



# TRAVELING THROUGH SPACE AND TIME WITH OUR MEMORIES

**Nina Curko\* and Maureen Ritchey\***

*Department of Psychology and Neuroscience, Boston College, Chestnut Hill, MA, United States*

## YOUNG REVIEWERS:



**LAS VEGAS  
KITTIE CATS**  
AGES: 11–13

What is your favorite memory? When you think back to moments in your life, you can often recall where you were, what happened, and how you felt. How does your brain bring together all of these different details? And why does it feel different from when you remember the name of your favorite animal or facts that you learned in school? People are constantly using their memories to understand and navigate the world around them. However, not all memories are the same. In this article, we will talk about two different types of memory—episodic memory and semantic memory. We will explore how they are different and how they are related, and how they can be used together to strengthen people's knowledge of the world.

## WHAT DO MEMORIES DO?

What if we told you that you have the power to travel through space and time? And that you probably do this every day? Okay, we are not talking about actual time travel. We are talking about the kind of “mental time travel” that you do when you remember what happened yesterday, last week, or even last year. This kind of memory is called **episodic memory**: you use it to remember *episodes* in your life that happened in the past [1]. Think of a moment in your life, like the soccer game when you scored the winning goal, or the last time you built a snowman. You might be able to recall where you were, who was there, what happened, and how you felt. Episodic memories are special because these details can make people feel like they are re-living the moment.

Aside from remembering what you have experienced yourself, you also need a memory system to store your general knowledge. **Semantic memory** is what you use to remember facts, words, numbers, and concepts you have learned, like the fact that snow only falls when it is cold outside or that Washington, D.C. is the capital of the United States. You also use semantic memory when you remember facts about yourself, like the date of your birthday. Unlike episodic memory, semantic memory does not involve mental time travel. When someone asks you what the capital of the United States is, you do not have to remember the exact moment you learned that information. You just know. This allows you to access your general knowledge about the world quickly, without having to remember everything else that happened.

## HOW DOES THE BRAIN SUPPORT EPISODIC AND SEMANTIC MEMORIES?

The **hippocampus** is the star player for team episodic memory. This funny word comes from the Greek word for seahorse. Humans have two hippocampi, one on the left side and one on the right side of the brain. They are tucked away inside the **temporal lobes**, the brain areas next to the ears (Figure 1). We know that the hippocampus is necessary for episodic memory because damage to the hippocampus, caused by illness or some kinds of brain surgery, results in episodic memory loss. This is also known as **amnesia**. A person with hippocampal damage would struggle to tell you what happened 5 min ago. Surprisingly, though, they would still be able to tell you about their semantic memories, like what the capital of the United States is or where they grew up. This is how we know that the hippocampus is especially important for memory that involves mental time travel, and less important for other kinds of memory.

While memory scientists can learn a lot from studying people who have damage to the hippocampus, we can study the memory

### EPISODIC MEMORY

The type of memory that allows people to remember specific events that have happened in their lives.

### SEMANTIC MEMORY

The type of memory that allows people to remember general knowledge about the world, such as facts, words, numbers, and concepts.

### HIPPOCAMPUS (PLURAL, HIPPOCAMPI)

A brain region that plays an important role in memory. The hippocampus is located inside the temporal lobe.

### TEMPORAL LOBE

The part of the brain that is located on the sides of the head, next to the ears.

### AMNESIA

A loss of memory, which might come from an injury to the brain.

### Figure 1

In this map of the brain, the yellow areas are brain regions that make up the default network. The purple area shows the location of the hippocampus (Figure credit: Colette Chen).

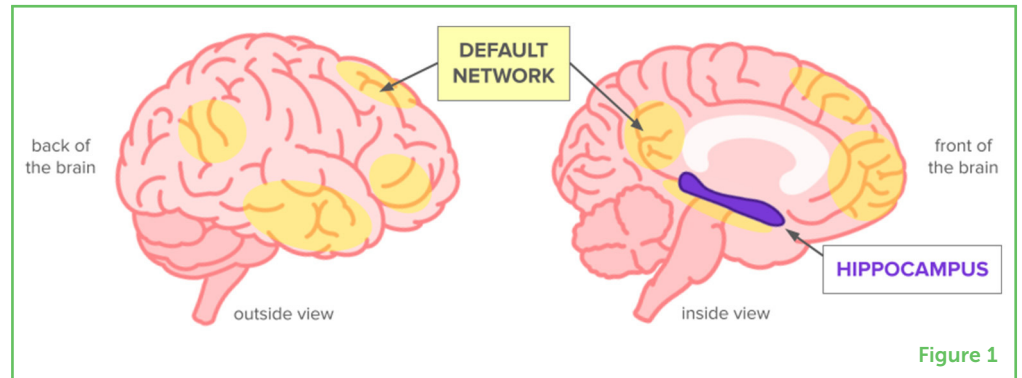


Figure 1

### FUNCTIONAL MAGNETIC RESONANCE IMAGING (fMRI)

A technique scientists use to take detailed pictures of the brain, to see which brain regions are being used while a person is doing a memory task or thinking.

### DEFAULT NETWORK

A collection of brain regions that are active when people are thinking, daydreaming, or remembering. It involves many regions from across the brain.

functions of the brain in healthy people, too, using a tool called **functional magnetic resonance imaging (fMRI)**. fMRI allows scientists to take pictures of people's brains, almost like a big camera. It records how much brain activity is happening in different brain areas. Memory scientists use fMRI to take pictures of a person's brain while they are learning new information and remembering the past, so that they can see which brain regions are active during memory tasks. Using these methods, we have learned how the hippocampus works with other brain areas to store and retrieve memories. For example, the hippocampus works with brain areas that have information from the five senses, like the faces you see and the sounds you hear. This is how the hippocampus can combine sights, sounds, and feelings into a single episodic memory [2].

The hippocampus also communicates with another team of brain areas called the **default network**. This network includes regions in many different parts of the brain (Figure 1). It is called the default network because these areas tend to be the most active when people have downtime in between tasks. But the default network is also strongly active when people use their episodic memories to do mental time travel [3]. This may be because the default network helps the hippocampus bring together information from the five senses into a combined memory experience, giving people the feeling of "re-living" the past. In the Pixar movie *Inside Out*, when Riley remembers the past, her memories are shown playing back on a giant screen in vivid color. If you think of the hippocampus as the projector, then default network areas are like the screen in Figure 2, bringing details into focus and pulling them together into a multi-sensory experience.

## EPISODIC AND SEMANTIC MEMORIES DEPEND ON EACH OTHER

We began by contrasting episodic memory with semantic memory. But it turns out that episodic and semantic memory have a lot in common, too. Like episodic memory, semantic memory involves brain regions in the default network [4]. Why might they be so similar? You

## Figure 2

Different pieces of semantic knowledge come together with information about a specific time and place to form a specific episodic memory. The hippocampus helps make these connections (Figure adapted from <http://www.storyset.com>).

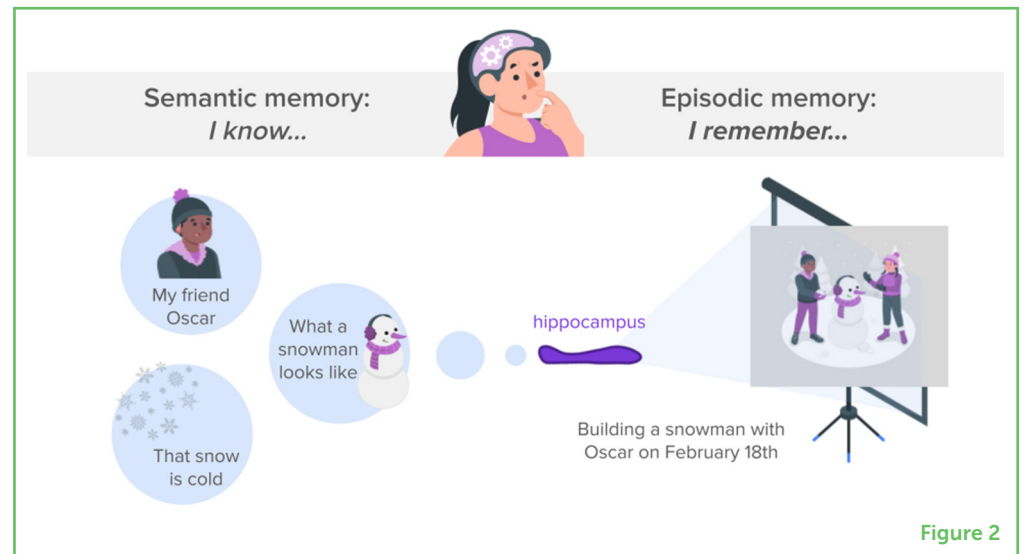


Figure 2

can think of semantic memories as the building blocks for episodic memories. When you remember the last time you saw a dog, for example, you have to draw on your knowledge of what dogs are like—the soft texture of a dog’s fur, the shapes of its ears and tail, maybe even the smell of its breath. Semantic memories give you a foundation of knowledge that you can use to understand and remember the details of events, like in Figure 2. When the hippocampus works together with the default network, it combines episodic associations, like a specific place and time, with everything else a person knows. In other words, the default network is where episodic and semantic memories come together.

A person’s semantic knowledge can also influence the way they remember past events. Episodic memories are not a perfect recording of the past, even though it is fun to imagine little movie screens in your mind. Even when a memory feels very clear, it is common for someone to have forgotten or misremembered some details. When this happens, people draw on their semantic knowledge to *reconstruct* or fill in the gaps of the episodic memory. As a memory’s specific details fade over time, it gets harder to time travel to that memory, and semantic knowledge plays a bigger role in remembering. For instance, you might not be able to remember exactly what you were wearing the last time you built a snowman, but you might guess that you were wearing gloves and a hat because you know it must have been cold outside.

## EXPANDING YOUR KNOWLEDGE WITH MEMORY

How can people combine their episodic and semantic memory systems to get better at remembering new information? New experiences lead to new episodic memories, and those memories can be used to build up semantic knowledge about the world that



### RETRIEVAL PRACTICE

A technique for strengthening your memory by trying to remember the target information, such as through self-quizzing, rather than simply re-reading or reviewing.

people can remember later. Imagine that you live in a neighborhood with many families who have golden retriever dogs as pets. Since you have many episodic memories of seeing golden retrievers around your town, you might start to think of dogs as always having fluffy tails and floppy ears. One day, a new family moves to town with a Shiba Inu and a bulldog. Now you have some specific episodic memories of different types of dogs: they can also have curly tails and pointy ears, or short legs and wrinkled faces. Your episodic memories have helped you create a better understanding of what dogs can look like. Congratulations, you have just leveled up your semantic knowledge!

You can speed up this learning process by practicing retrieving your episodic memories. Just like learning a new instrument or playing a new sport, one of the best strategies for improving memory is to practice using it. For example, if you are trying to memorize a set of new vocabulary words, quizzing yourself on the words will strengthen your memory more than simply reading them over again. Or, if there is an event that you want to remember for a long time, like a family vacation, you might practice remembering that event by sharing the story with your friends. These types of **retrieval practice** help strengthen the associations in memory and make them more likely to become part of your long-term semantic knowledge about the world [5]. Think of retrieval practice as a short-cut to making a memory that is easy to bring to mind and will last for a long time.

## THE SUPERPOWERS OF MEMORY

In summary, your brain has an incredible ability to store information about what you have learned and experienced. With episodic memory, you can mentally travel through space and time to re-live your past. With semantic memory, you can quickly retrieve facts about the world. Together, the brain areas involved in episodic and semantic memory work as a team to fill in the gaps of your memories and expand your knowledge. Whether you are traveling through time and space to find an episodic memory, or pulling information from your semantic library, understanding how your memory powers work together can help you learn and make sense of the world.

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## YOUNG REVIEWERS

### LAS VEGAS KITTIE CATS, AGES: 11–13

We like soccer and making crafts along with reading. We are between 11 and 13 now. We all like to play with our friends. We are currently watching a show called Supernatural, and we love it!



## AUTHORS

### NINA CURKO

Nina Curko is a doctoral student studying cognitive neuroscience at Boston College. Before starting her Ph.D., she received her college degree in psychology from Lafayette College. She enjoys researching the brain regions that help us remember events in our past, and how our memory connects to our emotional and social experiences. Outside of research, she enjoys playing volleyball, listening to music, and reading a good book. \*[curko@bc.edu](mailto:curko@bc.edu)



### MAUREEN RITCHEY

Maureen Ritchey is an associate professor of psychology and neuroscience at Boston College. She directs the Memory Modulation Lab, a team of researchers who conduct experiments to examine the brain processes supporting episodic memory. She and her team study how different brain regions work together to store and retrieve the details of our memories. Outside of research, she enjoys reading, doing arts and crafts projects, and spending time with dogs and cats. \*[ritcheym@bc.edu](mailto:ritcheym@bc.edu)

