06a | Introduction

In the last unit, we talked about memory in terms of the structures of various memory stores. We are going to discuss memory again, but this time more in terms of the processes that are involved in processing memory. The general idea here is that one's ability to retrieve information in memory depends largely on how well we stored that information in memory, not in the particular place where it is stored.

We will also spend some time discussing the fact that memory is not a carbon copy of what one has seen or processed. Instead, memory is quite malleable and often changes over time.

We've all experienced forgetting- that's simply a normal consequence of memory. We will spend time discussing profound forgetting, or amnesia. This type of profound memory loss is usually the result of some form of brain trauma or disease.

We'll also make an important distinction between two types of memory- episodic, which is our own personal memory, and semantic, which is the store of all our world knowledge, and tends to be similar across people who have had the same experiences.

Finally, we'll spend some time discussing two types of ways to test memory- implicitly, or without the individual realizing that his or her memory is being tested, and explicitly, when people are aware that their memories for particular events or things is being tested.

06b | Levels of Processing

In the last unit, we talked about various memory stores (sensory memory, short term memory and long term memory) and what is thought to happen in each of them. The view of memory that we are going to discuss now does not treat memory as some form of storage place, but rather focuses on the types of processing that we do in order to store and retrieve items from memory. This is known as the levels of processing theory of memory.

Levels of processing was first discussed by Gus Craik and Bob Lockhart at the University of Toronto, and we'll introduce it by way of the following demonstration.

Basically, this theory identifies two types of rehearsal that can be done in order to store information in memory- maintenance rehearsal and elaborative rehearsal. Maintenance rehearsal is essentially what one does when trying to simply memorize something. For instance, a new friend has just given you his or her phone number, and while you're getting ready to input it into your cell phone, or write it down, you might repeat it. Basically, then, all this type of rehearsal does is to maintain or hold information until you need to use it, without transforming it to any other type of code. Not surprisingly, Craik and Lockhart state that this type of rehearsal does not promote good memory. In contrast, elaborative rehearsal is argued to promote good memory. When we perform elaborative rehearsal, we elaborate on the meaning of a concept. Craik and Lockhart argue that this allows us to transform the information into a deeper code, thereby promoting better retrieval. In terms of the demonstration that you just completed, both the physical appearance (PA) task and the rhyming task (R) are considered to be relatively shallow, whereas the meaning-based task (M) is considered to be deep. Therefore, Craik and Lockhart would predict that your memory would be better for the M items, than for the PA and R items.

Craik and Endel Tulving published an experiment much like this one in 1975. As you can see in the Figure before you, memory was better for their meaning based task than it was for their case and rhyme tasks. Although levels of processing makes good intuitive sense, it is not without its detractors, however. Specifically, theorists such as Alan Baddeley have argued that it is a circular or tautologous theory, and cannot be falsified. How does one decide what is shallow processing and what is deep processing prior to the experiment? Despite these challenges, however, LOP provided a useful, novel way of conceptualizing memory.

06c | The Reconstructive Nature of Memory

Our discussion of memory to date has relied on lab studies. What about memory for real-life events and objects? How can we assess that? Bartlett, in the 1930s, studied memory for more than just lists of words, and introduced the concept of a memory schema. The panel in front of you shows the story "The War of the Ghosts," used by Bartlett to study more real-life memories. Participants in his experiments were asked to read this story, and their memory for the story was tested a short while after, and also several weeks later. What Bartlett found was that far from being like a camera or tape recorder, memory was quite malleable. The manner in which individuals' memories changed was interesting, as well. That is, over time, their memories for the story began to become distorted, and these distortions were consistent with items in their own cultures. Bartlett states, then, that a schema is a framework for organizing memory, and our own schemas are consistent with our prior life experience.

Also along the lines of more "real-life" memories are what are known as flashbulb memories. These memories are held to be crystal clear, vivid memories of some important event. For instance, most of us have very clear and detailed memories about where they were when they first heard about the terrorist attacks of 9/11. There is some debate as to whether these really are such special, accurate memories, but it is generally thought that they are different from our memories for everyday, mundane events. This is possibly because of the highly emotional content of most of these memories, and our desire to link ourselves to history.

In the US, over 50,000 court cases each year are decided on the basis of eyewitness testimony. Jurors are very strongly affected by the testimony of an eyewitness, especially when that witness seems very confident. Is this good, or should it be a matter of concern in the judicial system?

Elizabeth Loftus is a pioneer in the study of eyewitness memory. In one of her earliest studies, she showed participants a film clip of a car crash. All participants viewed the same film. Afterwards, they were asked this question: About how fast were the cars going when they ____ each other? The blank was filled by the words "smashed, collided, bumped, hit and contacted" for separate groups of participants. As you can see in the panel, despite the fact that everyone had observed the same event, the participants' speed estimates varied as a function of the verb put in the sentence. Amazingly a week later, all participants were asked if they had remembered seeing broken glass? There was no broken glass, yet some people remembered seeing it. Remarkably, people who had received the stronger verbs were more likely to misremember broken glass than were those who received the weaker verbs.

Clearly, then with memory being so falliable, it is important to keep this in mind when evaluating eyewitness testimony.

You are going to see a short list of words. I'd like you to read through the list, and after the last word disappears, write down all the words that you read, in the order that you read them.

This is the basis of a study first done by Deese in the 1920s, and recently made popular by Roediger and McDermott. What I am most interested in in this demonstration is whether your list of memories included the word "spider." In Roediger and McDermott's experiment, 40% of the participants recalled a word that was not presented at all, but was related to the other words on the list. Amazingly, they were nearly as confident in these false memories as they were in their actual true memories!

Cabeza and colleagues, using brain imaging techniques showed that despite an individual's belief in a false memory, the brain regions activated by the false memories actually activate a brain area different from that activated by real memories.

06d | Amnesia

We've spent some time talking about memory for things that did not occur, but what about the loss of memory for things that have occurred? Scoville and Milner, of the Montreal Neurological Institute documented the case of Henry M, who had profound memory loss after surgery on his temporal lobes and hippocampus to help control his severe epilepsy.

After the surgery, HM's epilepsy did improve, and he retained his intelligence, and his perceptual abilities. He could remember much of his life prior to the surgery, but was unable to form any new long-term memories. That is, you could meet HM, carry on a conversation, and if you were to return to him an hour later, he would not remember having met you!

The case of Clive Wearing is perhaps the most profound case of amnesia that has been recorded. Clive was a music producer and commentator for the BBC when he became ill with viral encephalitis. As you see in the movie clip, although Clive's memory for his past is somewhat impaired, the biggest disability is that he, like HM, is no longer able to form new memories. In fact, Clive's experience of life is that of constantly waking up and being conscious for the very first time.

Both HM and Clive Wearing suffer from anterograde amnesia, or the inability to form new memories. In terms of the modal model of memory that we discussed last unit, anterograde amnesia is argued to affect LTM but not STM. Individuals like HM and Clive can keep information active in STM just like you or I, but are not able to transfer it into LTM.

In contrast, retrograde amnesia is the loss of memory for past events, and how far back in time it goes varies from person to person. Alzheimer's disease and Korsakoff's syndrome are two examples of this. Korsakoff's syndrome is brain damage resulting from a lack of B vitamins generally due to the long-term abuse of alcohol. Less severe retrograde amnesia is also commonly seen when one has a concussion- perhaps from a car accident, or a fall. Although it affects memory for life events, it does not appear to affect things like social skills, language, or any previous skills that we have mastered.

06e | Semantic Memory

In discussing HM and Clive Wearing, we've talked primarily about the loss of their episodic, or personal, memory. Obviously, each of us has a unique episodic memory, given our unique existence and experiences.

Memory researchers are also interested in what is known as semantic memory, or our general collection of world knowledge, our language, etc. Semantic memories tend to be pretty similar between people who have had the same general experiences. That is, as speakers of the English language, we all have fairly equivalent memories for words. We know about the law of gravity, and what meatloaf is.

Researchers are interested in understanding how that information is stored in semantic memory. One of the first models of semantic memory was Collins and Quillians hierarchical semantic network. As you see in the Figure, in this model concepts are organized into hierarchies. For instance, a bird is a type of animal, so is therefore stored under the concept "animal." An important characteristic of this model is cognitive economy. Cognitive economy means that a concept shares all the characteristics of the concept it is stored under, unless a specific exception is made. Therefore, a bird, because it is an animal, has skin, can move around, eats and breathes. Those characteristics don't need to be stored again under "bird." Notice that one of the characteristics of a bird is that it "can fly." Therefore, all concepts stored under bird can fly, unless an exception is noted, like in the case of an ostrich.

According to this model, when a concept is activated, all of its characteristics are activated, and activation also spreads between the links to related concepts. That is known as spreading activation, and it is hypothesized that spreading activation allows us to activate associated concepts in memory. For instance, spreading activation can account for why, after having read the word doctor, we often think of the concept nurse.

Patient KC provides an example of someone who has relatively preserved semantic memory, but very badly impaired episodic memory. That is, as you see in the clip, he can remember facts, but does not know how he acquired them.

06f | Implicit versus Explicit Memory

We are all very much aware of explicit tests of memory. Any exam that you write in class is an explicit test of memory. You know you are being tested on your memory for material in that course. Explicit memories, then, are ones that we consciously recall. That is, you can at this moment, pick up a pen and write down all the things you remember doing on your summer holiday. Explicit memories are generally linked to particular periods of time.

In contrast, implicit memory is a memory test that you are not aware of taking. Although individuals like HM and Clive Wearing have greatly impaired explicit memory for new information, they do show some signs of implicit memory. That is, there is some small amount of learning that they might not be able to tie to a particular event, but if tested, it will be evident.

The Figure in front of you shows the results of a study conducted by Warrington and Weiskrantz examining memory in amnesics and healthy controls. As you can see, the amesics showed impairment relative to the controls on explicit tests of memory such as free recall and recognition, but their performance on two implicit tests, word fragment identification and word stem completion, was not affected. Therefore, even though the amnesics would likely not consciously recall having studied the items, or possibly even the study session at all, their behaviour shows evidence of having studied those items before. Thus, they show a form of implicit, or unconscious memory.

06g | Summary

In this unit we've viewed memory as a process, rather than a place. We discussed the fact that if we really want to remember some information, our chances of doing so will improve if we do more complete, or deep, processing of that item. So, for instance, if you really want to remember the material that you learn in this course, or any course, the best way to do so is to try to elaborate on it when you study it. Put concepts in your own words, think about what they mean, try to explain them to someone else. That will promote memory that is better than if you merely read through your notes and the textbook.

We've also seen that despite the fact we are able to remember quite a lot of information, our memory should be in no way viewed as perfect. That is, we are prone to misremembering things, especially if we are asked about those things in a suggestive manner, as Loftus' work shows. Some of our memories seem crystal clear and detailed, the so-called Flashbulb memories, but it is also possible to show that people actually form memories for things that never happened.

In discussing our 3 neuropsych cases of amnesia, we get evidence for different types of memories. Episodic memory is our own personal memory store, whereas semantic memory consists of the basic facts that we know, the concepts we know, etc. We've seen that it is possible to lose one, but not the other. We've also seen that amnesia can either work backward in time, when we lose information we used to know, or forward in time, when we are unable to form new memories.