

Milner carried out a classic case study of the role of the hippocampus on memory formation. You can use this study for the following content in the biological approach:

Research methods used in the cognitive approach.

Techniques used to study the brain.

Localization of function.

In addition, for the cognitive approach, you can use this study to address models of memory - particularly, the evaluation of the Multi-Store Model.

## Background information

HM is perhaps the most famous participant in a psychological study ever. It is a **longitudinal case study** and many different data collection methods have been used over the years.

HM was born in Manchester, Connecticut in 1926. HM was hit by a cyclist while crossing the street when he was 7 years old and sustained a serious head injury. 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 medication did not help him. With the approval of the patient and his family, neurosurgeon William Scoville 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 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 the names of people to whom he had just been introduced. He described his state as "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 the operation. 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 primarily 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 several years.

## Procedure and results

The aim of this case study was to better understand the effects that the surgery had had on patienToder to carry out her research, Milner used many different strategies. This is an example of how **method triangulation** may be used in a case study:

- Psychometric testing: IQ testing was given to HM. His results were above average.
- Direct observation of his behavior;
- Interviews with both HM and family members.

- Cognitive testing: memory recall tests as well as learning tasks such as reverse mirror drawing.
- Corkin later did an MRI to determine the extent of the damage done to HM's brain.

HM could not acquire new **episodic knowledge** (memory for events) and he could not acquire new **semantic knowledge** (general knowledge about the world). This suggests that the brain structures that were removed from his brain are important for the transfer of information from short-term to long-term 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. This may mean that this type of memory is not encoded in the same way as semantic or episodic memories.

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 using constant rehearsal. However, after the task was over, HM would not be able to recall the number.

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 in the performance of new skills such as reverse mirror drawing in which he had to acquire new eye-hand coordination (Milner, 1966). Although he showed improvement in the skill over time, he never remembered learning the skill. Every time Milner asked him to do it, he would say that he had never tried it before.

In 1992 and then 2003, Corkin carried out an MRI scan of HM's brain to see the extent of the damage. It was possible to see that parts of HM's temporal lobe including the **hippocampus** had the most damage. However, the damage was less extensive than originally estimated by Scoville. Damage to the hippocampus explains the problem of transferring short-term memory to long-term memory as this is the area where the neurotransmitter acetylcholine is believed to play an important role in learning and the formation of memories.

The following is a summary of the key findings:

- The memory systems in the brain constitute a highly specialized and complex system.
- The hippocampus plays a critical role in converting memories of experiences from short-term memory to long-term memory.
- However, researchers 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.
- Since HM was able to retain some memories of 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.
- 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.

## Evaluation

- The study was a case study. The strength of this study is that it was **longitudinal** over 50 years! This means that change could be observed over time. In addition, case studies use **method triangulation**.
- The limitation of case studies is that they cannot be easily replicated. However, there are several other case studies of patients like HM for example, Clive Wearing which confirm the findings.
- Some aspects of the study were retrospective. This means that we do not have a lot of data on HM's
  actual cognitive abilities before the accident.
- The medication taken to treat epilepsy may have resulted in some of the damage, but this is not highly relevant as it is the damage to specific parts of the brain that is important.
- High **ecological validity**, no variables were manipulated and HM was observed in his natural environment.
- Milner's research met high ethical standards of consent, confidentiality, and protection from harm.