Maguire (2000)
Your Amazing Brain!
What do a London taxi & a seahorse have to do with your brain?

• This study looks at the brains of London taxi drivers and examines the role of the hippocampus (Greek for seahorse) in helping them to navigate their way around the city.
St Albans street map
Maguire (2000) What is the hippocampus?

- Hippocampus is the latin name for seahorse.

- In the brain, the hippocampus plays a key role in spatial memory and navigation.
The following examples illustrate how the volume of the hippocampus can increase.

1. Animals that have a large territory have larger hippocampi.

Gaulin & Fitzgerald (1996): meadow voles; males have larger hippocampus than females during mating season.

2. Small mammals and birds who engage in lots of food storage have a larger hippocampal volume.

3. Racing pigeons renowned for their skill at flying home long distances from unknown locations have larger hippocampi than other breeds of pigeon.
Maguire (2000) – Navigation skills in Taxi Drivers

• Black Cab drivers are required to have a detailed \textit{knowledge} of the 25,000 streets within a six-mile radius of Charing Cross as well as a more general knowledge of the major routes throughout the rest of London.

• They are given a written test on the first 80 routes and then interviewed on the other 240.

• \url{http://www.taxiknowledge.co.uk/main.html} Have a look at a mock test and archives of the top 50 routes requested.
Maguire (2000) – Navigation skills in Taxi Drivers

Maguire (2000) – **Aim**

- To *investigate the role of the hippocampus in navigational and spatial skills*, and the extent to which the brain shows changes (plasticity) when exposed to extensive navigational experience, as demonstrated by London taxi drivers.

- Also, to see if there is a *correlation* between the length of taxi-driving experience and the measure of grey matter volume.
Maguire (2000) - Sample

- 16 licensed London taxi drivers.
- Right-handed.
- Aged between 32 and 62 (mean age of 44 years).
- Healthy medical, neurological and psychiatric profiles.
Maguire (2000) – Sample

• A comparison group of 50 control participants were chosen from the structural MRI scan database at the same unit where the taxi drivers were scanned.
  
• All Male
• Non were taxi drivers.
• Right-handed
• Aged between 32 and 62. (Mean age similar to taxi drivers)
Maguire (2000) – Method and Design

- The method is best described as a **QUASI EXPERIMENT** because……..
- It also involves a correlational analysis.
- The IV is taxi drivers and non taxi drivers. The DV is the volume of the hippocampus.
- The design is **INDEPENDENT MEASURES** because……..
Data was collected using structural MRI scans.
The scans were analysed using two techniques:
• 1. VBM (Voxel-Based Morphometry)
• 2. Pixel counting.
Maguire (2000) – Procedure

- A structural MRI (Magnetic Resonance Imaging) scan involves using a computer software programme to produce a 3D image of the brain.
Maguire (2000) – Procedure
An MRI scan

- http://www.youtube.com/watch?v=PEDxWLNZTA4
Analysing the MRI scans;

- **1st Technique – Voxel-Based Morphometry.**

  Identifies differences in the density of grey matter in different parts of the brain.

  Grey matter has dense neural connections and is associated with higher order thinking.
Maguire (2000) – Procedure

Analysing the MRI scans;

- **Pixel 2nd Technique Counting.**

A pixel is a single point on a graphic image. In order to calculate hippocampal volume, pixels were counted on photographic ‘slices’ made through the brain using an MRI scan.

The person counting the pixels was ‘blind’ to whether the brain belonged to a taxi driver or control participant.

Pixels were counted for the anterior, posterior and body of the hippocampus.
Maguire (2000) – **Procedure**

- **CONTROLS**
  - Participants were all scanned using the same scanner.
  - The hippocampal volume for each participant was calculated to include an adjustment for the size of each person’s brain. This was to ensure that all participants’ data was comparable.
Maguire (2000) – Results

The image shows a bar graph illustrating the hippocampal cross-sectional area (mm²) for different regions (anterior, body, and posterior) and hemispheres (LH, RH), with significance markers (*). The graph compares T drivers and control groups.
Maguire (2000) Results

• **Volume** – some regionally specific differences were noted.

• Taxi drivers have greater grey matter volume in their **posterior right hippocampus**. (As measured by VBM)

• Controls have greater volume in their **anterior hippocampus**.

• These results are significant at $p < 0.05$
Maguire (2000) Results

![Graph showing adjusted VBM responses vs. time as taxi driver (months).]
Maguire (2000) **Results**

- **Correlational Analysis** – a comparison of length of driving experience with the measure of grey matter volume of the taxi drivers showed a **significant positive correlation** for the right posterior hippocampus. \( r=0.6, \ p<0.05 \)

- This means the more experienced the driver is, the greater the grey matter volume is in their right posterior hippocampus.
Maguire (2000) - Conclusions

• Maguire states ‘professional dependence on navigational skills in licensed London taxi drivers is associated with a relative redistribution of grey matter in the hippocampus’.
• EXPLANATIONS FOR RESULTS.

• 1. This difference in the taxi drivers’ hippocampi might have always been there and this could have led them to doing a job where navigational skills were important...... OR

• 2. The taxi drivers’ hippocampi may have changed as a result of studying for the ‘knowledge’ thus showing plasticity of the brain.
The results of the correlational analysis would support the second idea – because the longer they had been a cab driver, the greater the volume of their right posterior hippocampus.