

Memory and Learning

A unique characteristic of humans and some animals is the ability to alter behavior based on past experiences. Arguably, some humans are better than others at this behavior and some seem to never learn, but by definition, **learning** is the acquisition of information and **memory** is the retention and storage of that information. Generally, memory is categorized as either **short-term** or **long-term memory**. Short-term, as the name implies does not remain with us long. It is usually limited to only a few bits of information, generally 7-12. It may only be retained for a few seconds to a few minutes. For example, you can remember a telephone number long enough to dial it but if the line is busy and you want to try again in a few minutes you usually have to look it up again. A special form of short-term memory is **working memory**. Working memory allows us to correlate our current situation with our experiences so that we can function. For example, if you need to cross the street you look to your left and see that no cars are coming, you then look to the right and see no cars are coming so you proceed to cross. Without functional working memory you would not remember what you saw when you looked to the left, making it very difficult to get across the street.

Long-term memory is information that is retained for extended periods of time, up to a lifetime. Unlike short-term memory, there seems to be no limit how much information we can store in long-term memories. The hippocampus has been shown to be essential for generating long-term memories. Indeed, in individuals who have had part or all of their hippocampus removed to treat certain types of epilepsy, generation of long-term memory is very difficult. They can remember things learned before the surgery but have a difficult time generating new long-term memories after the surgery. The creation of long-term memories appears to involve physical changes in the neurons such as the formation of new synapses or reinforcing existing synapses creating a permanent **memory trace**. Long-term memories seem to be stored in areas of the brain that are most easily accessible by the regions that need them. For example, visual memories are stored in the occipital cortex and memories of sound are stored near the temporal cortex. The process of converting short-term memories to long-term memories is known as **consolidation**. Students often ask what the best techniques for consolidating memories are. The answer is simple, though no one we really wants to hear it. The answer is repetition. The best way to create long-term memories is to review the material over and over.

Long-term memories can be divided into two categories: **explicit** or **declarative memory** and **implicit** or **procedural memory**. Explicit memories are things like what you are trying to learn in school, names, dates, processes, etc. Explicit memory involves essentially those things that can be expressed verbally. Recalling explicit memories requires conscious processing and recalling of the memory. The hippocampus is intimately involved in generating explicit memories. Among the different types of long term memory, declarative (explicit) memories are most easily lost over time.

Implicit memory is memories of things that are not expressed verbally and that we do not have to consciously recall. For example, once we learn how to ride a bike or even walk we do not have to think about it anymore, it is automatic (even reflexive). Some memories start as explicit memory, like when you were first learning to ride a bike, but then become implicit once we have mastered the task. Once again repetition and practice are the best way to generate implicit memories. The amygdala and cerebellum have been shown to play important roles in generating implicit memories.



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