DP IB Psychology: HL

Localisation of Function

Contents

Localisation of Brain Function

What is localisation of brain function?

- Specific behaviours and functions e.g. memory, **executive control**, are associated with specific regions of the brain e.g. the **hippocampus**, the **pre-frontal cortex (**PFC)
- Localisation of function (LOF) assumes that there is a **biological basis to behaviour** and that thoughts, actions and other behaviours are linked to a biological function
- **LOF can be measured using techniques to study the brain such as MRI, fMRI and PET**

What are some examples of LOF?

- Language production is located in **Broca's area** in the left hemisphere of the brain
- Both **declarative memory** and **spatial navigation** have been linked to the hippocampus
- **Executive control (e.g. impulse control, the ability to plan and to understand consequences) which is a higher-order cognitive function has been linked to the prefrontal cortex**

Which research studies support LOF?

- **Corkin (1997)** used MRI to measure the brain of HM: HM's hippocampus was almost completely destroyed in his previous surgery so the ability to form new memories can be localised to the hippocampus
- **Maguire (2000)** used MRI to measure the volume of grey matter in taxi drivers' brains and found that the left posterior hippocampus was increased in size, thus this region may be localised to spatial navigation
- **Raine et al. (1997)** used PET scans to demonstrate the lack of activity in the PFC of impulsive murderers which highlights a link between the PFC and executive control

These studies are available as separate Key Studies – just navigate the Brain and Behaviour section of this topic to find them.

Evaluation of LOF research:

- **Corkin (1997)**
  - Strength: The **longitudinal** nature of this research provided valuable insight into the importance of the hippocampus in relation to memory
  - Limitation: This was a **case study** of one participant, so the results are not easily **generalisable**
- **Maguire (2000)**
  - Strength: The additional use of correlational analysis (time as a taxi driver and volume of hippocampal grey matter) gave extra support to the idea that spatial navigation is linked to the posterior hippocampus
  - Limitation: It is not clear as to whether the participants had pre-existing high levels of posterior hippocampal grey matter before the study commenced
- **Raine et al. (1997)**
  - Strength: The use of a **matched pairs design** means that individual differences are to some extent controlled for
  - Limitation: The findings may be interpreted as being **deterministic** i.e. lack of PFC functioning means that an individual is destined to be a violent criminal

Worked Example

Evaluate research into localisation of function. [22]

Here is part of a response to the above essay question:

One strength of Maguire's study is that controls were put in place e.g. using only right-handed males. This was done to ensure that the confounding variable of handedness did not impact the validity of the study (handedness may have some effect on the size of certain brain regions like the hippocampi).

One limitation of this study is that the sample is biased as it consisted of only 16 males who lived in or near central London. The findings cannot be generalised to women, left-handed males or taxi drivers from other parts of the UK. The sample size is small which also impacts the generalisability of the findings, but this was due probably to the time and cost-intensive procedure and equipment used in the study.

Two Key Studies of Localisation of Brain Function: Maguire (2000) & HM (Corkin 1997)

Key Study 1: Maguire (2000)

Aim: To investigate **localisation of function** linked to **spatial navigation** experience in London black cab taxi drivers

Participants: 16 healthy, right-handed male London black cab taxi drivers who had passed 'The Knowledge', a test of spatial navigation, aged 32–62 years with a mean age of 44 years. They had all been taxi drivers for at least 18 months, with the highest number of years as a taxi driver at 42 years

Procedure: The participants were placed in an **MRI** scanner and their brains were scanned. The MRI measured the volume of **grey matter** in the **hippocampus** of each participant, and this was then compared to pre-existing scans of 50 healthy, right-handed males (the **control group**). Grey matter was measured using **voxel-based morphemetry** (VBM) which focuses on the density of grey matter and **pixel counting**

Results: The **posterior hippocampi** of the taxi drivers showed a greater volume of grey matter than that of the controls, who had increased grey matter in their **anterior hippocampi** compared to the taxi drivers. Maguire also carried out a **correlational analysis** which showed a positive correlation between volume of posterior hippocampal grey matter and length of time spent as a taxi driver

Conclusion: The posterior hippocampus may be linked to spatial navigation skills

Evaluation of Maguire (2000)

Strengths

- The use of MRI technology means that the researchers were able to pinpoint the key area of the brain localised to spatial navigation
- The **correlational** analysis of time spent as a taxi driver linked to increased volume of hippocampal grey matter lends **validity** to the idea of neuroplasticity due to learning and experience

Limitations

- A correlation cannot show cause-and-effect so it is impossible to know whether the taxi drivers already had naturally high levels of hippocampal grey matter
- MRI technology is not 100% reliable: it is vulnerable to noise, temperature and operator-error

Key terms:

- **Spatial navigation**
- **Anterior hippocampus**
- **Pixel-counting**

Key Study 2: The case of HM (Milner 1968, Corkin 1997)

Aim: To investigate memory loss in a brain-damaged patient known as HM and to investigate the areas of the brain implicated in his amnesia

Participant: The patient known as 'HM, (Henry Molaison) had been run over by a bicycle at the age of nine which resulted in him experiencing **epileptic** fits. These became so severe that at the age of 27 he underwent a **bilateral medial temporal lobe** re-section which involved the removal of about two thirds of his **hippocampu**s. HM's epilepsy improved but he began to suffer extreme **anterograde amnesia** and partial **retrograde amnesia**: he completely lost the ability to form new memories while long-term memories from the past remained fairly intact

Procedure: HM was initially studied by Brenda Milner, a doctoral student who visited HM frequently, administering a range of tests and measures including **psychiatric** tests such as personality, mood and depression **questionnaires** as well as **interviews** with psychiatrists. His scores did not indicate depression, anxiety or psychosis and he communicated a good awareness of his condition (i.e. he did not 'forget' that he was suffering from anterograde amnesia). He completed a standard IQ test on which his score was normal, however his scores on the Wechsler Memory Scale test demonstrated his severe memory impairment. Milner noted that HM frequently forgot what had happened that day, thought he was younger than his actual age, forgot the names of people he had just met and commented that every day felt as if he was just waking up from a dream. Milner studied him (and later, Corkin, who used MRI to scan HM's brain) for over 50 years until his death at the age of 82

Results: The key finding from the study of HM is that memory is not simply part and parcel of a collection of **cognitive** functions which reside in the **cortex,** rather it is a distinct function which is localised to the **temporal lobe**, specifically the **hippocampus**. Post-mortem analysis of HM's brain helped to confirm these findings. The MRI scans agreed with the post-mortem analysis

Conclusion: Hippocampal damage may be linked to long-term anterograde amnesia

Evaluation of the case of HM (Milner 1958, Corkin 1997)

Strengths

- This case study employed both **qualitative** and **quantitative** methods, generating both reliable and rich data
- HM's case highlighted important new insight into the brain and its link to memory function, specifically the role of the hippocampus in memory formation

Limitations

- One possible **confounding variable** could be that HM's brain was already damaged due to his epilepsy which would decrease the validity of the findings
- Working closely with one participant for decades could mean that **researcher bias** may have interfered with Milner's objectivity