


Introductory Guide to Psychology

Chapter 8: Memory

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Memory

In the last chapter, we learned about the theories and physiological and social components of motivation and emotion. We will now turn our attention to learning and memory, the processes by which we absorb and utilize information about the world in which we live. Much of our behavior, including how we learn, how we react to others, and how we respond to our environment is dependent upon our memory stores and processes; in this chapter, you will investigate how we encode, store, and retrieve memories.

Early Research in Memory

Research in memory began nearly as early as the study of psychology itself. Hermann Ebbinghaus, a German psychologist, began to research memory in the late 1800s and early 1900s, focusing on the links of association between words, sounds, and visual stimuli (Ebbinghaus, 1885).

Ebbinghaus believed that memory must be studied without using words that already had meaning assigned to them. Because he wanted to understand how we form associations between stimuli when no learning had previously taken place, he researched memory using nonsense syllables. He started his research using himself as a subject and memorized nonsense syllables such as *vuk*, *ter*, and *dur*. The measurement method he developed is called **serial learning** (also known as ordered learning), in which a participant is asked to repeat material in the order it was initially presented to determine if the correct sequence has been learned (Baddely, Papagano, and Andrade, 1993).

A few years after Ebbinghaus began his work on serial learning, another German psychologist, George Elias Müller, developed a technique called **paired-associate learning**, in which an unfamiliar word or nonsense syllable is associated with a familiar word. People often use this technique to learn a new language, when they associate a familiar word with its foreign counterpart.

The final measurement technique is **free recall,** which is now the preferred method of measuring learning; this strategy requires a participant to try to recall as many items as possible in no special sequence.

Ebbinghaus's early work led to our understanding of the **curve of forgetting**, which measures how we forget or remember what we have learned. While researching memory capabilities for learned material, he discovered that we remember material best directly after a learning session. Other psychologists have replicated this research many times; in one such study, results showed that participants recalled the most when tested immediately following learning (Jenkins and Dallenback, 1924). Participants were given a list of 10 nonsense syllables, which they then tried to recall one-half hour later and then one, two, three, four, and eight hours later. Participants were able to recall only half the material one-half hour after the session had ended, and their ability deteriorated as the time extended. Therefore, we remember the most directly after we have initially been presented with material—a concept not lost on many college students who spend late nights cramming for exams!

RECOGNITION AND RELEARNING

Two additional methods were later developed to test memory and forgetting. Students are probably most familiar with the first method, the **recognition method** for memory measurement, which involves recognizing previously learned items from a list. Multiple choice tests use this principle. The second method is a **relearning test** and it is just what it sounds like. First, participants learn a list of nonsense syllables and practice repeating them until they make no errors. After an interval of time, usually a week or more, the original material is studied again, and the researcher compares the amount of time it took participants to memorize the material the first time with how long it takes for

them to learn it the second time. The difference between the two scores is referred to as a **savings score**. A comprehensive exam is a good example of a relearning test. Chances are quite good that the second time you study material previously learned will be easier than the first.

Psychologists today rarely use the methods that were initially designed by Ebbinghaus and other early memory researchers. Today's research centers on examining the processes by which memories are formed and used. This paradigm shift was largely due to the recognition of the mind as an active agent with many organizational properties.

Memory as an Information Processing System

The advent of computers has opened up many new worlds—not only are all of you taking this class on a computer to further your education, but the development of computer technology has also enhanced our understanding of how the mind works. The computer has given researchers a new understanding of how memory works; in many ways, computers and memory are similar in that they both have three separate processing stages: input (encoding), storage, and retrieval.

First, sensory information is received and transformed into neural impulses that are either processed further or stored for future use. A good deal of encoding relies on **rehearsal** (repeating) the input and then organizing it into groups and relating the groups to already stored information. This stage of memory is similar to a computer encoding bits of information into its central processing unit.

The second stage of memory is **storage**. As in a computer program, information must be stored in memory. Some data is stored only while it is being used and is then discarded, while other information is stored in long-term memory.

In much the same way we bring up certain files from a computer's hard drive, the **retrieval** stage of human memory brings up memories stored in consciousness; certain cues aid us in this retrieval process. For example, if you want to remember a person from your past, you may rely upon a cue such as the circumstance in which you met the person originally.

INFORMATION PROCESSING MODELS

There are three types of memory in the human brain: sensory, short-term, and long-term. Memory storage involves one of these three different types of memory. Therefore, the information processing model must be modified to accommodate these different types of memory (see figure 8.1).

Figure 8.1 Modified Information Processing Model

SENSORY MEMORY

Sensory memory is just what the name implies; it is storage for sensory events that include sights, sounds, tastes, and smells and requires no further processing. We may receive several sensory stimuli simultaneously and information in the sensory memory is fleeting, usually only lasting a half a second to a second. The sensory information that is not sent on to higher levels of the brain for further processing decays quickly and is then replaced by new sensory information. Our attention plays an important role here—it is the stimuli to which we attend that are selected for further processing. So, how much sensory information is discarded? It is not a fixed amount; it depends on the amount of processing that is involved. When we process information thoroughly, which requires a great deal of

attention, much newly incoming sensory information is lost; however, when we process a larger number of items less thoroughly, we retain more sensory information (Kahneman, 1973). The information that is selected from sensory memory is processed into the next stage of memory: short-term memory.

SHORT-TERM MEMORY

Upon selecting the sensory information to which we will attend, we must transfer it into conscious awareness (Engle, Cantor, and Carullo, 1993). Atkinson and Shiffrin (1971) devised a model of memory processes (see figure 8.2), which theorizes that information must undergo processing in the **short-term memory** (STM) before it can be transferred into more permanent storage. Short-term memory lasts a very short time—perhaps only as long as a few seconds. Most research indicates that the length of time is only around 10 to 20 seconds (Brown, 1958).

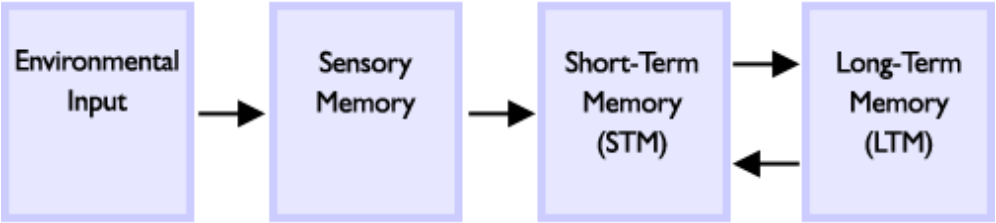

Figure 8.2 The Atkinson-Shiffrin (1971) Model of Memory

Atkinson and Shiffrin believe that two processes are at work in short-term memory: (1) information that is not repeated or practiced grows weak very quickly, and (2) some memories are quickly displaced to make room for the continuous stream of incoming information.

A quick exercise will help you understand how short-term memory works. Study the following phone numbers for 15 seconds:

415 – 287 – 3456

617 – 298 – 3285

508 – 967 – 5672

After studying the numbers for this short time, write them down on a piece of paper without looking at this page. Could you remember all three numbers? If you are like many people, it is probably very difficult to remember all three numbers. Research in short-term memory suggests that the average person can hold approximately seven items (plus or minus two) in STM at any one time (Miller, 1956). Some of you may be thinking, "I remembered two phone numbers and that is more than nine items of information—it's twenty numbers total." However, when you say the numbers, you pause in between the dashes, which breaks the numbers into groups. Therefore, two of the numbers equal six chunks of information, and all three numbers equal nine chunks. When we chunk information into groups, it makes it much easier for us to remember it.

The original theory of STM had some problems—it was way too short. While 10 to 20 seconds is long enough to input and store new information, it is not long enough to process the information (Ashcraft, 1994). Therefore, a modification to the theory was developed that added a second phase to STM, **working memory**, in which attention and conscious effort allow us to process information.

LONG-TERM MEMORY

If we did not have processes to transfer memory into long-term storage, we would not be able to function very well. You would not be able to remember any of the information you have learned previously in this class! It is critical that we be able to transfer information from short-term memory into permanent storage: **long-term memory** (LTM). Unlike STM, LTM has a surprisingly large capacity for storage—in fact, it is likely to be unlimited.

Atkinson and Shiffrin stress the importance of **rehearsal** (repeating) information to move it into LTM. If you repeat or practice information, it is much more likely that you will remember it. There are two different types of rehearsal: maintenance and elaborative. **Maintenance rehearsal** allows us to save memories for a short period of time. You have probably used this technique when you dialed directory assistance for a phone number and did not have a pen handy to write the number down. With maintenance rehearsal, we remember information only as long as we need it and then discard it. The other type of rehearsal is **elaborative rehearsal**, which aids in the transfer of memory into LTM because it adds meaning to the material that we want to remember. When you meet new people for the first time and want to remember them, you probably pick out certain aspects to remember that will help you identify them easily the next time you meet. The more meaningful information, the better it is learned.

Once we go through all the trouble of moving information into long-term memory, why do we forget so many things? It appears that some of the memory is lost because it simply fades away—referred to as **memory decay**—but some of it is lost because of interference, which may cause incorrect memories to be recalled. This effect is called **proactive interference**, which occurs when old information hinders our ability to remember new information. For example, if you move to a new house and do not transfer your old phone number, it may take you awhile to retrieve the new number when asked. Your first instinct would be to recite the previous one. Similar to this is **retroactive interference**, which occurs when information that was learned after an event or item we're attempting to remember hinders us from remembering it. For example, sometimes we *want* to remember old phone numbers or addresses, but when we search our memories, we can only recall new phone numbers or addresses.

Types of Long-Term Memory

We have more than one type of long-term memory. A memory is not simply placed into long-term storage, but rather the type of information influences the nature of the stored memory. Four types of LTM exist: procedural, semantic, episodic, and implicit.

Memory we use in skilled actions is called **procedural memory** (Anderson and Fincham, 1994). Remembering how to ride a bicycle, play a card game, or type on a keyboard are all examples of procedural memory. This type of memory is often used in conjunction with other types of memory. For example, if you are typing up a term paper, you will use procedural memory for keyboard skills but other types of memory for the content of the material.

Semantic memory refers to a bank of general knowledge, which includes concepts, the meanings of words, and facts (Rohrer et al., 1995). An interesting experience that occurs with semantic memory is the tip-of-the-tongue phenomenon in which some fact is right near the surface of your memory, but you cannot recall it.

Events that occur at certain times, regarding specific people, dates, and places, are stored in **episodic memory** (Goldringer, 1996). Episodic memories may be your high school prom, a movie you saw, or a night you spent clubbing. **Flashbulb memories** are episodic memories of situations that are very arousing, surprising, or emotional. A good example of this is September 11, 2001. You probably have a clear recollection of precisely where you were, whom you were with, and what you were doing when those devastating events occurred that day.

Priming memory (also called implicit memory) is one of the newer additions to our knowledge of LTM and may be one of the most important discoveries in memory research. **Priming memory**, which associates perpetual identification of words and objects, is a nonconscious form of memory. Because priming does not operate on the conscious level, it has been difficult to study. However, it is now understood that priming facilitates procedural and semantic memory processes by improving our ability to identify perceptual stimuli or objects we encounter (Rajaram and Roedinger, 1993).

Retrieval

Retrieval from short-term memory is not instantaneous; we must scan the STM, locate an item, and process it. Retrieval of long-term memories is much more complicated. Depending upon the situation, different processes may also be involved.

Semantic networks are formed by related concepts called **nodes** that are linked together (Collins and Loftus, 1975). One node activates the next, and the various links between nodes may be long or short, reflecting the strength of association. Not all memories are arranged in semantic networks, in which one concept triggers related items. Sometimes we use a clustering or grouping of knowledge about a sequence of events or an object, known as a **schema**. For example, when you get ready to go to a party, you may plan on a designated driver or a taxi and decide what to wear—both based on a schema you developed by going to similar parties in the past.

Memory Skills Techniques

As students, you may be very interested in the different strategies that have been tried and tested to improve memory skills. Research indicates that we learn best when the material is meaningful and when only one topic at a time is studied (Moravescsik and Healey, 1995). Also, it seems that we must concentrate more closely on the material we review during the middle portion of a study session than the material we review at the beginning or the end; this is called the **serial position effect** (Gershberg and Shimamura, 1994).

MNEMONIC DEVICES

Techniques that associate new information with previously stored memories are called **mnemonic devices**. These devices are forms of elaborative rehearsal and result in deeper processing. It is easier to remember new material when you first recall previously learned information and then recall the new information that has been associated with it. Some people swear by these techniques, yet others feel they are not very effective—try them for yourself and see what you think.

Using mental pictures often helps you to remember the items you study (Dewhurst and Conway, 1994). Research indicates that simply repeating items over and over again does little to help you recall them, but visualizing them does help. For example, in remembering the three stages of memory, it may be more effective to visualize a computer's similar processes than to simply think "encoding," "storage," "retrieval." Visual information is called **imagery**, and two specific methods have been developed for visualizing information: the method of loci and the pegword technique.

Loci means "places" in Latin, and the **method of loci** involves using cues to specific places that are stored in memory. To begin using this mnemonic device, you start with a set of familiar locations. For example, on your way home from work, list in order the major landmarks you see every time you take a specific route. Then assign each location an item you want to learn. For example, you may see a large oak tree at the end of your driveway; if you are remembering parts of the brain, you may want to assign "medulla" to the oak tree, and so on. To recall the parts of the brain in order, you would call up the mental images of the things in the order you see them on your way to work.

The **pegword technique** is similar to the method of loci in the way meaning is assigned; you start with a list of items you already know quite well. If you were using the pegword technique to remember parts of the brain, you would assign each part of the brain to a certain song on a favorite CD. When you need to recall the information, you simply go through the tracks on the CD to associate them with the parts of the brain. The big difference between the method of loci and the pegword technique is that the loci method visualizes locations and the pegword technique uses an already established list of items.

There are also mnemonic devices that involve reorganizing or coding data. **Chunking information** is also useful as a memory strategy. In chunking, we simply categorize information into meaningful groups. We often do this subconsciously; psychologists who have researched memory strategies have consistently found that we tend to group items when we recall them (Bousfield, 1953).

When items are not very meaningful or relevant to you, you do not learn them as effectively as items with personal significance. With the **coding method**, material that lacks relevance is assigned a code to give it meaning. A specific type of coding uses an acronym. An **acronym** is a word formed by the initial letters of the items to be remembered. For example, to remember a list of the four types of long-term memory (procedural, semantic, episodic, and priming), you may take the first letter of each (P, S, E, and P) and then create a code using each of the letters, such as **P**aper, **S**cissors, **E**nvelopes, **P**ens. These four words are related as office supplies—which may make the four types of memory easier for you to remember!

Another type of coding is an **acrostic**, which is a verse or saying where the first letter stands for a bit of information. Using the example of types of memory, you might devise an acrostic such as "**P**ick **S**omething **E**lse **P**lease." You may have already used techniques such as acronyms or acrostics—students often do.

Amnesias

When new information cannot be stored after traumatic brain injury has occurred, it is known as **anterograde amnesia**. One of the most famous cases of anterograde amnesia is that of H.M., who had an operation in which large portions of his hippocampus and amygdala (parts of the brain associated with memory) were removed; since this operation, he has been unable to form any new long-term memories (Scoville and Milner, 1957). He cannot remember what he had for lunch, the names of people that he has met recently or what he did on his last vacation—his memory is solely short-term. This famous case gave researchers a great deal of knowledge about which parts of the brain work with which memory processes. It is the hippocampus or amygdala that is responsible for the processes used in forming new long-term memories.

Retrograde amnesia may also be caused by traumatic brain injury or a traumatic event; however this type of amnesia involves the loss of memory of events that occurred before the trauma. For example, many people cannot remember the trauma of an assault or accident.

Summary

In this chapter, you have learned about the complexity of our memory processes, including how we encode, store, and retrieve our memories. You've also learned about the organizational skills and techniques that allow us to use information more effectively. In the next section, we will turn to how we develop cognitively and learn, which depends heavily upon memory.