Patrick has just been arrested for murder. He confesses to the crime of killing his next door neighbour. When asked why he did it, he said that he had had an argument with him as the neighbour kept playing loud music in the middle of the night and that he finally just “snapped”. Try to come up with as many explanations as you can to explain Patrick’s behaviour.

Specifically, how could Patrick’s behaviour be explained using the biological approach?

Aim and Context (Note: you will not be asked specifically about this, but you could include this information in other questions, for example evaluating the study etc)

One of the earliest theories of criminality was Lombroso (1876) who linked physiological features (mostly facial characteristics) to criminal behaviour (see picture on left). Lombroso argued that it is easy to spot criminals as they are not fully evolved, and are more throwbacks to a previous evolutionary state. This is known as atavism. He argued that criminals are born, not made. This was an early biological theory that has since been discredited due to lack of evidence. However, the search for a biological basis of criminality has continued, and with the advent of brain scanning, psychologists have been able to look inside the brains of criminals to see if they do indeed differ from the brains of non-criminal controls.

Previous research has suggested that various parts of the brain may have a hand in criminal behaviour. Studies have been done on animals, where deliberate damage is done to specific parts of the brain, causing the animal to exhibit highly aggressive and impulsive behaviour. Case studies on humans have also been investigated, where people who have experienced accidental brain damage to particular parts of the brain are left with changes in behaviour and personality (e.g. Phineas Gage). Specifically, it appears that damage to the prefrontal cortex, angular gyrus, amygdala, hippocampus, thalamus and corpus callosum are related to violent criminal behaviour.

Aim: Raine et al (right) wanted to investigate whether violent criminals had brain dysfunction in these parts of the brain. He would compare a group of murders with a control group of non-murderers using brain scans. He also hypothesised that there would be no dysfunction in the caudate, putamen, globus pallidus, midbrain and cerebellum. These are parts of the brain that had been implicated in mental illness, but were not linked to violence.

The specific group of murderers that he would use in his study would be those who had plead “not guilty” by reason of insanity (NGRI).
Using pg16, label the parts of the brain on the diagrams below. Make sure to assign each part to the correct brain:

<table>
<thead>
<tr>
<th>Would be different in murderers</th>
<th>Would not be different in murderers</th>
</tr>
</thead>
<tbody>
<tr>
<td>caudate, angular gyrus, amygdala, midbrain, thalamus, corpus colosum, globus pallidus, cerebellum, putamen, prefrontal cortex, hippocampus</td>
<td></td>
</tr>
</tbody>
</table>

**Methodology**

Complete any missing information below using pg 16.

**Research method:** This was a ___________ experiment. This means that it is not a true experiment as the participants could not be randomly assigned to one of the two conditions. The IV (Independent variable) was ________________________, and the DV (dependent variable) was _________________________. A matched pairs design was used. This means that each murderer was matched with a control participant of the same age and gender.

**Participants:** The experimental group consisted of __________ participants tried in the state of California (______ men, ______ women) with a mean age of _____ years who had been charged with either ______________________ or _______________________. Subjects were referred to the University of California to obtain evidence using PET scanning for a ___________ defence or they had been found guilty and were referred to obtain information that may reduce their sentence, or to ascertain whether they were able to stand trial. Reasons for referral included history of head injury or brain damage (table on pg 16). In 7 of these cases, there were also unusual circumstances surrounding the crime that additionally lead to the suspicion of some mental impairment. All murderers were instructed to be ______________________ free, which was checked with a ___________ scan two weeks prior to brain scanning.
A control group was formed by matching each murderer with a normal participant of the same sex and age who was to be tested using identical PET imaging procedures in the same laboratory. The mean age of the 41 controls (39 men, 2 women) was 31.7. They had been screened for health with a physical exam, a psychiatric interview and their medical history was checked. The six ___________________ were matched with six ___________________ from a mental hospital. The other controls had neither history of ___________________ nor a history of it in their family. They also had no significant ___________________ and none were taking ____________________.

All participants were obtained using __________________________ sampling. This means that the researchers used those participants that they were able to easily acquire.

What do you think the point of using a matched pairs design was? Why not just use a random sample of participants for the control group?

**Procedures**

*Read the procedures on page 16. Put the sentences below into the correct order.*

1. This task is designed to activate the parts of the brain that the researchers were interested in.
2. After 32 minutes a PET scan was done of each participant.
3. Participants started the CPT
4. A PET scan involves the use of Fluorodeoxyglucose (FDG). FDG is a mildly radioactive glucose (sugar).
5. The participants were given a chance to practice a continuous performance task (CPT)
6. A PET (positron emission tomography) scan was used to study the active brain of both the murderers and the control group.
7. 10 horizontal slices of the brain were recorded using the peel and box technique (see picture below)
8. The radioactive tracer FDG was then injected into each participant after thirty seconds
9. When a part of the brain is active, it uses glucose. Radioactive detectors in the PET scan can then “see” the radioactive areas, allowing researcher to see the active parts of the brain

<table>
<thead>
<tr>
<th>Correct Order</th>
</tr>
</thead>
</table>
C1. Approach 1: The Biological Approach

Why do you think it important that the study could be replicated?

Findings

- Both groups performed similarly on the CPT, suggesting that any differences in brain activity was not due to their performance on this task.

- As anticipated, the group of 41 murderers had significantly lower glucose metabolism relative to controls in both the lateral (towards the outside of the brain) and medial (towards the centre of the brain) prefrontal cortex in both hemispheres.
  - There was also reduced activity in the left angular gyrus and the corpus callosum. It was also found that there was reduced activity in the amygdala, thalamus and hippocampus, but only in the left hemisphere.

  ![Graphs showing glucose metabolism in different brain regions](image)

- Interestingly, the researchers also found parts of the brain that showed an increase in activity.
  - The cerebellum, and the occipital lobe showed higher glucose metabolism, as did the amygdala, thalamus and hippocampus in the right hemisphere.

- As predicted, there were no significant differences for the amount of midbrain, caudate, putamen, globus pallidus and cerebellum activity between murderers and controls. As these parts of the brain have not been found to be involved in violence, this is what was expected.

- Overall, the findings from this study fit with what was expected.
  - Reduced activity in parts of brain previously linked to violence
  - Reduced activity on the left half of the brain, and increased activity on the right, particularly in areas associated with violence (amygdala, thalamus, hippocampus)
  - No differences in areas of the brain not associated with violence

Look back at the brains you labelled on page 2. Do the findings match with what was found?

- The researchers also found that there were other differences between the murderers and the control group that had not been controlled for.
  - Handedness
  - Ethnicity
  - Head injury

- You can read more about these on page 17
Conclusions

The key findings from this study are that murderers pleading NGRI are characterised by:

- reduced glucose metabolism in the prefrontal cortex, the parietal cortex, and the corpus callosum
- abnormal asymmetries of activity (left hemisphere lower than right) in the amygdala, thalamus, and the hippocampus

These findings do seem to make sense with what we already know about how the brain works. Raine provided various explanations as to how such brain differences can relate to criminal and violent behaviour. A summary of the main conclusions can be found in a table on pg 17

- Murderers showed less activity in the prefrontal cortex. Damage to this area can result in impulsivity, loss of self control, immaturity and the inability to modify behaviour. This could in turn cause aggressive behaviour.
- The amygdala, hippocampus, and prefrontal cortex make up part of the limbic system which governs the expression of emotion. These areas in murderers showed lower activity, possibly causing abnormal emotional responses.
- The limbic system is also important for memory. Reduced activity suggests that offenders may find it hard to learn from their experiences, making punishment less effective.
- In animals, destruction of the amygdala results in a lack of fear. In the offenders, the reduced activity of the amygdala may likewise reduce their fear, making them less likely to fear the consequences of their violent behaviour.
- If the angular gyrus is damaged or experiences a reduction in glucose metabolism, the individual may experience reduced verbal, arithmetic and reading ability. Such cognitive dysfunctions could lead to educational and occupational failure, which in turn could predispose to crime and violence. Learning deficits have been found to be common in violent offenders who also have low verbal IQs.
- The corpus callosum is responsible for the transfer of information between the two hemispheres. Poor functioning of this part of the brain could explain the asymmetry in function, with the right hemisphere more active than the left. The right side of the brain is involved in the generation of negative emotions, while the left hemisphere controls and inhibits these emotions. Without a well functioning corpus callosum, the negative emotions generated by the right side of the brain may not be regulated by the left side, leading to violent, uninhibited behaviour.

Overall conclusions

The findings of this study suggest that the neural processes underlying violence are complex and cannot be reduced to single brain mechanism causing violence in a direct way. Instead, violent behaviour probably involves the disruption of a network of multiple interacting brain areas that predispose people to violence in the presence of other social, environmental, and psychological predispositions.

However it is felt that this study provides evidence that murderers pleading NGRI have different brain functioning compared to controls, and also gives initial suggestions as to which specific neural processes may predispose to their violent behaviour. However Raine also made clear that this does not mean that murderers can not be held accountable for their actions, nor that we can use a PET scan to diagnose criminals. He also acknowledged that he could not rule out head injury and IQ as factors that may have contributed to the results. There is also an issue of cause an effect. All we know is that brain dysfunction is related to violence. It may be that a violent lifestyle causes changes in the brain, rather than the other way around.
Evaluation

Before we evaluate this study, can you think of any strengths or weaknesses?

Evaluation: Methodology and Procedures

Read through these evaluation points below and highlight in two different colours the strengths and weaknesses.

- The main methodological strength of this study is the amount of control the researchers had over the procedure. For example they used a control group who were matched on variables such as age and sex and they were screened for their physical and mental health. They also eradicated the effect of medication.
- It can also be argued that PET scans are useful because we no longer have to wait for a person to die before we can examine their brain. The scan allows for a wide range of non-intrusive studies.
- PET scanning was used and such scans can be interpreted objectively by more than one researcher so results tend to be reliable. It is a scientific method because it is controlled and replicable.
- However the study does have methodological weaknesses. For example PET scans are still being developed and therefore the data should be treated with caution.
- The task used by the participants before the scan is a general activity task and has no bearing on violent acts or even the decision to be violent. Therefore the validity of the task could be questioned.
- The major methodological weakness is related to the design of the study. The design was a type of quasi experiment, which means that the researchers could not randomly allocate participants to either of the two conditions. Therefore we have to be careful in making cause and effect statements.
  - It is possible that any differences in brain activity between the two groups could have been caused by other factors. We can only say that the study shows a correlation and not a causal relationship. For example, it could be that the differences between the two groups might have been a result of the crime and its consequences rather than a cause of it.
- A large group was involved. The researchers pointed out that this was the largest sample that had been used in a PET scan study. There were sufficient people in each group for conditions to be fairly firm and generalisation might have been possible to other murderers pleading not guilty by reason of insanity.
  - However, how might the sample of offenders lack generalisability?
- The findings only describe the brain differences but do not explain them. The brain dysfunctions could have been present from birth and so biologically different. However, differences could also be linked to environmental influences and so although they are biological differences they are not caused by biology. This links to the nature-nurture debate.
C1. Approach 1: The Biological Approach 3: Classic Evidence

Evaluation: Alternative Evidence

What did Yang and Raine (2009) do and find?

What is a meta-analysis?

What did Tiihonen et al (2015) do and find?

How does the work of James Fallon contradict the idea that criminality is genetic?

Read the two newspaper articles 'Biological key to unlocking crime, and Violence 'not detectable' by brain imaging.'

What evidence is there that criminal behaviour is biological?

What evidence is there that criminal behaviour is due to factors other than biology?
“Criminals are born, not made.” How much do you agree with this statement? Explain your point of view.

**Evaluation: Ethical issues**

A number of ethical issues are raised by this study. Explain why each of the following are issues.

Lack of valid consent

________________________________________________________

______________________________________________________________________________________________

Possible psychological harm

________________________________________________________

______________________________________________________________________________________________

Lack of a right to withdraw

________________________________________________________

______________________________________________________________________________________________

A main strength of the researchers argument that dysfunctions in certain brain structures can lead to violent behaviour is the possibility of treatments for violent people. Perhaps drugs could be used to alter the functioning of brain structures thereby reducing a person’s possibility of committing violent crimes. However this argument raises many ethical dilemmas. We would be wise to have reservations about any suggestions that it is possible to identify potential murderers. This study therefore could be classed as “socially sensitive research”.

Imagine that we could use PET scans to identify those people who have the brain patterns of a potential murderer. What ethical issues could this raise?

The main criticism of this study refers to the issue of **reductionism**. Studies like this one have been criticised for being biologically reductionist in that they attempt to explain complex behaviour as a consequence of brain functioning. By doing so this ignores the many other possible reasons why a person may act violently. Brain functioning is possibly just one factor why a person may act violently. Other factors that must be taken into account include a person’s social background, their role models, psychological predispositions, learned responses and so on. Ignoring these other factors is unethical as it places the blame for the criminal behaviour solely inside the criminal, and absolves society as a whole from any blame.