

It is possible to break the part of your brain that creates and accesses memories. Allow me to explain.

INTRO

Amnesia is a disorder that you have likely heard about before, but because pop culture likes to distort what it is and how it works, you might have some misconceptions. So let's talk about what's true.

First, the human brain has more than one kind of memory. In order to discuss amnesia, we need a basic understanding of three types of long-term memory.

The first type of memory is called episodic memory. Episodic memory is when you remember something from the past and can re-experience it in your head. In other words, when you remember something episodically, the sights, sounds, smells, feelings, locations, and so on, all come back to you at least a little bit.

The second type of memory is called semantic memory, which is when you have memory for information but do not have memory for the details surrounding the learning of that information. For example, even if you remember that Antarctica is located in the southern hemisphere, you probably don't remember anything about where you were or how you were feeling when you first learned that information. Semantic memory is just the facts with no frills. Facts about yourself like your name, how many siblings you have, and the town you were born in also count as semantic memory.

The third type of memory is procedural memory. A procedural memory is a memory for how to do something, such as how to use a skill to complete a task. Riding a bicycle and tying your shoes are examples of procedural memory.

Importantly, procedural memory is non-declarative, which means that it's really hard to explain how to do one of these skills successfully to someone who doesn't know how. Your muscles can execute the skill without much active

decision-making from your brain, making procedural memory somewhat unconscious. In contrast, both episodic and semantic memories are considered declarative, meaning that you can consciously recollect the information associated with them.

Now that we have discussed the basic types of memory, we are ready to talk about types of amnesia.

The first type of amnesia is called retrograde amnesia. Retrograde amnesia is when you forget memories from your past. Generally speaking, retrograde amnesia has a large impact on episodic memory, a smaller impact on semantic memory, and almost zero impact on procedural memory. Each case is different, of course, but that pattern is generally true (Spiers, Maguire, & Burgess, 2001).

In mild cases, the person may just forget a small number of episodic memories that occurred recently. As cases of retrograde amnesia become more severe, more memories, and memories from longer ago begin to be affected. Semantic memories are often forgotten as well, but generally to a lesser extent than episodic memories. A typical person with retrograde amnesia will retain at least some semantic information about themselves, such as their name. The type of memory that is least affected by retrograde amnesia is procedural memory, such that people with this kind of amnesia can typically still play musical instruments or use other skills from before the onset of the amnesia.

The second type of amnesia is called anterograde amnesia. Anterograde amnesia is when you lose the ability to form new long-term declarative memories. Similar to retrograde amnesia, anterograde amnesia has a large impact on episodic memory, a smaller impact on semantic memory, and almost zero impact on procedural memory.

As one example of the loss of episodic memory, someone with anterograde amnesia will need to be re-introduced to new people that they meet such as healthcare workers, because they will forget the event of having met them within a

few minutes of meeting them. A conversation with a person with anterograde amnesia may seem relatively normal until more than a few minutes have passed, at which point they may begin to repeat themselves or forget what has happened in the conversation so far. There is evidence that with enough repetition, some new semantic facts may become learned, but this occurs extremely slowly (Freed, Corkin, & Cohen, 1987; Sekeres, Winocur, & Moscovitch, 2016). Interestingly, people with anterograde amnesia retain at least some ability to learn new procedural memories, such as new skills. However, they may not form episodic or semantic memories about the fact that they have acquired a new skill. This leads to an unusual situation where they may become skilled at an activity without knowing that they have any skill.

It is also possible for a person to have both retrograde and anterograde amnesia at the same time. The most famous instance of this came about because of a man in a motorcycle accident in the year 1981. This person was called K.C., and was studied extensively by memory researchers. Following the accident, he lost his episodic memory for all events that he had experienced over the course of his life, although he retained some semantic knowledge about himself, his parents, and other facts. K.C. was described as living in the “permanent present” due to both losing old memories and having extreme difficulties in forming new ones (Tulving, Schacter, McLachlan, & Moscovitch, 1988). When he was asked to think about his past or his future, he described his mind as blank. When he was asked to describe a procedural memory, such as how to change a tire, he could give an accurate description of how he would accomplish such a task, despite having no memory of ever having done that task before in his life.

Another subtype of amnesia is called Transient Global Amnesia where a person suddenly experiences both retrograde and anterograde amnesia, but on a temporary basis. During TGA, a person will experience a short episode of defective memory, often lasting only a matter of hours. When a person recovers from TGA, they typically do not recover memories from right before or during the episode, but otherwise their memory abilities return mostly to normal.

Here is a case study to illustrate the typical TGA episode. A 67-year-old man had just finished an interview with two journalists about a historical matter, and the guests had just left his home. Immediately after they left, he turned to his family and began asking questions about who the visitors were and what they had been doing there. Despite his family answering his questions, he continued to repeatedly ask and forget the answers. He was very worried during this event, asking whether his family noticed anything wrong with him. The transient global amnesia episode lasted around an hour, during which he couldn't seem to successfully gather his thoughts (Fisher & Adams, 1964, as reported in Lerner, 2017)

While there is still much to learn about how the brain creates and stores memories, what is known is that the process of creating and remembering episodic memories seems to involve an area called the hippocampus, located in the medial temporal lobe. One reason that this is known is that the typical amnesia case involves damage to this region.

Perhaps the most famous case of amnesia involved surgery that was performed on a young man called H.M. He had epilepsy, and in an attempt to treat it, surgeons removed both of his hippocampi. It was realized after he woke up from surgery that he could no longer form new memories, showing complete anterograde amnesia. H.M. still remembered events from his distant past, but forgot the year or so leading up to the surgery, showing a small amount of retrograde amnesia. Very informative psychological tests were performed on H.M. following the surgery, including experiments showing that he retained the ability to learn new skills, despite being unable to remember that he had learned them. (Corkin, 1968; Scoville & Milner, 1957)

When it comes to the recovery of memories following amnesia, what you have seen in the movies is generally inaccurate. For example, getting hit in the head is not likely to result in recovery of forgotten memories. Importantly, the semantic information that is forgotten, such as the names of loved ones, can be easily relearned, but the episodic memories are usually gone forever. In other words, if you forgot someone, even though you can be told how you met and what their

relationship is to you, you will generally not recover the episodic memories of being with them, and they will continue to feel unfamiliar.

Memories are a quintessential human feature that we hold quite dear, but this is one of the ways that your brain can break.

References

- Butters, N., & Cermak, L. S. (1986). A case study of the forgetting of autobiographical knowledge: Implications for the study of retrograde amnesia. In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 253-272). New York, NY: Cambridge University Press.
- Chan, J. C., & LaPaglia, J. A. (2013). Impairing existing declarative memory in humans by disrupting reconsolidation. *Proceedings of the National Academy of Sciences*, 110(23), 9309-9313.
- Cohen, N. J., & Squire, L. R. (1981). Retrograde amnesia and remote memory impairment. *Neuropsychologia*, 19(3), 337-356.
- Corkin, S. (1968). Acquisition of motor skill after bilateral medial temporal-lobe excision. *Neuropsychologia*, 6(3), 255-265.
- Fisher, C. M., & Adams, R. D. (1964). Transient global amnesia. *Acta Neurologica Scandinavica: Supplementum*, 40.
- Freed, D. M., Corkin, S., & Cohen, N. J. (1987). Forgetting in H.M.: A second look. *Neuropsychologia*, 25(3), 461-471.
- Fujiwara, E., Brand, M., Kracht, L., Kessler, J., Diebel, A., Netz, J., & Markowitsch, H. J. (2008). Functional retrograde amnesia: A multiple case study. *Cortex*, 44(1), 29-45.
- Hacking, I. (1998). *Mad travelers: Reflections on the reality of transient mental illnesses*. Charlottesville, VA: University of Virginia Press.
- Jäger, T., Bänzner, H., Kliegel, M., Szabo, K., & Hennerici, M. G. (2009). The transience and nature of cognitive impairments in transient global amnesia: A meta-analysis. *Journal of Clinical and Experimental Neuropsychology*, 31(1), 8-19.

- Kitamura, T., Ogawa, S. K., Roy, D. S., Okuyama, T., Morrissey, M. D., Smith, L. M., Redondo, R. L., & Tonegawa, S. (2017). Engrams and circuits crucial for systems consolidation of a memory. *Science*, 356(6333), 73-78.
- Larner, A. J. (2017). *Transient global amnesia from patient encounter to clinical neuroscience*. Cham: Springer International Publishing.
- Levine, B., Black, S. E., Cabeza, R., Sinden, M., McIntosh, A. R., Toth, J. P., ... & Stuss, D. T. (1998). Episodic memory and the self in a case of isolated retrograde amnesia. *Brain*, 121(10), 1951-1973.
- Mega, M. S. (2003). Amnesia: A disorder of episodic memory. In M. D'Esposito (Ed.), *Neurological foundations of cognitive neuroscience* (pp. 41-66). Cambridge, MA, USA: The MIT Press.
- Noulhiane, M., Piolino, P., Hasboun, D., Clemenceau, S., Baulac, M., & Samson, S. (2007). Autobiographical memory after temporal lobe resection: neuropsychological and MRI volumetric findings. *Brain*, 130(12), 3184-3199.
- Ryan, T. J., Roy, D. S., Pignatelli, M., Arons, A., & Tonegawa, S. (2015). Engram cells retain memory under retrograde amnesia. *Science*, 348(6238), 1007-1013.
- Scoville, W. B., & Milner, B. (1957). Loss of recent memory after bilateral hippocampal lesions. *Journal of Neurology, Neurosurgery, and Psychiatry*, 20(11), 11-21.
- Sekeres, M. J., Winocur, G., & Moscovitch, M. (2016). Revisiting Tulving et al.: Priming of semantic autobiographical knowledge: A case study of retrograde amnesia. In B. Kolb & I. Whishaw (Eds.) *Brain and behaviour: Revisiting the classic studies* (pp. 130-154). Thousand Oaks, CA: SAGE Publications.
- Sellal, F., Manning, L., Seegmuller, C., Scheiber, C., & Schoenfelder, F. (2002). Pure retrograde amnesia following a mild head trauma: A neuropsychological and metabolic study. *Cortex*, 38(4), 499-509.
- Spiers, H. J., Maguire, E. A., & Burgess, N. (2001). Hippocampal amnesia. *Neurocase*, 7(5), 357-382.
- Squire, L. R., Bayley, P. J., Smith, C. N. (2009). Amnesia: Declarative and nondeclarative memory. In L. R. Squire (Ed.) *Encyclopedia of neuroscience* (pp. 289-294). Oxford, UK: Academic Press (Elsevier).

Talmi, D., Caplan, J. B., Richards, B., & Moscovitch, M. (2015). Long-term recency in anterograde amnesia. *PloS one*, 10(6), 1-20.

Tonegawa, S., Pignatelli, M., Roy, D. S., & Ryan, T. J. (2015). Memory engram storage and retrieval. *Current Opinion in Neurobiology*, 35, 101-109.

Tulving, E., Schacter, D. L., McLachlan, D. R., & Moscovitch, M. (1988). Priming of semantic autobiographical knowledge: A case study of retrograde amnesia. *Brain and Cognition*, 8(1), 3-20.

“Clean Slate” 1994

“The Vow” 2012

Man with a 7 Second Memory Still Plays the Piano but Doesn't Know How | Only Human

Only Human

Published on Jan 2, 2018

<https://www.youtube.com/watch?v=SO-3Ruw61Sg>

“Memento” 2000

Teaching Kids About the Brain: Mirror Drawing
nbOutreachUW

Published on Oct 25, 2009

https://www.youtube.com/watch?v=Nz_FVxYU74Y

“Nit-Wit Kitty” 1951