The HM case study

HM was studied by researchers like Scoville and Milner, 1957; Milner, 1966; Milner et al. 1968; Corkin, 1984. It is a longitudinal study and many different data collections methods have been used over the year. HM was born in Manchester, Connecticut in 1926. HM fell off his bicycle when he was aged 7, injuring his head and was unconscious. Epileptic attacks began when he was 10; they were assumed to be connected to the accident. At the age of 27 he had become so incapacitated by his seizures that he could not lead a normal life and anti-convulsant medication did not help him. With the approval of the patient and his family, the neurosurgeon William Scoville therefore performed an experimental surgery where he removed tissue from the medial temporal lobe (including the hippocampus) on both sides of HM’s brain.

Brenda Milner is a neuropsychologist who studied HM until he died in 2008. The first observations of HM and the results of formal testing were reported in 1957 (Scoville and Milner, 1957). This paper is one of the most cited papers in neuroscience ever. The first time Brenda Miller visited HM after the operation she observed that he forgot daily events nearly as fast as they occurred, for example, he forgot names of persons to whom he had just been introduced. He described his own state “like waking from a dream; every day is alone in itself.” (Milner et al. 1968).

After the operation HM remembered his childhood very well. His personality appeared largely unchanged. There was no general intellectual impairment but he could recall little of the 12 years before to the operation in the beginning. When some time had passed after the operation, HM’s retrograde amnesia (i.e. memory for events before the operation) diminished and by 1966 he only had problems remembering the period of about one year before the operation.

HM suffered from anterograde amnesia. For example, he was unable to remember the faces of people he met after the operation. A psychologist could spend the morning testing him but in the afternoon HM would act as if the psychologist were somebody he had never seen before. He could not recognize people who came to see him regularly for six years. Reading and rereading the same magazine created no impression of familiarity. The researchers concluded that HM’s amnesia was manifested in the following ways. He could not acquire new episodic knowledge (memory for events that have a specific spatial and temporal context) and he could not acquire new semantic knowledge (general knowledge about the world, including new word meaning). This suggests that the brain structures that were removed from his brain are important for long-term explicit memory.

The researchers also found that he was able to remember his house and could draw a picture of the floor plan of his new home. This indicates that he was able to form a cognitive map of the spatial layout of his house. The scan of his brain showed that he had some of the components of what is called the spatial processing network, which includes part of the areas around the hippocampus.
The failure to update memories is an important part of the amnesic syndrome (Baddeley, 1997). HM had a capacity for working memory, since he was able to carry on a normal conversation. This requires a minimal level of retention of what has just been heard and said. On being asked to recall the number 584, HM was able to do so even 15 minutes later, apparently by means of constant verbal rehearsal. However, after the task was over, the number and HM’s strategy in remembering it were lost.

Memories in the form of motor skills, i.e. procedural memories, were well maintained, for example he knew how to mow a lawn. He also showed improvements on the performance of new skills such as reverse mirror-drawing in which he had to acquire new eye-hand coordination (Milner, 1966). Again, HM’s ability to assimilate skills is typical of the amnesic syndrome but patients like him have no consciously memory of acquiring the new skill. HM had some insight into his problem and a sense of humour. Corkin (2002) reports that when she asked him what he is doing to try to remember he answered: “Well, that I don’t know ‘cause I don’t remember (laugh) what I tried”. According to Corkin HM had a sense of self and he was altruistic. He said about Scoville: “He did medical research on people – all kinds of people. What he learned about me helped others too, and I’m glad about that.” He also had knowledge about his own appearance although he did not know his own age and that he had grey hair.

An MRI scan of HM’s brain was performed in 1992 and 2003 where Corkin et al. (1997) analysed the extent of the damage. It was possible to see that parts of HM’s temporal lobe including the hippocampus and para-hippocampal region had the most damage. This was a breakthrough in understanding the damage in HM’s brain. They seemed less extensive than originally estimated by Scoville. Mishkin (1978) suggested that damage to the hippocampus and the amygdala produced the severe amnesia in HM. This is generally supported by later research and recently it has been suggested that white matter and hippocampus are the most important factors in HM’s amnesia because these areas are involved in the cholinergic pathways to memory, i.e. areas where neurotransmitters such as acetylcholine are believed to play an important role in learning and formation of e.g. episodic memories.

What can be learned from the case study of HM?

- The memory systems in the brain constitute a highly specialized and complex system.
- The hippocampus and the parahippocampal areas play a critical role in converting memories of experiences from short-term memory to long-term memory (the permanent store).
- Since HM was able to retain some memories for events that happened long before his surgery it indicates that the medial temporal region is not the site of permanent storage but rather plays a role in the organization and permanent storage of memories elsewhere in the brain.
• The medial temporal lobes are important for forming, organizing, consolidating, retrieving memory but cortical areas are important for long-term storage of knowledge about facts and events and how this knowledge is used in everyday situations.
• The fact that HM and other persons with amnesia have deficits in some types of memories but not in others is taken as evidence that the brain has multiple memory systems that are supported by distinct brain regions.

Evaluation of the case study of HM

A case study is an in-depth investigation of an individual. The HM case study was a longitudinal study which ran over more than 50 years and HM participated in all kinds of research such as cognitive tests and scanning when that became possible. It is one of the most important case studies in the history of neuropsychology. It has contributed enormously to the knowledge of how memory processes are related to distinct brain regions. HM died in December 2008 and his brain was donated to science. The brain has been sliced up for further anatomical studies so HM continues to contribute to scientific research on the brain and memory.

One of the major contributions of this case study was the discovery that there are many different forms of memory and that they are located in different areas of the brain. HM’s memory loss is related to forming, sorting and storage of new memories which is linked to the hippocampus. Researchers have also found that short-term memory is not stored in the hippocampus as HM was able to retain information for a while if he rehearsed it. They also concluded that the hippocampus is not involved in forming and storing new procedural skills. The fact that he could acquire new skills contributed to the knowledge of procedural memories being formed and stored by other parts than the removed parts of HM’s brain. Researchers have also concluded that implicit memory contains several stores - for example, procedural memory, emotional memory and skills and habits. Each of these areas is related to different brain areas.

The case study has sparked off research with animal models of memory to get a deeper understanding of the exact biological correlates of memory. Researchers have for example trained animals to run a maze and then operate the specific part of the brain related to that memory to investigate if the animals could still run the maze or were unable to do it. The case study of HM has thus contributed to more research in the area of localization of function.

It is normally not possible to generalize from one case study to a large population but since other case studies of people with brain damage like HM’s tend to support the findings from this case study it can be argued that some generalization is possible. It can also be argued that the brain is functionally the same in all humans so therefore we can use the example of one case study like HM to generalize.