They will semantically encode content and use effortful processing and self-referent thinking as well as apply knowledge in a practical manner.

Working alone or with a partner, students should be instructed to write a letter to a younger student (for example a 9th grader) at their school to teach the student about effective ways to study. Letter writers should pick five of the most important tips they can relate to from the chapter on memory and explain what these tips are, how to do them, and why they

help. Students should be instructed to be creative. They should feel free to use images, comics, cartoons, or whatever might be needed to be engaging.

The letter should explain the information in language that is professional and appropriate to younger students at their school. Concepts can include spaced practice, the peg-word method, chunking, mnemonics, and self-referent encoding. Students may bring in other chapters to include references to sleep and stress reduction and developmental neuroscience (such as the continuing development of frontal lobe).

Exercise D

Have students devise mnemonic devices to help encode information about psychology concepts.

DISCUSSION QUESTIONS FOR MEMORY

1. What are the major assumptions of the information processing model of memory?
2. What are some examples of shallow and deep processing of information?
3. Describe some methods for increasing the capacity of working memory.
4. What are the differences between implicit and explicit memories? Provide examples of each type.
5. What are your earliest childhood memories? How accurate do you think they are? Why?
6. Think of an example of a time you have forgotten something and describe a mechanism or mechanisms related to that forgetting.
7. Provide some specific examples of proactive and retroactive interference.
8. What is prospective memory and why is it important? How is prospective memory different from other types of memory?

RESOURCES, REFERENCES, AND RECOMMENDED READING

RESOURCES

Websites for Teaching Activities

- *Great Memory Demonstrations*

  Dr. Timothy Bender, Missouri State University

  http://courses.missouristate.edu/timothybender/mem/mydemos.html

  Students can test their iconic memory based on Sperling's partial report technique through the activities presented on this website (specifically, the "Original Astound Demonstrations"). Please note that the software is old and that some demonstrations may not work. Potential users should test each demonstration to determine if it is suitable for use in their classroom. Anyone who uses the site may want to download the demonstrations and keep them for instructional use.

- *Memory Experiments From Neuroscience for Kids*

  Eric Chudler, PhD, University of Washington

  http://faculty.washington.edu/chudler/chmemory.html

  Several memory experiments, including one on chunking, can be found through this Neuroscience for Kids website.

- *Preparing Teachers for a Changing World: What Teachers Should Learn and be Able to Do*

  A good activity on self-referent memory appears in Chapter 2 of *Preparing Teachers for a Changing World: What Teachers Should Learn and be Able to Do* (Darling-Hammond & Bransford, 2005), available

online at http://blog.lib.umn.edu/cehd/teri/Chapter%20two.pdf (see pp. 43-45).

Bransford, J., Derry, S., Berliner, D., Hammerness, K., & Beckett, K. L. (2005). Theories of learning and their roles in teaching. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do.* San Francisco, CA: Jossey-Bass.

Videos

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The following YouTube videos, originally from Annenberg Learner's *The Mind* series, may be of interest to teachers:

The Mind: Life Without Memory: The Case of Clive Wearing Part 1a

http://www.youtube.com/watch?v=OmkiMlvLKto

The Mind: Life Without Memory: The Case of Clive Wearing Part 2a

http://www.youtube.com/watch?v=Lu9UY8Zqg-Q

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