

# Exploring Human Memory and Understanding The Human Tendency of Forgetting

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## Abstract

Memory is a vast and complex branch of human cognition that is pivotal to the understanding of human beings. In fact, the topic of memory is so extensive that there are three different types of memory: sensory memory, short-term memory and long-term memory. Each type of memory is different on how much information can be stored and for how long, with sensory memory holding the least amount of information and for the shortest amount of time, and long-term memory holding the most amount of information and for the longest amount of time. However, it does not end there as there are multiple divisions of long-term memory: explicit and implicit, which each branch out into further, more specific types of memories. It should come to no one's surprise that with the brain having to store and remember so many different memories, it will forget some in the process of recalling others. To explain the process of forgetting and recalling, theories, like: Interference Theory, Decay Theory of Forgetting, Retrieval Failure Theory and Cue Dependent Theory. However, when a memory is forgotten, it is not removed from your long term memory; forgetting typically has to do with a failure of memory retrieval. Now, in order to help one's brain remember and recall all of the memories, there are various different kinds of techniques that people can employ to improve their memory. These range all the way from exercising the brain by playing puzzles to changing one's diet by incorporating less sugar in their meals. However, it is important to note that no matter how hard one tries, the brain is still limited on how many memories it can store, even if that limit is extensive.

## What is Human Memory?

In a simple definition, memory is one's ability to recall information. There are multiple different types of memory, which can be categorized into three types: sensory memory, short-term memory and long-term memory (Harvard Medical School, n.d).

When information is first entered into the brain, it is sent to the sensory memory. Sensory information holds sensory information for one second or less. However, if a person pays attention to the sensory memory, then it can be moved to short term memory and then possibly long term memory (according to one model of theory). This is the beginning of memory processing. Next in the memory stages comes short term memory, which consists of information that someone needs to recall for a few seconds or minutes. Short term memory is limited in the amount of information that it can store as it includes remembering a string of five to seven words and repeating them back or remembering a phone number whilst getting a pen and paper to jot it down for future reference (the golden rule is  $7 \pm 2$  items). Lastly, all other information is stored in long-term memory after repetition, which is responsible for storing a range of memories and experiences from one's life. Generally speaking, any information that someone recalls for more than 30 seconds usually ends up being a part of long term memory. Within long term memory there are two different categories in which the memories can be categorized into: explicit and implicit memory. Explicit memory consists of conscious memories of events, facts, and other things that a person learns about. Within explicit memory, there is semantic memory and episodic memory. Semantic memory is concerned with remembering factual information like what is the capital of the United States, whereas episodic memory is the memory of events in an individual's life, like remembering their 4th

birthday party or where they were on the day of the 9/11 attack. On the other hand, implicit memories are the opposite of explicit memories, meaning that they are memories that people are not consciously thinking about. Procedural memory, priming and conditioning all go under implicit memory. Procedural memory is the memory that a person has about performing a task, whether that be remembering how to drive or how to make their grandmother's famous thanksgiving pie. Priming is when an individual is more likely/faster to identify a stimulus if they have seen it before. Whereas conditioning can be applied to memory in the sense that a stimulus can be remembered due to the learned association of something (Villines, 2020).

There are different cortical structures that are associated with explicit versus implicit memories. More specifically, there are three structures used for explicit memory: hippocampus, neocortex, and amygdala. Located in the temporal lobe, the hippocampus is where episodic memories are formed and stored for later use. Whereas, the neocortex is a sheet of neural tissue that forms the outside surface of the brain and is the largest structure of the cerebral cortex. The information from memories that are temporarily stored in the hippocampus then gets moved to the neocortex where it functions as general knowledge. Lastly, similar to the hippocampus, the amygdala is a structure in the temporal lobe that is responsible for allowing us to process emotions such as fear. The relation between emotion and memory is that the stronger the emotions that are associated with a memory, the more likely one is to not forget it. Moving on, there are only two cortical structures related to implicit memory: basal ganglia and the cerebellum. The basal ganglia are multiple structures located in the center of the brain that assist with habit formation, movement, learning, reward processing and emotion, among other functions.



When it comes to memory, the basal ganglia help facilitate formation of procedural memories that are needed to perform certain skills. Similarly, the cerebellum, a structure located in the back of the head, is involved in processing procedural memories. (Queensland Brain Institute, n.d).

## Human Tendency to Forget

Contrary to popular belief, forgetting does not always indicate memory loss; rather, forgetting can be viewed as altered memory access and can lead to more flexible behavior and decision making. Forgetting allows us to have storage space for creating new memories; without forgetting, our brain would have too many memories that would consequently cause our memory recall to be inefficient (Chawla, 2018). Forgetting happens because, in the spur of the moment, the brain cannot decode what is important during encoding, so it tries to remember everything and gradually forgets any information that is not important. Changes in our ability to recall specific memories are based on environmental feedback and predictability. Humans learn to forget memories when trying to retain memories that are more important and necessary to recall in the future.

When focusing on the biological aspect, memories are stored in groups of neurons called “engram cells” and recall occurs when these cells are successfully reactivated. Forgetting occurs when these engram cells fail to activate. Memories are still stored but until and unless the specific engram cells for that memory are activated, that specific memory cannot be recalled. All the different ways of forgetting have one thing in common: they try to make the engram cells harder to access and activate (Chawla, 2018). For memory-related diseases like Alzheimers, forgetting mechanisms that are responsible for “natural forgetting” are taken over, thus resulting in decreased engram cell accessibility, consequently decreasing activation as well. Scientists have now proposed a new theory that states forgetting occurs due to the circuit remodeling which is a mechanism that causes the engram cells to deactivate from being in an activated/accessible state (Trinity College Dublin, 2022).

There are many theories that propose an explanation for the human tendency to forget. For instance, according to Interference Theory, forgetting occurs as a result of multiple different memories interfering with each other. The more similar the memories, the more likely they are to interfere with each other. The Decay Theory of Forgetting states that the length of time between the encoding of a memory to its retrieval determines what memories and information will be recalled and what will be forgotten. The relationship between these two variables is that the longer the time interval, the decreased probability that someone will recall the memory. Whereas, the Retrieval Failure Theory states that humans forget information because the environmental stimulus failed to enter their long term memory. The last theory is Cue Dependent Theory, in which information that is present in our memory cannot be recalled unless retrieval cues are given (Cherry, 2021).

## What Happens To A Memory When It's Forgotten?

Memories are first stored in the hippocampus and then can be stored in the neocortex after some time has passed. Through the process of synaptic plasticity, neurons are continuously producing new proteins that remodel their synapse, which is a gap between the neurons that allow for chemical messengers to be passed through. Consequently, this causes the neurons to strengthen the connections with one another. This forms a network of cells that work together to encode a memory, and the more often a memory is recalled, the stronger the connection becomes. When the frequency of a memory being recalled decreases, the connections between neurons weaken, making it harder to access a memory, thus leading to forgetting. Memories are still in your brain even when they are forgotten as there is no passive decay of memories. Everything isn't gone. A memory is not removed from your long term memory when it is forgotten; moreover, forgetting has to do with a failure of memory retrieval (Gravitz, 2019). In a sea slug experiment, when looking at the gene expression on both sides of the brain, 11 genes were still active on one side of the animal's brain even though they had apparently forgotten about the shock. The test exemplifies the idea that memories continue to stay in the brain even after they have been forgotten (Chawla, 2018).

## Ways to Improve Memory

There are multiple ways in which humans can improve their memory and thus reduce their tendency to forget. Some methods include staying mentally active by engaging in mentally engaging activities like solving puzzles, using a different route when driving, playing an instrument, etc (Mayo Clinic, n.d). These are all methods in which people can exercise their mind to keep it active and improve memory by challenging their mind to complete mentally stimulating activities. Incorporating healthy habits in your day-to-day life like sleeping well, being physically active and eating less added sugar helps your body, which then has a positive impact on your brain. More specifically, sleeping allows the brain to reconsolidate a person's memory, thus allowing them to better recall that information later. As seen in MRI scans, slow brain waves of deep NREM sleep transported memories from the hippocampus to other permanent sites of storage, according to Matthew Walker, Professor of Neuroscience and Psychology at UC Berkeley (Cappello, 2020). Physical activity leads to an increase in blood flow through the body, especially the brain, which then aids in keeping your memory sharp. When it comes to diet, a high sugar diet has been linked to cognitive decline, poor memory and reduced brain volume, so reducing the amount of sugar present in one's diet can not only help one's overall health but also target memory improvement in the brain (Kubala, 2022). Another way to increase the amount of items memorized is by using mnemonics and memory associations can help with making it easier to remember information especially when needing to retain a lot of information. Socializing regularly by talking to loved ones frequently, especially when alone, is shown to



reduce risk of depression and stress, which are both contributors to memory loss (Vogin, n.d).

## Conclusion

The human mind and cognition are extremely complex, with memory being one of its most extensive branches. Memory is a significant part of human life, and understanding the science behind storing, recalling and retrieving these memories is so imperative for truly experiencing life. As the brain continues to store more memories, scientists around the world are trying to dig deeper to find answers to questions like what happens when a memory is forgotten? Where does a forgotten memory go? Does a forgotten memory still remain in the human mind? Though there are "surface-level" answers to these questions, there is still so much more that can be learned about this aspect of the human experience.

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