THE SCIENCE OF MAKING MEMORIES

Illustration by **Vicki Turner**

Ahead, we've curated 65 experiences that you'll never want to forget, but how do we create – and retain – long-lasting holiday memories? What sears an event into your consciousness? Neuroscientist **Moheb Costandi** explains how travel ignites our senses and helps compound what we remember

Burying dad in sand on the beach in Alicante. Getting drunk during that stag weekend in Zagreb. Snorkelling in the Red Sea at Sharm el-Sheikh. Trips abroad with family or friends can create fond, long-lasting memories.

Memory enables us, as William Blake put it, to "traverse times and places far remote". But what makes some events so memorable, and how can we recall them so vividly years, or even decades, later?

Of all the functions that the brain performs, memory is by far the one that has been studied the most. We still do not know exactly how memories are stored and retrieved, but decades of scientific research give us a pretty good idea.

Much of what we do know comes from studies of a now-famous amnesic patient known as HM, who developed epilepsy following a childhood accident. HM's seizures became more frequent and debilitating and did not respond to anti-convulsant drugs. In 1953, HM, aged 27, underwent a radical surgical procedure to remove the damaged brain tissue causing them. Neurosurgeon William Scoville identified a brain structure – the hippocampus – as their source, and removed it from both sides of HM's brain. This cured HM's epilepsy, but left him completely unable to form new memories. Investigators had suspected that the hippocampus played some role in memory; HM's operation confirmed that it is critical for memory formation.

In 1957, psychologist Brenda Milner began a series of pioneering studies with HM that revealed more about memory function. Milner' found that HM's memories of events that occurred long before his operation remained intact, indicating that the ability to recollect remote memories does not rely on the hippocampus. HM also retained his ability to learn new skills. Thus, a distinction was drawn between memory for facts and events and memory for motor skills, such as riding a bike, which are served by independent brain systems.

More recent technological advances allow researchers to probe the mechanisms of memory in finer detail. The human brain has an estimated 86 billion neurons (nerve cells, each of which can generate up to 1,000 electrical signals per second). Neurons form intricate networks and connect with each other at minuscule junctions called synapses, using chemicals to communicate.

It is thought that memory formation involves the strengthening of connections within networks of neurons in the hippocampus, and that memories are recalled when electrochemical signals 'reactivate' the same networks. We make memories by learning to associate otherwise unrelated items, encoded in the neuronal networks of the hippocampus. Related items may recruit overlapping networks, and the associations between them likely strengthens the connections between different networks. Thus, recalling any particular memory may initiate a chain reaction in overlapping networks that triggers the recollection of related memories. Recalling one particular trip abroad can bring back memories of other, similar trips.

Recall of recently formed memories relies on the hippocampus. With time, however, memories are transferred to the frontal cortex for long-term storage. We also know that the hippocampus serves as the brain's global positioning system, creating spatial memories that help us navigate our environment. Travel involves visiting new places, meeting new people and experiencing new sights, sounds and smells, all of which become associated with each another, leading to the formation of rich new memories.

Strong emotions enhance memory formation. That's why we may recall a significant life event 'as if it happened yesterday'. So, the more we enjoy ourselves on holiday, the more likely we are to remember it for longer. The opposite is also true (see below).

We also know that memory is 'reconstructive' rather than reproductive. That is, it does not work like a video recorder, and we do not remember events exactly as they happened. Our memories are influenced by what we paid attention to at the time they are formed, and our recollections become contaminated by our inherent biases and expectations. Your nostalgia for those family beach holidays you took as a child may seep into memories of later beach holidays.

When we remember something, we do not recall the memory in its entirety, but instead retrieve fragments of it and stitch them together. Your memory of an event may therefore differ from that of a friend who attended the same event. Most of the time, our memories are accurate enough. Yet, they can easily be distorted; some may be completely false (this has major implications for the legal system, which relies heavily on eyewitness testimony).

Why does memory work like this? It may be because the function of memory is not to recall the past, but to predict the future. When we encounter a new situation, we can draw on past experience, and stitch together new combinations of memory fragments to simulate what might happen and work out the best course of action.

The reconstructive nature of memory could also explain *déjà vu*. Any given situation automatically reactivates memories of similar situations from the past. If one is similar enough, it may cause us to believe that we have experienced it before. So frequent flyers, who travel regularly and stay in similar business-oriented hotels, may begin to feel that all their trips resemble one another.

Blake understood that memory is a form of mental time travel that can take us back to the remote past. Yet, visionary as he was, he did not imagine that it could transport us into the future.

Body Am I: The new science of self-consciousness (MIT Press) by Moheb Costandi is out now

FORGET ABOUT IT...

Why those embarrassing moments stick (and will go around and around your mind at 4am)

We recall embarrassing, sad or traumatic events far better than mundane ones because strong emotions enhance memory formation by engaging the amygdala, a small, almond-shaped structure attached to the front of the hippocampus.

Surprising or shocking events can be remembered as 'flashbulb' memories, which tend to be vivid and long-lasting, and include details of where one was, or what one was doing, when the event took place. The prototypical example of such an event is the assassination of JFK.

People recall flashbulb memories with great confidence but, as is the case with memories in general, they may not be as accurate as we think they are. They often involve 'time slice' confusions, whereby details from the second or third time one heard news about the event are confused with those from the first.

On a personal level, your memory of an embarrassing moment, such as that belly flop you did in the hotel pool to impress your friends, may be inaccurate. You may remember everyone staring at you as you climbed out of the pool afterwards, when in fact it was only your friends that noticed.

Illustration: Vicki Turner