Brain case study: Patient HM

Patient HM was an important case study for neurological research in the 20th century. Holly Story discovers how his life and his unique condition helped scientists to understand the brain.

Henry Gustav Molaison, known to the world as ‘Patient HM’, has been called the most important patient in the history of brain science. He was studied by a team of neuroscientists for more than 50 years – from the age of 27 to his death aged 82 – yet he could not remember their names or their experiments. Henry Molaison suffered from profound amnesia, and his unique condition helped neuroscientists to understand more about how our memory functions.

As a child, Henry suffered from epilepsy, which may have been caused by a head injury he sustained when he was seven years old. At first his seizures were minor, but from the age of 16 they became increasingly severe. By the time Henry was 27, he was unable to work.

Undergoing surgery

In 1953 Henry was referred to neurosurgeon Dr William Beecher Scoville at Hartford Hospital, Connecticut, USA. Scoville suggested surgery to remove the part of Henry’s brain that was causing his seizures. This was major and experimental surgery, but Henry was so incapacitated by his epilepsy that he agreed to undergo the procedure.

Dr Scoville performed something called a bilateral medial temporal lobe resection. This involved removing a portion of Henry’s temporal lobe, including parts of the hippocampus and amygdala, from both sides of the brain. Resection is still used today to treat severe epilepsy. It is a highly precise surgical procedure, informed by advanced brain imaging and a detailed knowledge of the brain. Scoville had none of these tools at his disposal and he could not foresee the effects of his surgery.

When Patient HM woke from his surgery, he was suffering from severe amnesia. Henry could remember much of his childhood: he knew his name and family history and could remember the stock market crash of 1929. However, he struggled to remember events from the few years leading up to the surgery and could not remember some things that had happened up to 11 years before.

Henry also had severe anterograde amnesia. This means that he had lost the ability to form new memories. Later, he would describe his condition as being “like waking from a dream...every day is alone in itself”.

ABOUT THIS RESOURCE

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Scoville contacted researchers at McGill University in Montreal, who had reported on two similar cases of amnesia in patients who had undergone temporal lobe surgery. Dr Brenda Milner, a psychologist from McGill, travelled to Hartford to visit Molaison and began her research into his amnesia, his remaining memory and his brain. As Scoville never repeated the operation, Henry’s case was unique. It was also well-suited to research: his amnesia was unusually severe, his condition was stable, he was a willing subject, and researchers had some knowledge of the anatomical basis for his condition.

In 1957 Dr Milner published the first results of her formal testing. She used the pseudonym ‘Patient HM’ to protect Henry’s anonymity. This paper became one of the most cited papers in neuroscience.

Making memories
At the time of Henry’s operation, it was thought that memory functions were spread throughout the brain. The fact that Henry suffered one kind of amnesia so acutely as a result of damage to one part of his brain, and yet retained his intellectual abilities, prompted researchers to reassess this assumption. It was clear that the temporal lobe must be vital for memory function.

At that stage, the scientists could not identify which structure within the lobe was specifically responsible, as several different structures – including the hippocampi, amygdalae and entorhinal cortices – had been affected by the operation. It would take years of study using animal models and great advancements in technology before the medial lobe memory system was fully understood, but Patient HM helped to lay the foundations of this vital research.

In 1962 Milner published the results of a series of trials that she had conducted with Henry, which revealed one of her most notable discoveries. In the trials she had asked Patient HM to draw a line between two outlines of a five-pointed star while watching his hand and the page in a mirror. Milner asked Henry to repeat this task several times on several different occasions. Each time Henry did not remember having completed the task before, yet his performance improved. This demonstrated that, although he was not conscious of it, Henry was able to learn new motor skills by repeated practice.

From these trials Milner was able to conclude that this form of memory, called motor learning, must be distinct from the system of memory that records new facts, faces and experiences. Furthermore, it must be located in a different part of the brain, one unaffected by Henry’s operation. Milner’s discovery that we have multiple memory systems and that they are located in different parts of the brain was a huge step forward in neuroscience.

Henry’s legacy
Henry was always supportive of the research that he enabled and said he was glad that he could be of help to others. In 1992 he gave his consent for his brain to be used in further research after his death, and this led to the establishment of Project HM.
When Henry died in 2008, his brain was removed and scanned repeatedly using MRI. It was then sent to the Brain Observatory at the University of California. In 2009 scientists sliced the brain into 2401 pieces, each just 70 micrometres (millionths of a metre) thick. Their aim was to create stained histological slides that would enable researchers to map the brain in new ways and connect individual anatomical structures with specific functions.

The dissection took 53 hours to complete and five blades were used in the process. Each slice was photographed and the images were posted online, and the whole procedure was streamed live on the internet.

Henry and his doctors could not have imagined the technology that would eventually be used to preserve his brain, nor could they have predicted the advances in neuroscience that would result from his operation, his condition and his generosity.

To read about how resection operations are done today and to hear a surgeon talk about how technology helps him operate, read our interview with Conor Mallucci on our website.

QUESTIONS FOR DISCUSSION
• Would you donate your brain to science? Why?
• What is the Brain Observatory? Search online to find out more.