Chapter 4 Physiological psychology

Study 7: Maguire et al. (brain scans)

Qs (page 115)

1 One reason she picked the hippocampus was because previous research has found that in some species, hippocampal volume increases temporarily during seasons which require much more spatial ability and navigation (e.g. foraging or migrating). This indicates that the hippocampus is involved in navigation.

2 They used taxi drivers because of their extensive training in order to acquire ‘The Knowledge’ to become a licensed London cab driver. The training is usually very intense over a period of 2 years and then in their jobs they need to use their navigational skills at all times. It is unlikely that any other identifiable group would have undergone such intense navigational experience like this.

3 The control group is needed so that you can compare the size of the taxi drivers’ hippocampus to the normal group who had not had all the navigational training. Without the control group, it would be impossible to know whether the taxi drivers’ hippocampal volume was different.

4 They were age matched because it is likely that brain volume and density changes with age. Therefore, the researchers wanted to control for this so that any differences between the taxi drivers and the controls could be said to be related to the navigational experience, and not due to being younger or older.

5 The mean just tells you ‘the average’; it might be that they match them according to the mean, and for the taxi drivers the mean is 44 with peoples age ranging from 32 to 62, whereas in the controls, everyone is 44. This would be a bad way to match the groups as it would not be a sufficient way to control for age. Just having a couple of people over 50 in the taxi driver group might make a huge difference to the mean VBM etc.

6 This study is a quasi- (or natural) experiment because there is an IV but this IV is not manipulated by the researcher – instead it has happened independent of the researcher: taxi drivers chose to be taxi drivers themselves (and were not assigned to that condition).

7 IV is whether the participant is a taxi driver or a control. The DV is hippocampal volume (as assessed by VBM and pixel counting).

8 Unbiased means that it is objective. It is a technique which enables every part of the brain to be measured and given equal attention, and not just larger areas.

9 This is a control to make sure that a researcher does not (subconsciously or otherwise) (mis)interpret the images in order to help support the hypothesis. If the analysis was done by someone who expected the taxi drivers’ hippocampi to be bigger this might lead them to interpret the data slightly in that direction. Thus, the ‘blind’ analysis helps to keep the results as objective and as bias free as possible.

10 A Voxel-based morphometry (VBM) measures the density of grey matter, and b pixel counting measures the volume as a function of total brain size.

11 Anterior, posterior and body of the hippocampus.

Qs (page 116)

1 Intercranial volume means the area within the skull or cranium.

2 One conclusion is that the taxi drivers had increased volume in the body of the right hippocampus compared to that of the controls. Another conclusion is that the taxi drivers had increased volume in their posterior hippocampus.

3 The evidence to support this was that, in the taxi drivers, the posterior hippocampal volume correlated positively with number of years of taxi driving.

4 This means that part of the brain can change its size and is not fixed in size.

5 Some previous research which fits well with this study is on rodents and monkeys which found that, again, it was the posterior hippocampus which was involved in spatial navigation.

6 This means that different parts of the hippocampus have different functions. It seems likely that the left hippocampus (which did not correlate with years of driving experience) has a different role in spatial memory, e.g. episodic memory rather than storing actual navigational maps – which seems to be the job of the right hippocampus.

7 A mental map is a representation, stored in the mind, of routes, buildings, areas etc. and how they interlink and relate to each other.

Evaluating the study by Maguire et al. (page 117)

NB all answers should be contextualised.

The research method

Strength: Enables the study of an IV which would not be ethical or practical to manipulate – in this case it would be difficult to manipulate a person’s whole career choice and whether someone becomes a taxi driver or not!

Limitation: You can’t draw conclusions about cause and effect because the IV was not directly manipulated by the experimenter. This means that other characteristics could have co-varied with the IV such as family background for example. One of the taxi driver’s parents might themselves be a taxi driver.

Additionally, the direction of cause and effect is not clear: without direct manipulation of the IV it is equally possible to conclude that taxi driving caused changes in the hippocampus or that having a large posterior hippocampus ‘allowed’ the person to memorise the streets of London and pass ‘The Knowledge’.

Research techniques

Strength: They have used two techniques – VBM and pixel counting, which can be cross-referenced to check the results. This helps to increase the validity of the findings.

Limitation: It may not be possible to identify areas of the brain with precision. It was only conducted on one occasion for each person in the sample (snapshot study). It would be useful to know how easily or quickly hippocampal volume can vary, and whether the posterior hippocampus could be seen to increase through increased navigational experience, e.g. through doing a yearly MRI of taxi drivers after first beginning their training.

Qualitative or quantitative?

The data is all quantitative in this study – VBM looks at the volume of specific areas while pixel counting is also clearly quantitative. A strength is that this allows ways of clearly comparing differences in hippocampal volume between the two groups, and determining whether that difference was statistically significant. This would not be so easy to do if the data was in the form of qualitative data, e.g. descriptions of the shape of the hippocampus.

One limitation of this kind of data is that the quantitative data only tells us about the size of the hippocampus and its component parts. It does not actually tell us why there are these differences. (Is it really due to number of years of taxi driving?) Also, it does not tell us how these changes have happened. Maguire et al. suggest that the cells of the hippocampus are reorganised in response to the increased demand to store navigational information. The increase in grey matter in the posterior region may occur because it is ‘borrowed’ from the anterior region to cope with the demand. However, with just quantitative data, we cannot be sure of this.
Chapter 4 Physiological psychology

Nature and nurture
Maguire et al. suggest that this study shows that the brain can change as a response to practice on a particular skill – i.e. nurture and environment can alter the brain. Maguire et al. say that the positive correlation between number of years and volume of posterior hippocampus is evidence in favour of nurture. (‘There is local plasticity in the structure of the healthy adult human brain as a function of exposure to environmental stimuli.’) However, because this research is correlational and the original design is only quasi-experimental, strictly speaking it is not possible to conclude cause and effect in terms of nature or nurture.

Validity
We might be able to infer that taxi driving might increase posterior hippocampal volume (though see critical comments above), but it may not be valid to infer that other forms of navigation (e.g. navigating a boat, or even just on foot, or creating a mental map of a rural area rather than an urban area) would have the same effect on structures of the brain. Without studying people with such skills, it would be impossible to be sure.

Determinist
This study suggests that some aspects of brain structure are determined by our experience. One strength of determinism is it helps us identify causes and effects and makes the world and behaviour more predictable and understandable. Thus, we can understand specifically which area of the brain reflects navigational skills and this could be useful in identifying the treatment and rehabilitation of brain damaged patients. However, one limitation of determinism here is that determinism is all about causes and effects and possibly in this study there is no hard evidence of cause and effect – only correlation.

Applications/usefulness
Because this study indicates that the brain has plasticity – that it can alter and re-form itself as a function of environment and experience – this gives hope to sufferers of brain damage. This study suggests that brain functions which may have been lost after brain injury or stroke can return with sufficient practice and exposure. This is very valuable to know because it can mean that such people should not just be ‘written off’ but instead deserve treatment and rehabilitation of brain damaged patients.

What next?
One change to this study could be that Maguire et al. could find another group of people with different sets of navigational skills, e.g. regular hill walkers. It would be interesting to study them as they navigate on foot (rather than in a car), have to make use of landmarks in a different way, and have to navigate more in a three dimensional sense (up and down) rather than just 2D. This group could also be compared with the taxi drivers and controls. It might be that the regular walkers’ hippocampi are similar to the taxi drivers – however, there may also be some differences too.

Exam-style questions (page 119)

Section A questions
1 a They used taxi drivers because of their extensive training in order to acquire ‘The Knowledge’ to become a licensed London cab driver. The training is usually very intense over a period of 2 years and then in their jobs they need to use their navigational skills at all times. It is unlikely that any other identifiable group would have undergone such intense navigational experience like this.

b One criterion was age – they had to be between 32 and 62. Another criterion was mental health – they had to have been healthy previously.

2 a One finding from this study was that the posterior hippocampus was larger for the taxi drivers than for the controls.

b They can be used to help understand and help people who have suffered from brain damage. It suggests that it is possible for the brain to alter and change in response to experience – which means that it is possible for stroke victims to improve given appropriate stimulation.

3 One major idea of the biological approach is that the brain reflects our experience and our behaviour. This is shown by this study as the hippocampal volume seems to reflect the experience of navigation in the two groups (taxi drivers versus controls) and the right posterior hippocampal volume correlated positively with number of years of driving. Another idea of the biological approach is that we are a complex biological machine, with parts which are highly specialised in function. This is shown in this study, as it does not just look at ‘the brain’, or even at how one structure of the brain has a particular function. In fact, this shows that even just one structure – the hippocampus – does not have a single, uniform function or purpose. The right and left body, anterior and posterior all showed differing results, suggesting that the different parts of the hippocampus have a different purpose. This supports the biological idea that we are highly complex machines.

4 One control was that the control group were matched for age. Overall the profile of the control group had the same mean age (44) and the same range (age 32-62). It was important to have this control so that any differences between the taxi drivers’ hippocampal volume and that of the controls could not be explained by age differences and only by taxi driving.

5 a One common technique of brain scanning is MRI – magnetic resonance imaging. This technique essentially takes images of the brain and brain structures by making the atoms in the brain ‘spin’ by exposing the person to a massive magnetic force. Also, the machine gives out radio waves. A detector in the MRI machine reads the radio signals from the cells in the brain as the magnet is switched on and off and this is converted into images of the brain.

b One reason for treating results with caution is that with many physiological effects, it is not possible to establish cause and effect. For example, the fact that taxi drivers have larger posterior hippocampal volume may be caused by all their navigation experience. Or it may be that they are predisposed to have good mental mapping and navigational skills and that meant they became taxi drivers and passed the test. Much brain research just shows that two things ‘go together’, but does not establish the direction of cause and effect.

6 a Voxel-based morphometry (VBM) measures the density of grey matter.

b The VBM showed that taxi drivers had greater density of grey matter in the posterior hippocampus compared to the taxi drivers.

7 a A positive correlation is when, usually in the same people, two measurements are taken, and that as one increases, so does the other. Maguire et al., found that as the number of years of taxi driving increased, so did the posterior hippocampal volume.

b Maguire et al. suggest that it shows that the posterior hippocampus increases in size because of the increase in mental maps and navigation, and therefore this study suggests that our brains can change and alter due to experience.

Section B questions
a The aim of this study is to support the idea that the hippocampus is the structure in the human brain which has the function of storing mental maps and navigational information. Previous studies had suggested that this area of the brain was related to processing/storing spatial information.
b The main sample was London taxi drivers, all male, right-handed, mean age 44, and age range 32–62. They were all medically and psychologically healthy. There were 16 of them altogether. There were also a control group, also male, right-handed etc. who were matched for mean age and age range. One limitation of this sample is that it does not contain any women and so, although likely, it is not possible to infer from this study that the hippocampus is the key navigational structure of the brain for women. Male and female brains do differ.

c The data the study recorded was intercranial volume (the volume within the skull) and in particular, from the MRI scan, they looked at two measures: (i) Voxel-based morphometry (VBM) which measures the density of grey matter, and (ii) pixel counting which measures the volume as a function of total brain size. In particular, they looked at the volume of the hippocampus. They also checked on how many years the taxi drivers had been driving their cabs as well.

d The reliability could be assessed by checking the inter-rater reliability, where, independently, two researchers could analyse the images produced by the MRI and count the pixels in each slice. Then, these two sets of data would be correlated. If the data is reliable, there should be a high positive correlation. Another way of checking the reliability of the data would be to do a test–retest, i.e. get all the participants to return to the lab a couple of weeks later, have another MRI, analysed according to VBM and pixel counting etc. If, for each participant, the results of the first MRI correlate highly with the second MRI, and the overall findings are replicated, then the data has high reliability.

e Maguire et al. found that when comparing the MRIs of the taxi drivers with the controls, there were only two brain regions with significant differences – the right and the left hippocampus. There were no other differences in particular brain structures, or, according to the pixel counting, in the intercranial volume or the total hippocampal volume. The differences were localised to particular parts of the hippocampus. In the controls, the right anterior hippocampus was larger than that of the taxi drivers. On the other hand, the taxi drivers had larger posterior hippocampus when compared with the controls. Also, the controls had a larger right body of the hippocampus than the taxi drivers. The results also found that there was a positive correlation between number of years as a taxi driver and posterior hippocampal volume, and a negative correlation between number of years as a taxi driver and anterior hippocampal volume.

f One change in this study could be to have women participants. These would be in both the taxi driver sample and the control sample. As in the original study, they would be matched for age. It is difficult to say whether this would change the results. Often, people claim (and some research has backed this up) that women are less good at navigation and mental maps than men and it is possible that conducting MRIs in this way may discover that the female taxi drivers do not have such a markedly different posterior hippocampal volume as the male taxi drivers; and that this might bring down the overall significance of the results. However, it might also be possible that female brains have slightly different areas of specialism and it might be that a different part of the brain shows changes according to years of taxi driving. Certainly, this would be an interesting change to the study and would tell us about female brains and navigation, which the original study does not.

Another change to this study would be to recruit a sample of left-handed taxi drivers and controls. In the same way, they would be matched for age etc. It would be interesting to see what effect this had on the results. Instead of finding that it was the right anterior hippocampus which was larger in the controls than in the taxi drivers, the picture might be reversed – that it was the left and so on.

Section C questions

a One assumption of determinism is that people do not have free will – they do not have free choice over their behaviour, their responses, their emotions and so on. Even though we might think that we have genuine choice, it might just be an ‘illusion’.

b The biological approach would explain navigation in terms of brain and genes. For example, this approach might claim that, in our genes, we are predisposed to be able to navigate and learn our way around the environment. It might be that there are particular genes or chromosomes which are responsible for navigation and this would account for individual differences in the ability to navigate well and not get lost. Also, the biological approach would explain it in terms of the brain and want to determine which parts of the brain are responsible for navigation and storing mental maps.

c The study by Maguire et al. is an example of determinism because it shows that we cannot just, as it were, wake up one morning and decide to learn to navigate around London. We do not have that free choice. Our ability to learn and store mental maps is limited by how quickly the brain can compile information on routes etc. – and make the change in brain organisation between the anterior hippocampus and the posterior hippocampus. Therefore, our behaviour and abilities are determined, or at least limited, by the brain.

d One strength of the determinist approach is that it establishes cause and effect. Because, according to determinism, every action has a cause, an explanation. For example, in Maguire et al., we can see that differences in the hippocampal volume can be explained in terms of number of years of taxi driving experience. This sort of approach means that research with a determinist standpoint presents the world and human behaviour as highly predictable and subject to being described and understood. Another strength is that a determinist approach is usually quite scientific. In order to test a hypothesis and determine cause and effect, many other variables are controlled for so that when the results are analysed and the meaning of them discussed the researchers can say that the changes in the DV are not due to the factors controlled and only due to the IV. For example, in Maguire et al., they say that differences in the hippocampal volume are due to being a taxi driver and not due to age or handedness and so on. This means the research, because it is scientific, is more likely to be respected and taken note of.

One weakness of the determinist approach is that it can be too reductionist. Because determinist research often focuses in on a single cause and single effect, it can ignore other explanations which may be important. For example, in Maguire et al., it may be that there are other things about being a taxi driver, other than navigating, which have caused changes in the hippocampal volume. It may be that spending long hours in a car, having to coordinate eye and hand and foot movements to steer, brake, change gear etc. and keeping the car in the right place on the road have had an impact on the hippocampal volume – not actually mental maps and navigation. It could just be ‘driving’. This research overlooks this as an explanation.

Another weakness of the determinist approach is that it overlooks free will. This means that the ‘model’ of behaviour does not allow for humans making genuine choices of what they want to do next etc. In Maguire et al., it shows us that we cannot just wake up one morning and decide that we will learn many complex routes, because we are limited by how quickly the brain can assimilate and compile the mental map information. Our ability is determined, or at least, limited by the brain. This is an example of ‘soft determinism’, but some people would object to it and say that we can exert free will at all times.
**Study 8: Dement and Kleitman (sleep and dreaming)**

**Qs (page 125)**

1. Eyes move, relatively fast EEG pattern (also: lack of sleep spindles, dreaming).
2. The participants’ answers to the questions that were asked upon wakening (‘Were you dreaming, yes or no?’; ‘How long do you think you had been dreaming: 5 minutes or 15 minutes?’; ‘Describe your dream.’). Hence, there were several DVs:
   - self-report of dreaming or not
   - perceived duration of dream
   - description of the dream
   - number of words used to describe the dream.
3. IV – whether the participant was woken up during REM sleep or NREM sleep.
4. It might be considered a natural experiment because the experimenters could not make someone go into REM – they had to wait for it to happen naturally.
5. Participants are more likely to recall having a dream when woken from REM rather than NREM sleep.
6. It might matter because they might make their answers different. For example, they might pretend not to have had a dream or pretend they had been dreaming if they knew the aim of the study was to link REM sleep to dreaming.
7. It is a small sample and it is not good to make generalisations from a small sample because the people might have unique characteristics. In fact, the occurrence of dreaming in REM sleep varied quite a bit from one participant to another, e.g. DN had 65% dreams whereas KC had 90%, and DN had a lot more dreams in NREM sleep. You could consider the sample to be the number of nights’ sleep observed – this is not reported in the article but cannot be that many nights sleep because the average number of awakenings was 5.7 times a night and, for example, DN was woken 50 times in total (= about 12 nights’ sleep). However, you could also consider the sample was the number of awakenings – which was a large sample.
8. There was quite a lot of difference, e.g. for DN dreams were recalled in REM sleep 65% of the time, for WD this was 88%.
9. These substances can affect sleep patterns so might be an extraneous variable. Therefore, it needed controlling.
10. They might not sleep so deeply in the laboratory, they might be anxious, or they might be affected by frequent awakenings. The fact that they slept for an average of 6 hours a night suggests that they were not sleeping as well as usual.
11. If they knew which type of sleep, they might feel they should make someone go into REM – they had to wait for it to happen naturally.
12. They were asked a series of questions through a speaker (the experimenter only came into the room if there was a special need to do so). The questions were: ‘Were you dreaming, yes or no?’; ‘How long do you think you have been dreaming: 5 minutes or 15 minutes?’; ‘Describe your dream.’

**Qs (page 126)**

1. They were more likely to recall dreaming later in the night rather than earlier in the night – there are more periods of REM towards morning.
2. The vast majority of reports of dreaming during NREM were within 8 minutes of a period of REM finishing – so it is likely that the dreaming reported was a remnant, an echo or a vague memory of a dream which had happened very recently i.e. in REM.
3. Since participants were often woken up during an REM period this means their REM sleep was interrupted and because of REM rebound they were needing more REM sleep. Therefore
they may subsequently have had more REM sleep than normal which would mean the results are not representative of normal sleep.

4 Approach to investigation

| a | Participants were asked to recall their dreams during REM and NREM periods. | The study found that more dreams were recalled in REM sleep and almost none were recalled from NREM sleep (and those that were occurred almost entirely within 8 minutes of REM activity). This suggests that REM activity is the physiological equivalent of dreaming. |

| b | The subjective estimate of sleep was compared to the length of dream. | It was found that the length of time people thought they had been dreaming generally matched how long the REM period lasted. This again leads to the conclusion that REM activity is the physiological equivalent of dreaming. |

| c | The pattern of eye movements was related to the dream content. | The pattern of eye movements matched what people said they were actually dreaming about. This again leads to the conclusion that REM activity is the physiological equivalent of dreaming. |

5 Aside from the obvious answer that they weren’t reported because people weren’t having a dream, it is possible that the dream was too fragmentary to be remembered.

Evaluating the study by Dement and Kleitman (page 127)

NB all answers should be contextualised.

The research method

The strengths of an experiment are that you can demonstrate a causal relationship but this isn’t true for a quasi-experiment. You can’t say that REM sleep caused the dream activity; just that the two are related.

A strength of a laboratory experiment is that variables can be controlled so we can be more certain that the only thing that varied was REM/NREM sleep.

A limitation of this control is that the situation is more artificial, so people may not be sleeping as normal. The fact that they were woken through the night might change their sleep patterns as well as the fact that they knew they had to report their dreams.

The research techniques

Strengths: With self-report methods it is possible to find out what participants were thinking/feeling, which you can’t do with other methods. You certainly can’t find out about dreams without asking a person to tell you – that’s why an objective measure methods. You certainly can’t find out about dreams without asking a person to tell you – that’s why an objective measure

Qualitative and quantitative

Strength: Easy to analyse numbers, e.g. can draw bar chart to compare dreams reported in REM and NREM sleep; can correlate number of words used to describe the dream and number of minutes in REM.

Limitation: In some ways such data are oversimplified – just having a number for how many dreams were reported or the length of the dream doesn’t tell you about important differences between kinds of dreams such as more coherent ones, or ones that are disturbing or happy.

Qualitative data: The actual descriptions of the dreams, e.g. two people throwing tomatoes at each other, taking shots at a basketball net.

Strength: You get a richer picture of dream states which might be important. For example, it was found that NREM dreams were more fragmentary, which might be a key factor in distinguishing between the dreams in the two states. There might be other important differences which would only appear in qualitative data. Also, this qualitative data helped to support the hypothesis that eye movements were related to the content of the dream.

Limitation: It is difficult to summarise and analyse these answers because they are each unique, e.g. a description of a dream would be hard to categorise.

Ecological validity

There are many ways in which the sleep that was studied wasn’t very much like normal (repeated wakings, strange bed, less sleep than normal etc.) so it is necessary to be cautious about making generalisations from these findings. However, even if dreaming was affected (such as there being more or less dreaming) the contrived nature of the study might not affect the fact that when you do have REM activity you are dreaming, so the results may be relevant to everyday life.

Applications/usefulness

This study was very important for psychological research; for example theories of dreaming have been built around the link with REM. One theory (activation-synthesis) suggests that dreams are simply an attempt by the brain to make sense of the random electrical activity from the brain during REM sleep. A better understanding of sleep is important for trying to help people with sleep problems and sleep disorders. People don’t function very well when they are short of sleep.

What next?

A change to this study could involve waking a person only once in the night, so that their sleep/dreams might be more like normal and not affected by REM rebound. Also, a wider range of participants could be tested so that the findings can be generalised to the wiser population.

Exam-style questions (page 129)

Section A questions

1 One piece of evidence was that people were more likely to recall a dream during REM than they were in NREM. Another piece of evidence is that the movements of the eyes in REM matched the content of the dreams. For example, someone who was observed to have horizontal eye movements recounted a dream which involved watching two people throwing tomatoes at each other.
Section B questions

a One hypothesis for Dement and Kleitman would be: Participants were more likely to recall having a dream when woken from REM rather than NREM sleep.

b The sample used were 9 people – 7 men and 2 women. Five of them were studied intensively while the other four were studied more superficially. One limitation of this sample is that it is mainly men and therefore not representative of the population generally. This might mean that the results have low generalisability to the whole population.

c Dement and Kleitman measured sleep by monitoring brain waves with the EEG – electroencephalogram – this detects electrical activity. It gives a read out of the patterns of the waves – e.g. fast, spindles etc. which show the researcher what stage of sleep the participant is in.

Another way they measured sleep was by monitoring the eye movements using an EOG – electro-oculogram. Electrodes attached to the eyelids can detect the rapidity and direction of eye movements. Again, this gives an indication which stage of sleep the participant is in.

d One way to assess the validity of these measurements is through concurrent validity. If two measurements which claim to measure the same thing match or correlate, this supports the view that the measurement is valid. Therefore, it would be possible to see whether the EEG and the EOG match in terms of whichever sleep stage they indicate. Another measurement of sleep could also be compared with each of these. This could be an EMG – electromyogram which measures muscle tension (which also alters throughout the night according to sleep stage) or perhaps a more modern way of brain scanning such as fMRI which shows changes in blood oxygen level and should also give information on the activity of the brain.

e The conclusions of Dement and Kleitman were that a physiological state – REM – does indeed go with a psychological state – dreaming. The two are highly related. Therefore, they conclude that it is possible to objectively measure when dreaming is taking place. This is because they found that participants were much more likely to say they had experienced dreaming during REM and that there was a match between the eye movements and the content of the dream.

f One change to the study is that it could be conducted on a larger sample of participants. Instead of just nine participants, they could widen it to, e.g. 20 or even 50 participants and study each participant for two or three nights. In terms of the overall results, they would probably find that there was still a strong relationship between REM and dreaming. However, they might uncover more individual differences in terms of the pattern of the different stages of the sleep stages, duration of REM, and ability to recall a dream. However, having a larger (and therefore, likely to be more representative) sample should mean that the results can more validly be applied to the general population.

Another change to the study could be that they conduct it in the participant’s home instead of in a laboratory. This should mean that the participant should sleep more naturally as they would be in their own bed and normal sleeping environment (normal smells, bed linen, background noise and so on). Overall, this might change the pattern of sleep and depth of sleep – people might sleep more deeply if they are more relaxed at home), but it probably would not affect the overall finding that there is a relationship between REM and dreaming.

Section C questions

a One assumption of the biological approach in psychology is that much of human behaviour is governed and can be explained by biology e.g. hormones, genes, neurotransmitters, brain structure and so on. This means we probably have less control and free will than we would like to think.

b The biological approach would explain dreaming in terms of biological processes. It would say that, in the first case, sleep and the various sleep stages are genetically pre-programmed to occur, and that the order of the sleep stages is also predetermined. REM sleep is one of these, and there must be some biological reason for REM, perhaps something akin to giving a car a service or giving a computer a ‘virus check’. Dreaming is just a psychological spin-off of this process. The brain just naturally tries to make some sort of psychological sense of the electrical activity that occurs in REM.

c One similarity with Maguire et al. is that both studies monitor the brain. Maguire et al. use an MRI scan, while Dement and Kleitman use an EEG. Both studies use these techniques because both are interested in the relationship of the brain with psychological phenomena – Dement and Kleitman are interested in linking the biological event or REM with the psychological event of dreaming; Maguire et al. are interested in linking the biological structure of the brain (size of hippocampus) with the psychological activity of navigation.

One difference between the two studies is that Dement and Kleitman’s study is monitoring ongoing, ‘live’ changes in brain activity. The EEG shows differing levels of activity in the brain as it is really happening, second by second, (akin to ‘live TV’). In contrast, the MRI just shows a one-off image of the brain, fixed at a particular point in time (akin to a photograph).

d One strength of the biological approach is that it is scientific. It probably represents the most scientific end of psychology. This means that it is objective, usually empirically based and widely respected. For example, in Dement and Kleitman, the measurements of REM were reliable and valid (still used today!) and the procedures were highly controlled – same questions, single blind technique so participants did not know which stage of sleep
they were woken from and so on. Because all these aspects of the procedure increase the validity and objectivity of the research, it is widely accepted and respected.

Another strength of the biological approach is that it generally produces useful contributions to psychology – both in terms of applications and in terms of usefulness for helping further research in the area. For example, Kleitman’s work on the physiological/biological aspects of sleep and dreaming means that he is often described as ‘the father of modern sleep research’ – linking REM and dreaming has meant that the research provided a tool (both for other research and for diagnosing people with sleep disorders) for investigating sleep. This really has changed the way that we think about sleep, work with sleep disorders, and how sleep is researched.

One weakness of the biological approach is that it can be reductionist – only looking at simple explanations. For example, in Dement and Kleitman, they are not interested in the psychological motivations for particular dreams, why people dream particular things and what they might mean. So whereas Freud would be interested in interpreting the content of the dream in terms of fears and wishes, the biological approach completely ignores this. Therefore, it could be said that it is reductionist as it only looks at the simple explanations and ignores more complex psychological explanations. Dreaming is probably a fusion of physiological activity and ‘subconscious’ activity.

Another weakness of the physiological approach is that it overlooks nurture and over-emphasises nature. For example, the implication of this study is that dreaming is hard-wired into humans as a result of the genetically determined physiological activity of REM and sleep stages. This may well be broadly true – however, the time that people choose to go to sleep and for how long they sleep, and what they dream about is also influenced by nurture, e.g. if they have been reinforced in sleeping for long periods and what they dream about is also influenced by nurture, e.g. if they have been reinforced in sleeping for long periods as a child (by, e.g. praise) they may grow up to need more than average sleep. And we frequently dream about events of the preceding day. This all shows the influence of ‘nurture’ on the sleep and dreaming process, which the biological approach largely ignores.

qs (page 131)

1 In the study by Maguire et al., the data has high reliability. This is achieved and demonstrated in a number of ways. Firstly, they used highly scientific and quantitative methods (MRI with pixel counting and VBM), where there is little scope for subjectivity. For instance, the VBM enables every point of the brain to be examined in an objective and unbiased way.

Secondly, for the pixel counting, they used one person to do the counting who is highly experienced in this technique. Because only one person was used, there is, for instance, no problem with inter-rater reliability.

Thirdly, an indication of the high reliability of the data is that the two separate techniques (VBM and pixel counting) both revealed the same findings – increase in the posterior hippocampi for the taxi drivers and relatively larger anterior hippocampi for the controls. Because both sets of results match and are consistent, this indicates high internal reliability.

In terms of validity, we need to ask, are they measuring what they claim to measure? Maguire et al. wanted to measure the size of brain structure, and these are definitely two methods which do just that. (It is always easier to be more sure of validity when measuring something essentially physical like this ... it is not always so obvious when measuring something a bit more psychological.)

2 In Dement and Kleitman, the participants were asked to sleep in a laboratory. Of course, sleeping is a natural, everyday task. However, there were some alterations to the way in which participants had to sleep that lowers the ecological validity. For example, they were not sleeping in their normal bed but in a strange bed in a sleep laboratory. The participants also had to sleep wired up to an EEG and EOG. The sensation of wires attached to the head and eyes may well have affected their normal sleep pattern. Also, participants were woken frequently throughout the night by a bell and had to answer questions into a microphone – this must have been highly disruptive and unlike a normal night’s sleep.

3 This might have affected the pattern of different sleep stages (such as REM and slow wave sleep (SWS)) and how frequently they occurred and for what duration. This may have had a knock on effect to the nature and frequency of dreaming. Participants may have dreamt more or less vividly, or incorporated aspects of their environment into their dreams. This would mean that the findings from this study may not be very representative of every day (or every night!) sleep. However, on the positive, you might argue that as sleep is a biological given – we all sleep – that it will not make too much difference whether a person is in a laboratory or at home – it will make very little difference overall.

4 If Dement and Kleitman wanted to do this study in a more natural environment (i.e. participants’ own homes) they may have had a few problems. For a start, the environment would be different for each participant, reducing the overall amount of control, and this might account for differences between participants. They would also have some problems with equipment. The EEG and EOG equipment is quite cumbersome and difficult to set up. Sleep researchers tend to use specially designed beds with particular headboards with a hole in for all the wires to go through (to stop the patient getting tangled up in them) and it would be difficult to set up such an arrangement in a person’s home. Finally, the research may seem even more intrusive if it took place in someone’s home. Participants would have to let a stranger into their private space to observe them etc. which may feel rather strange.
Chapter 4 Physiological psychology

Study 9: Sperry (split brain)

Qs (page 135)

1. The cerebral commissures, which includes the corpus callosum.
2. Akeelatis had found that human split-brain patients showed no important behavioural effects.
3. Participants did not have the commissurotomy (the procedure to cut the corpus callosum) just for the purpose of the experiment. They had had the procedure done anyway in order to treat their epilepsy. Thus, the researchers had not manipulated the main condition of the study – it had happened ‘naturally’.
4. It is a major operation with possibilities of long-term effects as well as high risk of problems and side effects. Altogether, it would be just too harmful and would break all notions of ‘protection of participants’.
5. Split-brain patients will show a different pattern of responses when information is presented selectively to the two brain hemispheres when compared with normal patients.
6. As a control in order to prevent the patients moving their eyes or head. If this were allowed to happen, information would be received by both hemispheres.
7. Information presented to the left visual field is processed by the right hemisphere. The right hemisphere does not have the capacity for language production and therefore is unable to ‘speak’. So even though the right hemisphere might apprehend and know what it has seen, it cannot say so.
8. The information is passed from the right hemisphere (left visual field) via the cerebral commissures to the left hemisphere speech centres.
9. If a material is presented to the left visual field they could recognise it with their left hand. Information from the left visual field goes to the right hemisphere; the right hemisphere is linked to the left hand.
10. As a control, because if they saw their hands then information would go to both hemispheres.

Qs (page 136)

1. The $ was presented to the left visual field and the ? to the right visual field. Sperry found that the split-brain patients, when asked to use their left hand to draw what they had seen, could write the $ with their left hand. But when they were asked what they had written, they said ‘question mark’. This is because the left hemisphere, the talking hemisphere, had seen the question mark (received by the left hemisphere from the right visual field) and presumed that the right hemisphere had too and must have drawn it. This mini-study shows two things – firstly, that the right hemisphere does see and understand what it has seen, even though it cannot speak what it knows.
2. As shown in the $/? study, the two hemispheres act and think independently – and when the corpus callosum is cut, they become self contained. Another example is that Sperry placed two objects, one in each hand, and then asked the split-brain patient to find the objects from in a pile of objects; each hand could find its own object, but ignored the other hand’s objects. Sperry said, ‘it is like two separate individuals working over a collection of test items with no cooperation between them.’ i.e. like two minds acting separately in one body.
3. It is not a problem in everyday life because information is not presented to one hemisphere at a time – it is always processed by both hemispheres, the eyes are always moving and images are available to be seen for longer than 0.1 seconds. Also, the right hemisphere can know what the left hemisphere is thinking when the left hemisphere speaks out loud. This means that the person can act in a coordinated way.
4. Writing, speech, right hand.
5. Emotion, spatial awareness, left hand.
6. Because it doesn’t speak and doesn’t control the dominant (right) side of the body. It has less ability to process language.
7. It means that some people are different to others, for example in some people the right hemisphere may have a stronger role in language production. Individual differences explain why some split-brain patients have less difficulty on some of these tasks because they were less lateralised.
8. ‘Lateralised’ refers to things that are on one side of the brain or the other. It literally means ‘sidedness’.

Evaluating the study by Sperry (page 137)

NB all answers should be contextualised.

The research method

Natural experiment

Strength: You can study IVs that can’t be varied directly for ethical or practical reasons – in this case you couldn’t conduct the operation for an experiment. Taking advantage of existing conditions gave the opportunity to see the effects of separating hemispheres.

Limitation: Since the patients were not randomly allocated to the condition you can’t claim that the IV really was the cause of the change in their behaviour (as compared to a normal person) – there may have been other causes such as epilepsy.

Case study

Strength: Permits study of unique individuals and provides rich data about those individuals, in this case people who had split-brain operations.

Limitations: Because such individuals are unique (they were severe epileptics who may have had brain damage either because of the epilepsy or as a cause of the epilepsy) we may not be able to make generalisations about all people from the data collected in this study.

The sample

It means that it is not possible to assume that the results apply to other people.

Ethical issues

Psychological harm: Participants might have felt more abnormal after the tests were done and this could lower their self-esteem. The researchers might have counselled them afterwards to help their self-esteem.

Privacy: It should not be possible to identify who the individuals were so no names were mentioned.

Reductionist

Strength: If you reduce human behaviour to activity in the brain (e.g. the response of one hemisphere to visual or manual stimuli) it enables you to see how the brain responds and to understand the capabilities of the two hemispheres.

Limitation: Reducing behaviour to this level ignores individual differences and ignores the influence of other factors on brain activity. It doesn’t totally explain how the brain functions because it doesn’t explain the influence of higher cognitive activity.

Qualitative or quantitative?

Quantitative data, e.g. which hand was able to respond, whether participant could name the object.

Strength: Easy to analyse such data, e.g. can see that all participants behaved the same way.

Limitation: In some ways such data are oversimplified – it might also be useful to talk to the participants to understand their feelings.
Qualitative data were included, e.g. the comments made by participants such as ‘This hand is numb’ or ‘I don’t get messages from that hand’.

Strength: A truer picture of the experience is obtained, and participants might mention other things you didn’t think to ask.

Limitation: It is more difficult to summarise these answers because each is unique.

Applications/usefulness

The study was valuable from a theoretical point of view in order to understand the brain. You could also use the knowledge about different parts of the brain to better understand people who have suffered brain damage in, for example, a car accident. Also, sometimes people need to have brain tumours removed and surgeons need to know the effects of removing parts of the brain.

What next?

One change would be to test patients before the study to see if their brains were like those of normal people. This means the results could be generalised better.

Exam-style questions (page 139)

Section A questions

1 a In a split-brain patient if they touched an object with their left hand they couldn’t say what it was, though a normal person could do this.

b This is because information from the left hand goes to the right hemisphere which, in the split-brain patient, has no connection to the left hemisphere where speech originates.

2 a The operation was carried out as a treatment for epilepsy. The patients had all experienced serious and debilitating epilepsy and it was hoped that this operation would significantly reduce seizures and bring about an improvement in their ability to lead normal lives.

b The corpus callosum serves as a communication bridge between the left and right hemispheres so that information can be communicated from one side to the other.

3 One piece of evidence is from the $/? study: in this study the person could draw the dollar figure with their left hand but could not say what they had drawn – the dollar was flashed to the left visual field which is perceived by the right hemisphere. The right hemisphere is the silent hemisphere and controls the left hand.

Another example is that Sperry placed two objects, one in each hand, and then asked participants to find the objects from in a pile of objects; each hand could find its own object, but ignored the other hand’s objects. Sperry said, ‘It is like two separate individuals working over a collection of test items with no cooperation between them.’ I.e. like two minds acting separately in one body.

4 a One technique was using touch tests. Sperry would put an object into one hand only of a split-brain patient (behind a screen so that the patient could not see it). If an object is put in the right hand, the feel of this object is processed by the right hemisphere only.

b They do not have a problem because the hemispheres can communicate. If something is put into a normal person’s left hand, the information is relayed to the right hemisphere which can work out from feeling the object what it might be. The right hemisphere can communicate with the left hemisphere via the corpus callosum, so that then the person can say the name of the object out loud.

5 One piece of evidence supporting the idea that language is produced in the left hemisphere comes from the visual tests. When participants are shown an image in the left visual field it is processed by the right hemisphere. Here, when asked what they could see, split-brain patients generally said ‘nothing’. This is because the ‘talking hemisphere’, the left hemisphere, had indeed seen nothing. But when an image is presented to the right visual field (left hemisphere) the split-brain patient can readily say what it has seen which shows that language abilities are in the left hemisphere. Another piece of evidence comes from the stereognostic (touch) tests – an object in the right hand (left hemisphere) can be identified verbally. But if placed in the left hand (right hemisphere) the person cannot say what it is but can recognise it with the same hand.

6 a One problem with the sample is that all of them had suffered from severe and debilitating epilepsy. Because epilepsy can be caused by some form of brain damage, and in itself can cause further neurological problems, it might be that, even before the commissurotomy, these patients did not have ‘normal’ brains. Therefore, this study may not tell us about how a normal person’s brain works or what would happen if a non-epileptic person had the same operation.

b The left visual field is the area to the left of the central focus point when looking straight ahead. This visual field is processed by the right hemisphere.

Section B questions

a The aim of the study was to see whether split-brain patients (people who had had their corpus callosum cut) showed any problems or deficit as a result of this operation. Previous research suggested there were no important behaviour effects in everyday life in humans but effects had been observed in animals. Sperry wanted to investigate the patients under more experimental conditions and work out how the right and left hemispheres might work. In a way, this was a perfect opportunity to find out about lateralisation of brain function.

b The sample were all split-brain patients. They had all had a commissurotomy in order to treat severe epilepsy. For most of the patients, the operation had reduced the symptoms of epilepsy. There were only a small number of participants – approx. six participants. One problem is that the sample may not show how hemispheres work. This is because epilepsy can be caused by some form of brain damage, and in itself can cause further neurological problems; it might be that, even before the commissurotomy, these patients did not have ‘normal’ brains. Therefore, this study may not tell us about how a normal person’s brain works or what would happen if a non-epileptic person had the same operation.

c Behaviour was tested by presenting information to one hemisphere at a time and then asking the participant to do something or say something in order to test the functioning of a particular hemisphere. One set of tests involved presenting the information visually. An image or word would appear in one visual field, and then the participant would be asked to find the object with a particular hand (unseen, behind a screen), or to draw the object with a particular hand, or to say the name of the object out loud. Another test was to present information using touch tests. Here an object would be put in a particular hand and again they might be asked to find it (either with the same hand or a different one) or to name the object. They were also given other tasks such as smell tests, arithmetic tasks and block design tests to test lateralisation.

d One of the ethical issues raised is harm and protection from harm. The participants, who had recovered from their operation and got over a terrible illness, must have thought the operation was a miracle and that, despite having brain surgery, they were normal. However, Sperry’s tests revealed to them something that they did not know – that their behaviour was not normal under controlled conditions – that they had effectively two separate minds in one body. The right hemisphere did not know what the left hemisphere was thinking and vice versa. Discovering this must have been quite stressful. For example, when participants were given something in their left hand to hold...
and asked to name the object, participants often said that they could not feel anything, that they could not feel their right hand or that the right hand was numb. This revelation must have been quite alarming. Therefore, this study revealed something to the participants that perhaps they wished they hadn't known.

e Sperry concludes that split-brain patients have two minds in one body. Effectively they have two separate, independent streams of consciousness, each with its own perceptions, memories and even impulses and desires. The study generally found that the right hemisphere is the ‘minor’ hemisphere because it cannot produce language – however, it could understand language, e.g. the right hand (left hemisphere) could respond to spoken instructions, and could understand the general category of an object presented. The right hemisphere was also better on some tasks such as block design tests. However, on the whole it is thought that the left hemisphere is the major hemisphere because of its ability to produce language. Finally, Sperry concludes that there are notable individual differences between the patients – some showing more and some less notable split-brain behaviours.

f One change to this study could be to observe split-brain patients in their everyday lives to see how their condition might affect them. They could be watched doing ordinary tasks in ordinary conditions, e.g. preparing and eating food, cleaning, interacting with family members etc. This would make the study more ecologically valid. Also, it might reveal some everyday behaviours which were affected by having a split brain, which on a superficial inspection seemed quite normal. Another change to this study would be to use many more participants. This would probably show overall similar findings and would also help explore the individual differences between the participants and discover whether there was any pattern or reasons for why some participants could show ipsilateral control (right hemisphere communicating with right hand).

Qs (page 141)

1 One study is Loftus and Palmer. The components identified in this study are the input into the memory – specifically the information from the event and the information after the event in the form of the leading question. According to Loftus and Palmer, both of these influence memory for the event.

2 One advantage of reductionism is that it helps us to understand behaviour – simple explanations are more understandable than complex ones – so Loftus’ study really does help us to understand (albeit in simple terms) exactly how eyewitness testimony can be altered and become unreliable.

Another advantage of the reductionist approach is that, in experimental terms, it makes theories etc. more testable and so ideas can be verified or falsified. For example, some participants in the second experiment were given the leading question – ‘How fast were the cars going when they smashed?’ – and some participants were not. Later, when asked if they had seen any broken glass, the ones who had had the leading question were more likely to say yes. By breaking down the idea of unreliability of eyewitness testimony into separable components like this means it becomes much more testable.

One disadvantage of identifying single, simple causes is that they just don’t necessarily apply to everybody. For example, in experiment 2 of Loftus and Palmer, not all the participants in the leading question group did say that they had seen broken glass. In fact, only 16 out of 50 said they had. While this was more than the control condition, clearly, the leading question had not affected everyone in the same way. Therefore, simple explanations and components do not always have strong explanatory power.
Another disadvantage of the reductionist approach is that it presents humans as too machine-like because the components are too simple to adequately describe us as the complex multifaceted, psychologically complex beings that we really are. For example, in Loftus and Palmer, there are many more complex aspects to being human which affect our memory for a certain event. These include emotion, expectations, mental schemas, general alertness and so on. By ignoring these more complex aspects of being human, the study basically mis-describes the memory process in humans. Interestingly, leading questions did not have the same effect on all the participants and the differences between the participants can probably be explained only in terms of an interaction between some of these more complex factors.

3 This is an activity for you to do!