Long-Term Memory

6

Long-term memory has been an integral area of focus in cognitive psychology for many decades. Within the study of long-term memory it is worth noting that there will be several ways in which memory can be divided. All these different divisions will show different levels of overlap with each other. The first division of memory is declarative versus non-declarative memory. This can also be referred to as explicit verses implicit memory. **Declarative memory** in long-term memory contains knowledge that can be retrieved and consciously reflected upon. There is conscious awareness associated with declarative memory. **Non-declarative memory** is memory that is retrieved automatically and is outside of conscious awareness. These are often related to motoric processes such as skills like using a wrench or riding a bicycle. Non-declarative memories are generally not capable of being expressed verbally. Non-declarative memories are often automatic processes. The difference between explicit and implicit memory not only refers to accessibility, but also the content of memory. **Explicit memory** focuses on facts and events. **Implicit memory** falls into the category of skills, priming, conditioned responses, and non-associative learning.

Dividing memory up by content shows some of the largest differences in memory: episodic and semantic memory. **Episodic memory** is a type of declarative memory that is a person's autobiographical memory. These are experiences that have been experienced by the person themself and are actual remembered events. They are personal memories from the person's experience and often have sensory and emotional detail attached to them. In terms of storage they consume a large number of memory resources.

What causes someone to create an episodic memory? Episodic memories are created automatically. Often emotional situations create episodic memories. New and unusual situations stick out and grab out attention. There is a tendency to create new memories based on new/novel situations. This is called the isolation effect or sometimes the von Restorff effect (von Restorff, 1933).

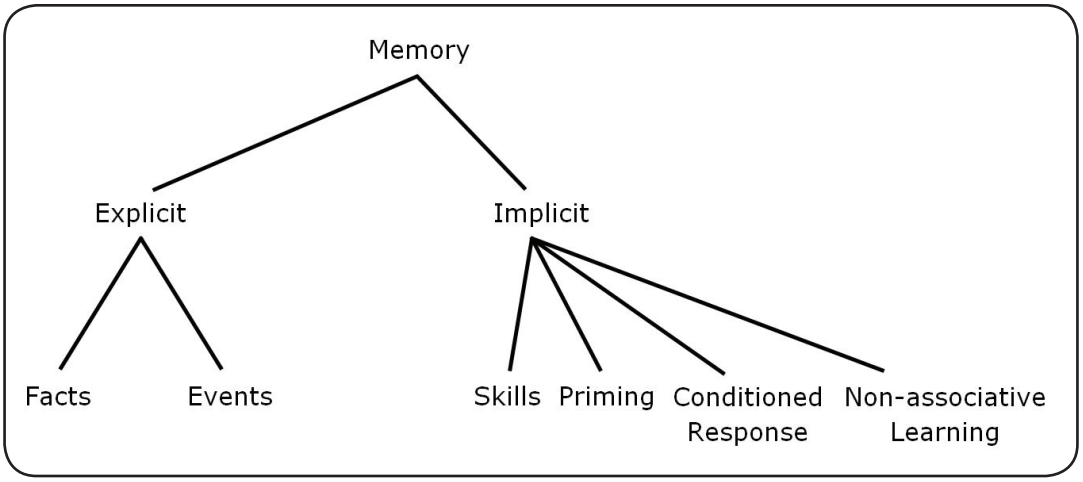
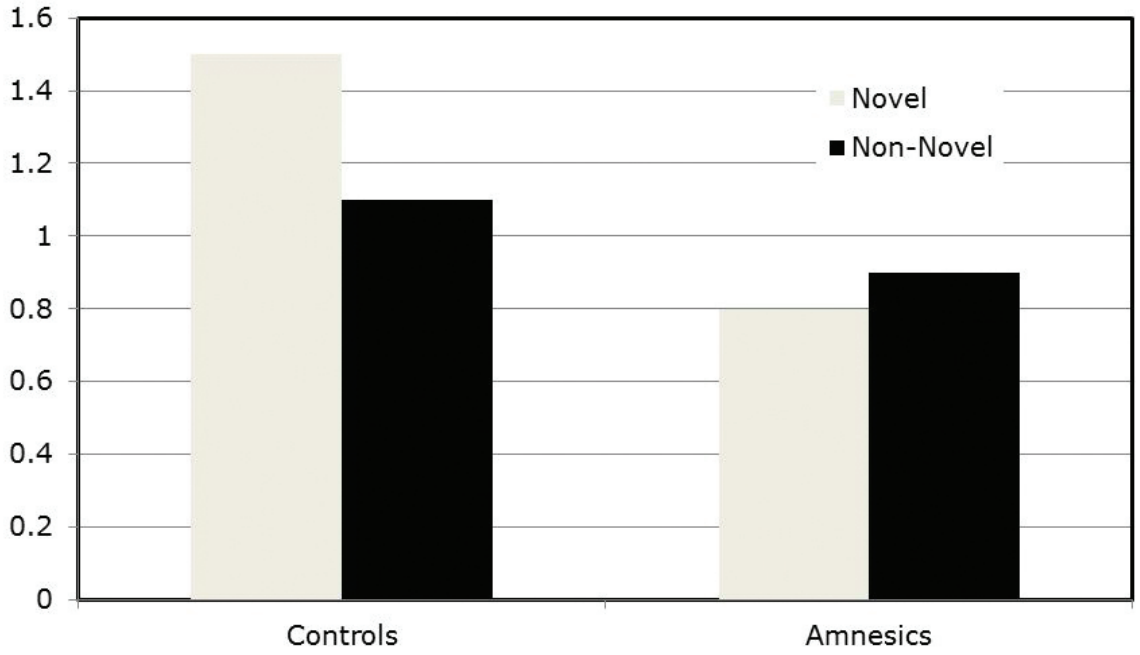
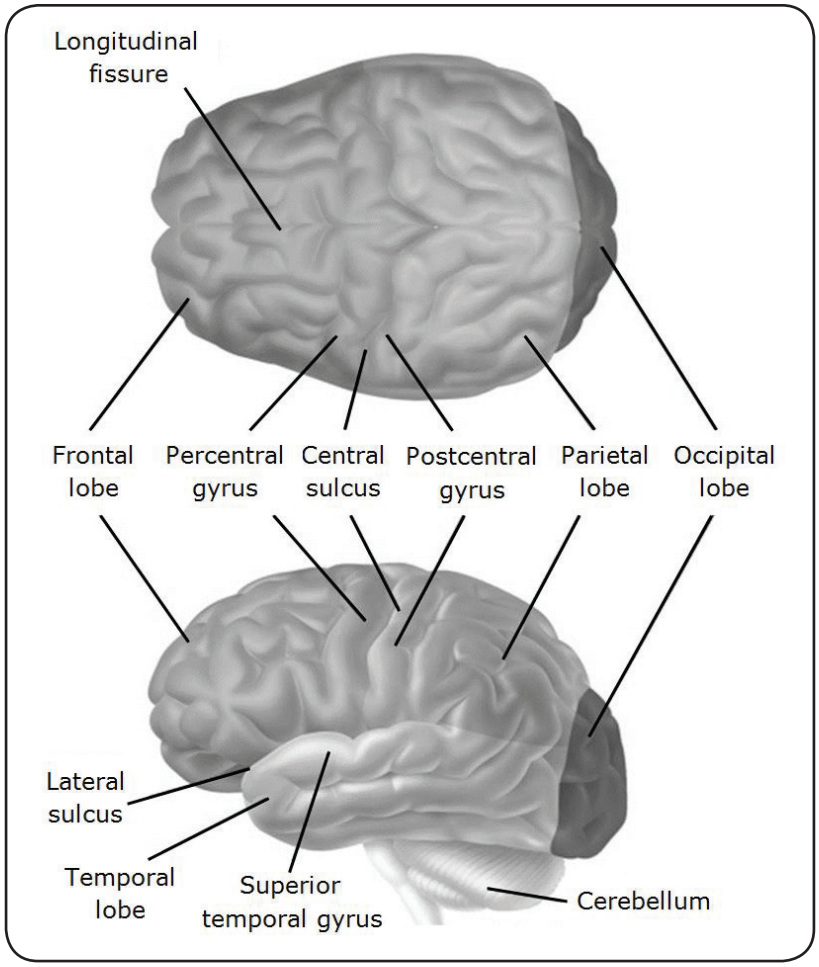


Figure 1

Kishiyama, Yonelinas, and Lazzara (2004) used a measure of sensitivity to example the von Restorff effect in healthy controls and amnesics. Healthy controls distinctly showed the von Restorff effect with novel items.





The different lobes of the brain process information and store memories. The frontal lobes play a role in episodic memory and the temporal lobes are involved in semantic memory.

In contrast, **semantic memory** is general world knowledge, knowledge of different concepts and ideas. They do not actually have to be experienced, these can be acquired. For example, your knowledge of history, one did not have to be at these historical events, one could read about these events in a textbook or attend a lecture. You do not have to have been at the Battle of Verdun to learn facts about the Battle of Verdun. A way to contrast between episodic and semantic memory is remembering what one did on your ninth birthday versus what happened on your last birthday. This is the difference between remembering and reconstructing. One might remember what they did on their last birthday because that would still be rather fresh. This would be use of episodic memory, however the ninth birthday might be so far off that you might not have the episodic memory. What may happen is that a person might reconstruct an episodic memory of what could have happened on their ninth birthday based on something plausible from semantic memory such as the knowledge of birthday traditions and your favorite foods. For example, if they know that chocolate cake is their favorite type of cake, then most likely on their ninth birthday they had a chocolate cake and played pin-the-tail-on-the-donkey. **Semantic dementia** is a condition in which a person retains working memory function and episodic memory, but suffers severe impairments in semantic memory

Long-term memory is a large vast storage area, and as a result, trying to get information in and out can be onerous at times. Use of mnemonic devices helps make retrieval as well as encoding much easier. A mnemonic device is any active or strategic learning device or method. Such as a rhyming scheme, or creating a little word that serves as an acronym of things within it. Mnemonic devices have several key characteristics. First, the mnemonic device must help you remember. Mnemonic devices must be effective and must be more effective than no device at all. Often some self-generated mnemonic devices are overly elaborate, but do not help the individual remember the material. The strength of a mnemonic device is based upon the material to be learned and is repeated over and over until it is mastered. Second, the material is integrated into an already existing framework, which is often personal. People can relate material to personally meaningful bits of information such as music, history, cars, etc… Third, the mnemonic device provides an excellent means of retrieval; therefore there is a high level of accuracy in recall.

An example of a mnemonic is the peg word mnemonic. This is where a pre-memorized set of words serves as a sequence. Each piece of material reflects a peg that can be hung on. There is an order that involves visual imagery. The mnemonic device starts out as: one is a bun, two is a shoe, and three is a tree. The visual imagery for the first item would be to memorize a bun, like a hamburger bun. Let us assume the first word is "wolverine." They must picture that a wolverine is in a hamburger bun. Continuing on the second word to be recalled is coffee mug. The person must recall that coffee mug is in the shoe. These are the mnemonics one is a bun, two is a shoe. A criticism of a peg word mnemonic is that one must memorize these rhyming mental pegs. Furthermore, and more critical, is that the peg word mnemonic is not personal. People will often have trouble grasping the relationship between the peg and the material to be hung upon it.

A more effective mnemonic is the method of Loci. The method of Loci involves a mental walk through a particular place. This place would be something familiar such as a person's own house or place of work. An example of the method of Loci would be a person coming into their own house might walk through the front door where there might be a hall closet to hang their coat and then pass through the living room and into a kitchen. What they might do is remember things to be remembered at each location. The list might consist of: wolverine, coffee mug, and milkshake. What they must do is remember that there is a wolverine in the closet, the first place they encounter. They must pass through the living room and find that there is a coffee mug on the couch in the living room. Then when they go into the kitchen, in the stove they will see an image of a milkshake. This works by having an already existing framework that is well known and personal to the individual. When looking at the usefulness and effectiveness of mnemonic devices as the method of Loci provides a good structure and the use of visual imagery for learning. Those locations also serve as cues. In the case of the method of Loci, those areas are well known to the individual, there is no effort put into pre-memorizing such things as: one is a bun, two is a shoe. One can just imagine those objects at those specific locations.

Although a mnemonic can help you to remember something it cannot help you remember when to remember something. Remembering when to do something can be difficult. **Prospective memory** is remembering to do something at a later time. **Time-based prospective memory** is remembering when to do something after a *specific* amount of time. The longer the time frame the more difficult it is to remember when to perform the action.

6.1 Models of Long-Term Memory

A way in which to conceptualize long term memory is to describe it as a network. In this network representations are on individual nodes with in a network. Each node represents a key element or idea and will form links or associations between the nodes to form large representations. A network can resemble at times a spider web. With this view of the network you can visualize the direction and transmission of information.

Activation of one node leads to the activation of adjacent nodes. The associative links between nodes are meaningful relationships. Not all associations have an equal level of strength; some associations are stronger than others. Often, these strong connections between nodes, represents integral facts. In a network that would represent *penguin* the nodes that will relate to penguin will be close in association and have great strength, will be nodes like *flightless* and *Antarctica*. Nodes with weaker association to *penguin* may be related to *eggs being balanced on their toes* or *varies in size.* This also highlights a component about activation of nodes. Often there is an automatic activation of more pertinent information represented by strong associative link.

What causes these strong connections in networks? First, as mentioned earlier, is that often integral, defining features will have strong connections to each other. Secondly, information that occurs in great frequency with each other will form connections. For example: peanut butter and jelly will often will be activated together, even though if we were to look at the characteristics of peanut butter and the characteristics of jelly, they are technically quite dissimilar. However, because they appear in the regular context of a peanut butter and jelly sandwich, the high frequency in which they occur forms a strong association. Finally, one way to form strong associations is by means of elaborative rehearsal. Elaborative rehearsal is a technique for trying to learn information by forming a deep meaningful connection for the material. If you were to try to memorize a list of words, you could repeat them over and over, but this is not a strong association. If you were to try in form a visual image of what each word means, that forms a stronger association and is the backbone of elaborative rehearsal.

Something that people noticed is that when they mention a certain topic, they then also automatically think about something similar. Perhaps, somebody mentions that they should pick up butter the next time they go to the grocery store, the other person hearing this says: "oh grocery store, that reminds me, the other day at the grocery store I saw your old college roommate..." In this case, what happened is the activation of one node, grocery store, activated the memory of having seen that person's college roommate. This process of activation of adjacent nodes is known as **spreading activation**.

Spreading Activation can often be thought of as dropping a pebble into a small pond, where the ripples move away from the point of contact. In spreading activation the activation of one node causes a ripple effect along associative links that happened to cause adjacent nodes to activate. This will in turn cause that node which was just activated to spread the activation into adjacent nodes.

The question somebody might ask is: "Why doesn't the activation of one node activate all nodes?" We have already talked about how certain activation links are stronger than others; therefore, as activation occurs weaker associations will tend to fade out. Spreading activation also decreases overtime. In addition, some activations travel weakly to connected nodes, this is where the activation levels falls below the threshold. This is referred to as sub-threshold activation. In sub-threshold activation, what is required to activate the threshold of a node are several other nodes that are connected to this node. This combined activation of the node under sub-threshold activation creates a summation effect where multiple nodes will be fired in order to make a node active.

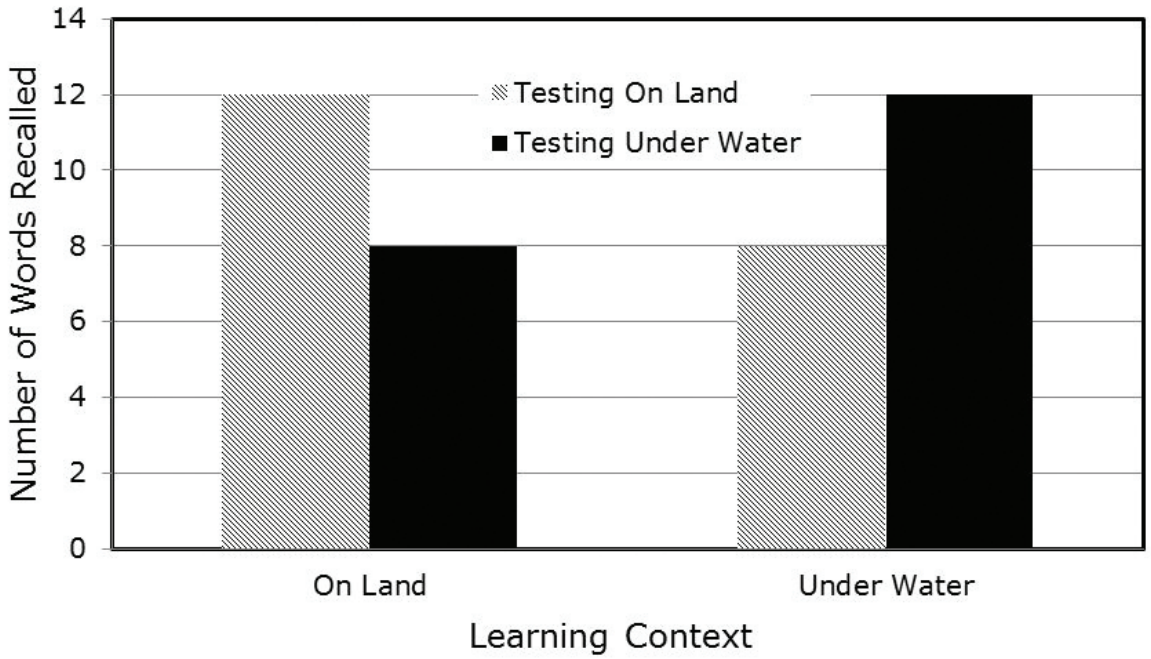
Some nodes, will cross the threshold easily. For example, if I wanted you to think of Thomas the Train and I were to say "talking train", it will be easy for you to think of Thomas the Train. However, if I were to say, "blue character", "needs steam", there is only going to be a small amount of activation for Thomas the Train. As I activate more nodes such as "children's icon" and "British TV show" this will start to have a summation effect that will eventually cross the threshold to identify "Thomas the Train."

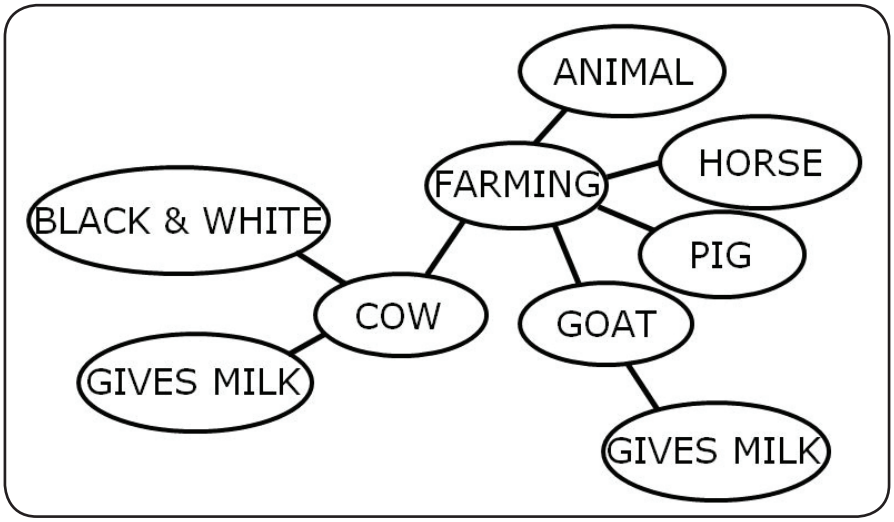
Different phenomena point to the evidence of networks, one key area is the use of context. We have seen that if somebody were to learn something under one context such as in a classroom, that retrieving that information in a classroom will be much easier than if they were to retrieve that information in a dissimilar place such as a night club. It seems perplexing that if you have learned the material then it should have a solid representation in your mind. Your location whether you are at a night club, a classroom, on a ship or on the moon, should not appear to affect how you recall that information. However, time and again, studies show having the same context for encoding and retrieval of information does improve the overall performance. How does this context effect work? Earlier in this chapter there was a discussion of sub-threshold activation. What context does is to serve as a way of activating nodes that have an associative link with the material, therefore at the time of encoding this material is also including association with the node related to the context. When that context is entered, such as going into a classroom, this activates the nodes for the context therefore, facilitating when the time does come to recall that information.

Another method that has been used to study networks is the sentence verification task used by Collins and Quillian (1969). The sentence verification task is where a person is presented with a sentence and they must respond by hitting one of two buttons saying whether the sentence is true or false. It is important for subjects to be quick and accurate in the sentence verification task. Collins and Quillian theorized that reaction time and accuracy would increase for sentences where the subject of the sentence also has a description. For example, if we will to encounter the sentence "a robin is a bird", or "a robin has eyes", the fact that "a robin is a bird" will be responding to much faster than "a robin has eyes." This is because the robin being a bird will be a key feature. In contrast, eyes are a feature of many different animals. This can be understood by comparing sentences like "dogs have wet noses" which will be responded to faster than "dogs have pancreases."

Figure 2

The results of encoding specificity from Godden and Baddeley (1975). People would learn a list of words either on dry land or under water. Subjects were given a recall test either in the same location they learned the list or in a different location from where they learned the words. The results clearly showed the advantage of encoding specificity.





Collins and Quillian's Model of Long-Term Memory.

In this case, Collins and Quillian noted that information that is stored will have a category where other information is already accessible. For example, many animals already have a pancreas, therefore, that property is not going to be associated (or at least will have a weak activation link) with sentences where key defining elements are associated. The cold wet nose of a dog is a defining feature of a dog. If we were to think of a duck, the key defining features will be web feet and the bill. Collins and Quillian noted that by also having to go to a larger category (e.g., "a duck has feathers") that will have a longer reaction time than "a duck has web feet". It is not only because there is a strong association between duck and the defining feature web feet, but they are also one jump along the link. Longer times happens by going back to the nodes of duck to bird and then to feather. Feathers are a component of birds and a defining feature of birds. In this situation there are three nodes activated rather than with "ducks have web feet", only two nodes are activated.

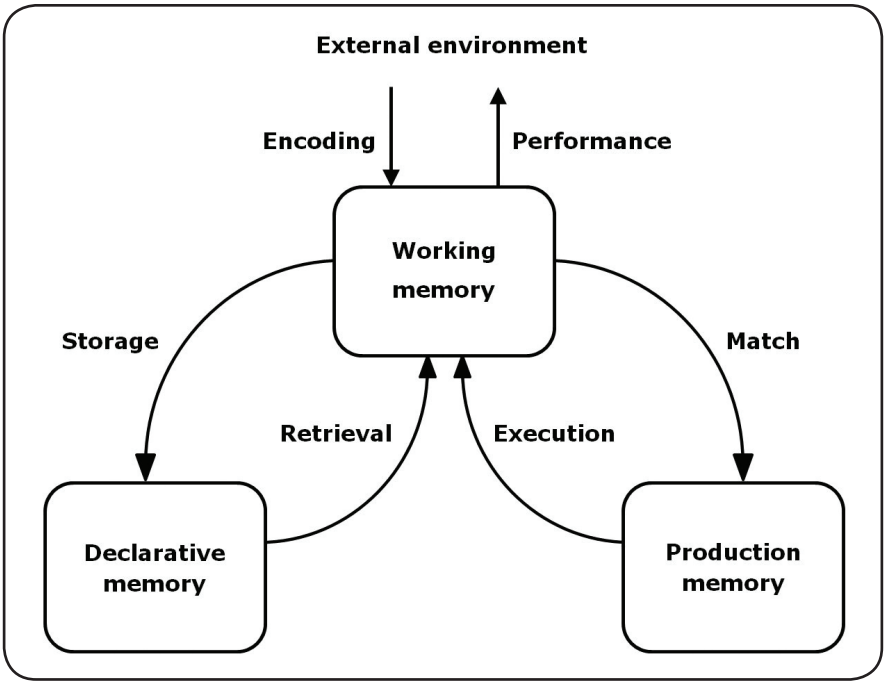
Collins and Quillian also noted that certain animals will be responded to quicker than other animals; "A sparrow is a bird" will have a faster reaction time than "an osprey is a bird". This is because sparrow is a more frequently encountered bird. This is known as the typicality effect. Often when examining certain semantic categories there is often activation of a representation that has a strong association with that semantic category. That node that is activated is called an exemplar. An exemplar is a typical and prime example of a category. If we were to activate the node of dog, the exemplar would be a dog similar to a Labrador or Golden Retriever; a Chihuahua or Pekinese would not be exemplars, they do not possess the average typical attributes of that category.

Another factor in networks strength and speed is the degree of fan. Degree of fan refers to the number of nodes attached to a single node. There are other nodes that are fanning out of it. Often we will find that frequently encountered and well-know things will have more information attached than more obscure nodes. A high degree of fan will allow for greater activation and ease to access to information. Furthermore, with high degrees of fan there will be greater spreading activation so more information will became accessible. If you were presented with a list of names of comic books superheroes and you see the name, *Ironfist,* you may know very little about this character. In that case one node that will be activated is *knows kung-fu,* another might be the node *fights crime.* However, *fights crime* would share an adjacent link with *Batman*. If *Batman* were activated then that would also activate, *has a Bat-mobile,* is *Bruce Wayne, has a butler, has a side-kick Robin,* and also there is information associated with *Batman.* This is because Batman is well-known to people who are not into comic books and there are many movies made about Batman. The spreading activation will most likely continue and may even activate the names of actors who have played Batman in movies such as Ben Affleck. If a *Ben Affleck* node is activated, then we may also think of movies that Ben Affleck has been in movies such as: *Mallrats, Chasing Amy,* and *Dogma*. This will in turn activate other adjacent nodes such as *Kevin Smith movies.* Therefore we see nodes which have a high degree of fan, such as Batman, can activate other nodes and those adjacent nodes having a high degree of activation also will continue on the spreading activation.

Although Ben Affleck (center) may not bear even a slight resemblance to Kevin Smith (in shorts); the activation of the Ben Affleck node can activate Kevin Smith based upon movies in which both actors have appeared.

When looking at spreading activation along nodes, the activation appears to be omnidirectional. However, we noticed that with certain concepts the nodes tend to be activated in certain ways. Almost everyone says "peanut butter and jelly sandwich." Does anyone really say "jelly and peanut butter sandwich?" The reason that this may came about is due to a relationship between the peanut butter and jelly and their specific attributes. In this case the peanut butter is the substance that is placed against the bread, therefore, it's the first thing to be used when making a peanut butter and jelly sandwich; the jelly is added after the peanut butter. Therefore, this provides a directional relationship between the two. Elaborating on the idea of networks, we can see that this relationship between nodes and this unequal directional relationship has an important factor for how information is represented. Anderson (1976, 1993), proposed a model of networks where nodes represented complex ideas that are in a directional relationship. This directional relationship is referred to this as a preposition. A preposition is a small node that can be either true or false. For example: "cars have wheels" is a preposition, but the word "cars" alone although a node is not a preposition. A preposition must be true or false and state a relationship.

Anderson's model of long-term memory is similar to a computer program. Anderson called his model ACT, later ACT was revised to ACT-R. In ACT there are nodes in associative links. These associative links are directional. The ACT model involves the use of syntax. Syntax allows for the understanding of prepositions by distinguishing the roles of the characters within that preposition. For example: "I drink beer", does not equal "beer drink I." The syntax serves as a vital clue for the conceptual understanding of the preposition.



The ACT model uses directional association links.

The ACT model is also able to discriminate between generalized prepositions and specific prepositions. A generalized preposition will involve type nodes. Type nodes are broad categories and contain prepositions that are true for entire categories. For example: the preposition "people from Spain speak Spanish" involves a type node that contains general prepositions about people in Spain. Specific instances can be put into token nodes. Token nodes are more individualized in nature. For example, there may be a node that is a type node that "many people in the Czech Republic drink beer." A token node will be "your uncle Fred drinks Guinness beer." That node about your uncle is a token node because it specifically refers to an individual.

The ACT model can also discuss time relevant information vs. time sensitive information. A time relevant piece of information as a preposition would be "Ted goes skiing." Something that would be more specific such as "last week Ted went skiing" would be time sensitive. The ACT model can also take advantage of recent activations as well as strong and weak associative links. Another way of looking at networks is through **connectionist models**. Connectionist models, also known as connectionist networks, utilize distributive representations of information. Connectionist models identify information and ideas by the use of patterns of activation. In this case different nodes must fire together which will form a representative pattern that would then activate the overall node necessary for identification and retrieval of that specific information. Also connectionist models state that any idea or piece of information is represented by a wide distribution of nodes. Often connectionist models are referred to as Parallel Distributed Processing Networks (PDP). This is because often the activation of one pattern of nodes will also cause the simultaneous activation of other similar nodes. This is in the same way as how hearing a song on the radio by a certain band can make you think of other similar bands. This activation is partially based on upon a pattern of activation that is relevant to the characteristics of the concept. If you were to hear "Blitzkrieg Bop" by the Ramones, part of the characteristics of the pattern that is activated by the Ramones, will also cause activation of similar bands such as The Misfits or the Damned. This similar pattern of activation might be caused by vocal styles or similar rhythm patterns. The simultaneous activation of similar patterns

also explains instances of misidentification. A person might hear a song, for example: "Stuck in the middle with you" by Stealers Wheel and mistake it for a song by Bob Dylan. The leadsinger for Stealers Wheel, John Egan, has a similar vocal sound to Bob Dylan. As a result, the patterns of activation in a parallel distributed processing network will be similar and misidentification can occur.

An advantage to parallel distributing processing is simultaneous multiple constraint satisfaction. Simultaneous multiple constraint satisfaction is where we can have a pattern of activation for something that fits with our demands and therefore we can have multiple demands became active. Let us say you are trying to perform a repair and you need to loosen a hex bolt. A tool for this could be a combination wrench, a socket wrench, or an adjustable crescent wrench. All three will work just fine and as you search through the tool box, which ever you come upon first will be used. When examining instances of simultaneous multiple constraint satisfaction, it does become apparent where there may be very similar patterns of activation, but only one outcome is preferred despite the similarity with the other attributes. In PDP models networks are connected but there is no central authority. Instead what will govern which pattern of activation is preferred is based upon connection weights. Connection weights represent strength between different nodes

As previously mentioned, there is no central authority determining how coordination between nodes occurs. Researchers of connectionist models have offered the idea of learning algorithms. Learning Algorithms attempts to accomplish learning by using connections weights. This creates different schemas that are learned at a lower level and start to generalize to larger levels. Eventually this leads to a **script** which is a specific set of procedures to follow. The benefit of learning algorithms is that when something is learned and has a strong connection weight is often difficult to unlearn. This is also refers to issues with automaticity that once a skill is learned it is hard to unlearn that particular skill. In connectionist models an error signal may occur when new information occurs that requires the correction of old information. This then creates an error signal which goes back to a process called back propagation and allows for changes in the weights of connections and pattern of activation to correct the model.

6.2 Metamemory

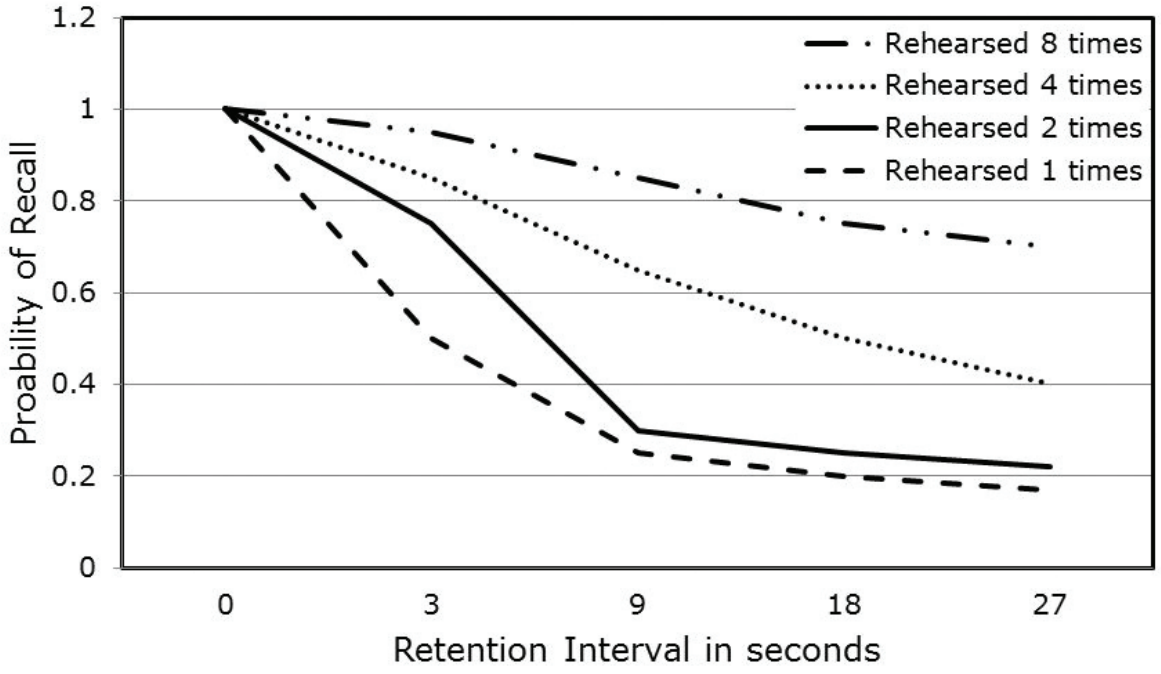
Metamemory is similar to metacognition; it is knowledge about one's own memory. Unlike like metacognition which deals with the understanding of not just memory, but attention, preference for one type of stimuli over another such as being better with numbers or words, metamemory is an understanding of your own memory. Metamemory assists you in understanding memory limits, such as your **operational span**, and preferences such as what mnemonic devices work for you, what type of information you are more easily able to store and retrieve. It is also involved in understanding the source of memory such as where did you acquire this memory as well as also understanding the veracity of the memory. Metamemory helps in understanding that perhaps some memory is not a true memory, it might be a reconstructed memory based upon information that was not personally experienced.

If metamemory is a personal, subjective understanding of one's memory, how can that be studied? Often researchers use "judgments-of-learning" which are the individual's confidence judgment about the effectiveness of their memory. Sometimes metamemory awareness is not that accurate and can cause judgments that are over or under representative of an actual memory (Koriat, Sheffer, & Ma'ayan, 2002). Efficient metamemory relies on self-monitoring. When studying the use efficiently self-monitoring can lead to better memory performance (Thiede, 1999). Regrettably people are seldom accurate in what they have learned or not learned (Metcalfe & Finn, 2008).

When trying to acquire new information often the to-be-learned information will go through rehearsal. Rehearsal is deliberate recycling or practicing of information that is in short-term memory. With rehearsal it is presumed that the longer something is in short-term memory, the more likely it is to transfer into long-term memory. This repetition is known as maintenance or type-one rehearsal. It is a low-level or repetitive kind of information recycling. This takes many more trials than if a mnemonic device were to be utilized.

Figure 3

Accuracy of recalling three-letter nonsense syllables as a function of rehearsal from Hellyer (1962).



Using a mnemonic device or drawing inferences is known as elaborative or type-two rehearsal. This is a more complex kind of rehearsal with more effort at the initial encoding. In this situation what happens is that instead of repeating something over and over again someone might use a mnemonic such as grouping items together. The effort by which this grouping occurs serves to strengthen the memory. For example, somebody is given a list to remember which might consist of: *chair, soup, cat, sofa, chicken, sandwich,* and *table.* What might happen is that, instead of remembering in that exact order, the person groups the furniture together, then groups the food together, then groups the animals together creating three units. Therefore when they repeat the list it may appear like this: *chair, sofa, table, soup, sandwich, cat, chicken.* This is known as chunking. Chunking provides an easier way of rehearsing and remembering.

An example of metamemory and how this leads to better memory for maintenance versus elaborate rehearsal is a study that was conducted by Murphy et al. (1987). In that study they used three groups. A control group, a group that was given a forced study time (the subject had to study a list for a certain amount of time), and then a self-monitoring group. In the self-monitoring group, these subjects were told to test themselves. The best results for memory came from the self-monitoring group. What this group would do is not just study the material for a time, but they would test themselves. What was found in the self-monitoring group is that they utilized personal evidence of effectiveness. Therefore when they would give themselves a quiz to see what they remembered they would then go back and study in more detail the items that they did not recall. They did this knowing that there is no need to put considerable effort into studying something that they already knew.

In the study of long-term memory it is important to understand that when an experimenter manipulates a study in terms of dependent variables this can also affect the results. These are known as task effects. When we use a different task it produces different results. For example, recall is more difficult than recognition. Recall has no cue and therefore there is an effortful retrieval of information. Recognition has the object to be remembered in front of you; therefore it serves as a cue and is more relatively automatic. The example contrasting the two would be an essay test versus a multiple-choice test. In a multiple-choice tests scores are generally better because in a multiple-choice test the answer is in front of you. One of the options is the correct answer; all you need to do is recognize it. In the essay test what it is required is for you to exert effort to pull up that memory of the material for the question without the benefit of a cue.

6.3 Organization of Memory

Organization of memory is a great study. Particularly as we discussed the idea of chunking. Bousfield and Cohen (1953) found that people tends to subcategorize things, particularly if given a list of animals they will start to group the animals by common themes, such as water birds and birds of prey. This implies that there is a high level of semantic setup. When looking at different ways in which we can categorize things, often we will use subjective organization. This is organization developed by the subject for structuring and remembering a list of items without and experimenter-supplied category. This is where the individual themselves uses, of their own volition, how they might group things or utilize different organization schemes.

When looking at how we might encode information and store it we also observe the phenomenon of how some words are easier to recall than others. This leads us to the dual coding hypothesis. Concrete words may be encoded twice compared to abstract words. Concrete words are words such as elephant or duck. These will have a semantic meaning as well as a visual image. Justice or liberty, on the other hand, are abstract words. These do not have an easily accessible visual image, but more of a definition. In paired-associate learning the dual coding hypothesis shows how imagery can strengthen memory performance.

Table 1 Example of a Paired Associate Learning Task

List 1		List 2	
WICKED	CLUMSY	WICKED	EVIL
STERILE	HAUGHTY	STERILE	FRUITLESS
SULLEN	BRAZEN	SULLEN	MOROSE
HORRID	VALIANT	HORRID	GRUESOME
SAVAGE	JOYOUS	SAVAGE	RUTHLESS
SINFUL	AWKWARD	SINFUL	CORRUPT
BARREN	SNOBBISH	BARREN	FRIGID
SULKY	SHAMELESS	SULKY	MOODY
AWFUL	FEARLESS	AWFUL	GHASTLY
BRUTAL	MERRY	BRUTAL	CRUEL

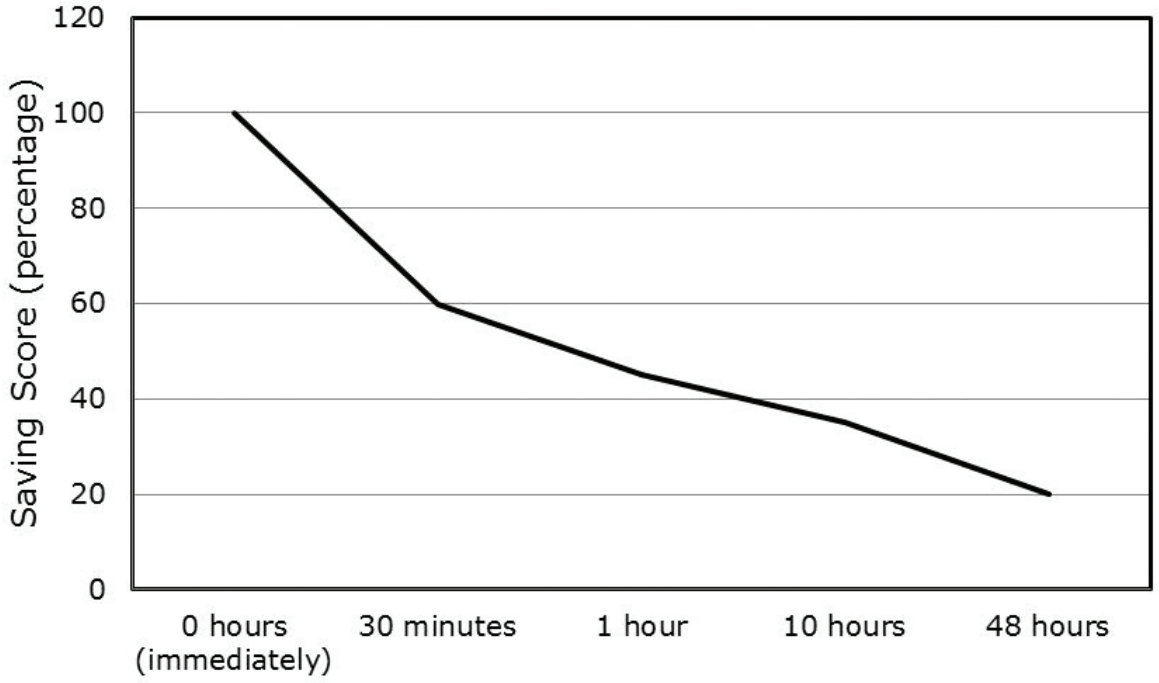
Other ways in which we can aid recall is through the use of encoding specificity. Encoding specificity is often an automatic process. Each item is encoded into a richer memory representation. This is often when people might encounter something and find a person that might have something similar. For example if you encounter somebody who has a name that is the same name of a relative of yours, you will have an easier time remembering that person's name. "Oh, I also have an aunt named Patricia". That is encoding specificity, even though it is a small connection, it helps aid retrieval because of the extra context. Another facet of encoding specificity is emotion. Emotion can influence encoding and retrieval. Mood-state-dependent memory shows that if the emotional state of the individual is the same at encoding and retrieval there will be better memory performance.

6.4 Faults of Memory

One of the most striking faults of memory answers the question: "what is the root cause of forgetting?" Most people believe that forgetting involves storing information and then losing the memory due to disuse. Most forgetting is that the information was not transferred to long-term memory at all. The process by which information is stored in long-term memory is called consolidation. Consolidation can be disrupted by interfering processes and information as well as simple thing such as disrupted sleep. Sleep has been shown to play a strong role in the process of consolidation.

Figure 4

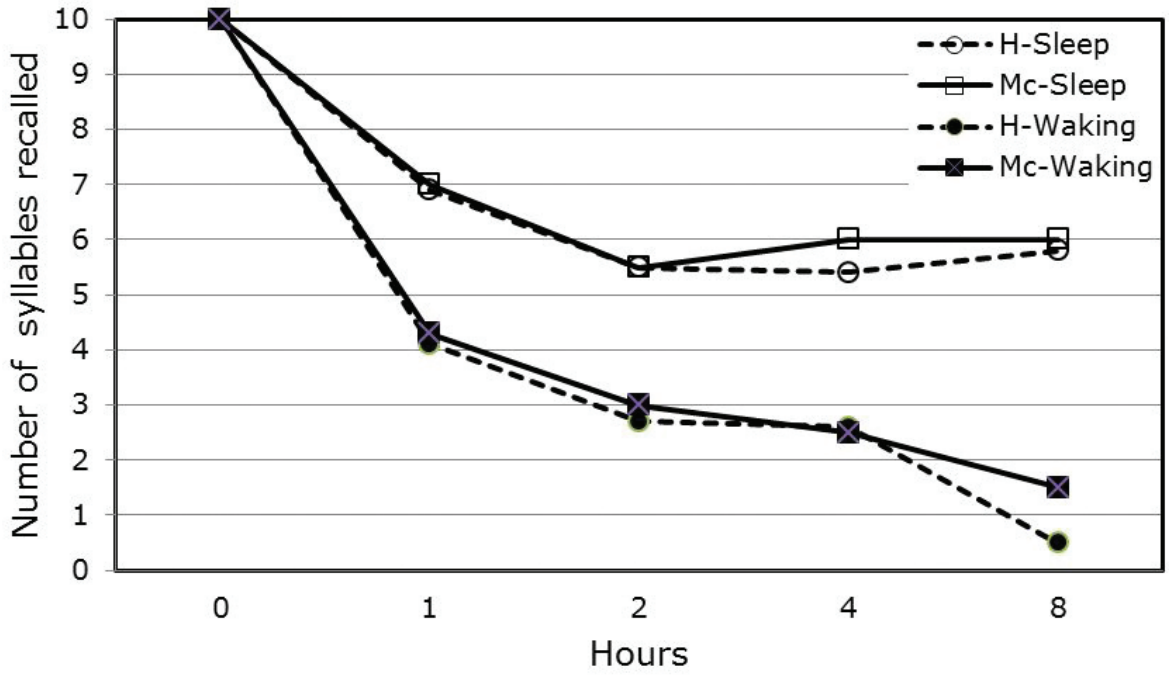
An example of a classic forgetting curve based on the work of Ebbinghaus. The saving score reflects the benefit to relearning as a result of different retention intervals (time elapsed between learning and recall).



When studying memory sometimes accuracy is not as important as error. Where we look at the faults of memory, particularly one important memory fault is the tip-of-the-tongue phenomenon (TOT). This is a momentary inability to recall information. Often this is associated with the name of somebody. During these times we are able to gather other bits of information about the person, but not their name. Often we will find that we are able to fixate upon one particular aspect of a person. Such as if you are watching a movie and you see an actress and you have an inability to recall the actress's name, but you remember the other movies that she was in and whether you like her acting or not. You will find that you are able to remember many details, but have trouble recalling her name. Sigmund Freud, one of the first to discuss the tip-of-the-tongue phenomenon, proposed that tip-of-the-tongue phenomenon occurs because of a dislike or repressed hatred of something therefore hiding the name is an act of aggression. In fact, what may actually happen in tip of the tongue phenomenon is a focus on semantic detail rather than semantic labels, therefore there is trouble pulling up the specific label because the person involved is actually retrieving details. Encoding specificity serves to provide powerful cues for retrieval. When looking at tip-of-the-tongue phenomenon where details that might have been encoded at that same time it becomes clear that a tendency exists to focus on semantic details more so than labels. For example, trying to remember the name of that actress you may also remember other details from when you saw that movie such as; if you were on a date, what you might have been eating. These are things that were coded during that initial time when you first encountered that actress.

Figure 5

The results of Jenkins and Dallenbach (1924) demonstrating the benefit of sleep and memory retention for nonsense syllables. This laid the groundwork for the understanding of consolidation.



Cognitive psychology's research into memory has been invaluably aided by a neurological or clinical approach for memory faults. This is epitomized by the study of amnesia. Amnesia is loss of memory or memory abilities as a direct result of brain damage. Whether this damage is a blow to the head, an infection, a stroke or some such cerebral insult. Amnesia takes two basic forms: Retrograde amnesia is a loss of memory before the brain damage. Anteriorgrade amnesia is the loss of memory after the brain damage. Often what is found is that there is some retrograde and anterior grade amnesia when somebody might suffer some traumatic brain injury. They might have trouble remembering things that happened hours or days before the accident. In addition incidents that occurred hours or days after the accident are also hard to remember or are completely forgotten.

Table 2

This is an experiment you can do based off of Bransford & Stein (1984; reviewed in Aschcraft & Radvansky, 2010). It demonstrates how profoundly retrieval cues can affect memory performance.

Read each sentence below taking a few seconds per sentence. Read each sentence only once. When you are done write down how many sentences you can remember without looking at the list (you do not need to write down "can be uses as").

A brick can be used as a doorstop,
A ladder can be used as a bookshelf.
A wine bottle can be used as a Candleholder
A pan can be used as a drum.
A record can be used to serve potato chips.
A guitar can be used as a canoe paddle.
A newspaper can be used to swat flies,
A TV antenna can be used as a clothes rack.
A sheet can be used as a Sail.
A boat can be used as a shelter
A rock can be used as a paperweight.
A knife can be used to stir paint.
A pen can be used as an arrow,
A barrel can be used as a chair
A rug can be used as a bedspread,

STOP and write down as many sentences as you can before moving on. Now try and write down as many sentences as you can using the following words are retrieval cues.

flashlight	lampshade
sheet	shoe
rock	guitar
telephone	scissors
boat	leaf
dime	brick
wine bottle	knife
TV antenna	pen
bathtub	pan
record	board
orange	newspaper
ladder	barrel
rug	balloon

Trying to understand amnesia gets into the concept of association between behavior and anatomy. This is where we might find one area where the brain is damaged and another is unharmed. As a result we might find a specific deficit within that particular memory function. Often we find a common association between implicit and explicit memory and different neuroanatomy. Sometimes people might have retrograde amnesia and may lose years of explicit memories. Remembering birthdays, weddings, and social events and other episodic memories are lost. Skilled memory (also called procedural memory) on the other hand might be preserved so that a person might have had a technical job before and is able to do something job-related afterwards even though that skill might have been acquired during the period of retrograde amnesia and have lost those explicit memories. Also noted in the case of implicit memories, when looking at anterior grade amnesia people might have trouble acquiring memories of new skills, but will still acquire the new skills. This is where they might repeat a certain task and having no knowledge of ever acquiring that task and yet start to gain proficiency. When asked, sufferers of anterior grade amnesia reply that, "It must be beginner's luck. I've never done this before", even though they have practiced it many times, but just do not remember practicing at all. This suggests that some of the implicit memory can be processed and stored towards the posterior portion of the brain. This would be motoric function in the cerebellum. This relates to repetition priming where previously encountered stimulus produces comparable effects even though you have no conscious memory of it.

Skill learning, often referred to as motoric learning, consists of three basic stages. These stages move from a more explicit processing to a more implicit processing. The first stage is the cognitive stage. In the cognitive stage knowledge is declaratively represented. We often use a verbal code and there is a high level of attention paid to the particular task. Through repetition we move to the second stage: the associative stage. The associative stage is where we start to find our behavior (the skill) becomes more fine-tuned and error rates start to decrease. Verbal mediation occurs where you might talk to yourself at particular moments of great difficulty only to recall what to do. During the associative stage some processes start to become more automatic. Finally, the third stage is known as the autonomous stage. This is where behavior is highly accurate, rapidly executed, and relatively automatic. As a result it also becomes less accessible to verbal output.

Some task effects that occur during memory are also involved with recall. A notable example is proactive interference. Proactive interference is when older material interferes with material learned later on in the task. In this case the first items you encounter prevent you from acquiring other items of information later. Proactive interference has the benefit of the first mention. Retroactive interference is when newer information interferes backwards with earlier encountered information so that the most recent items is recalled. If we look at this in a serial position curve, this is where if we were to give a list of items to be remembered and then have the person recall that list of items. We see two different ways of which this can occur. Serial recall is telling people to write down the list of items that they heard in the exact order that they heard them. Free recall on the other hand is where at the end of learning they have to recall as many items as they could in any order they prefer. In this situation what is often found is that in free recall people will write down the last thing they heard first, and then the first thing they heard. Writing down the last thing they heard is called the recency effect. The recency effect is a higher level of accuracy for recall of the most recently presented items. This is because they are still in conscious memory (i.e., short-term memory). A high level of accuracy of recall for items from the beginning of the list is known as the primacy effect. In the primacy effect there is high level of recall because those items were rehearsed over and over again and entered into long-term memory.

6.5 Clinical/Applied Perspectives of Long-Term Memory

People have been fascinated with people who have outstanding memory abilities for centuries. This ability to have exceptional memory has been referred to as photographic memories. In actuality, people do not have these memories so much as an ability to encode highly-detailed visual imagery. The modern term (and more accurate) for photographic memory is eidetic imagery. One of the earliest studies of eidetic imagery in psychology was conducted by Klüver in 1928. Klüver noted that methodologies for studying eidetic imagery would be difficult and there was no known reason why someone would store mundane images eidetic ally.

Many studies from the 1960s and 70s examined eidetic imagery across cultures. Cognitive psychologists looked at people from around the world who were illiterate by culture such as tribal people in Brazil, Kenya, and Australia to name a few. Although some people in these cultures appeared to have statistically proven eidetic imagery their performance did not indicate a significant benefit to recall performance. People with eidetic imagery are able to maintain a visual image of the stimulus, but have poorer performance for detail/feature recall than someone without eidetic imagery. People with eidetic imagery are able to recall images and report strong metacognitive judgments in their imagery.

If eidetic imagery does not improve recall then what would be the point of eidetic imagery? Researchers such as Gray and Gummerman (1971) have concluded that eidetic imagery is not a different type of memory, but only a more vivid ability of visual sensory memory. Although some cultures may try to rely on memory more than other cultures there appears to be no benefit to eidetic imagery. One possibility is that eidetic imagery may be the result of neurological abnormalities and serves no benefit. Cognitive psychologists have determined that although some people find it fascinating, eidetic imagery is of little use to memory performance. The next time you are exhausted from studying remember that having a photographic memory would not be much help to you when it comes time for the exam.

Summary

Long-term memory is the archive of the brain in which experiences and knowledge are stored. The serial position curve demonstrates the effects of rehearsal (primacy effect) and availability (recency effect). Implicit memory is outside consciousness, while explicit memory is open to conscious processing. Semantic memory is memory for facts and is composed of an interlinked network. This network connects points of information (nodes) to each other. More relevant nodes are closer together and have stronger links. Activation of one node will activate adjacent nodes because of spreading activation. Connectionist models describe how the adjustments to networks occur through changing the connection weights. Episodic memory is memory for personal experiences.Reconstruction of memory involved the creation of an imperfect or even false episodic memory by the use of facts from semantic memory. Metamemory is an understanding of your own memory. Tip-of-the-tongue phenomenon (TOT) is a momentary inability to recall information, usually a person's name.

Key Terms

Declarative memory

Non-declarative memory

Explicit memory

Implicit memory

Episodic memory

semantic memory

Semantic dementia

Prospective memory

Time-based prospective memory

spreading activation

connectionist models

script

Metamemory

operational span

encoding specificity

Mood-state-dependent memory

Consolidation

tip-of-the-tongue phenomenon

Anteriorgrade amnesia

procedural memory

Proactive interference

Retroactive interference