Raine et al (1997)

The aim of the study was to look at direct measures of both **cortical** and **sub-cortical brain functioning** using **PET scans** in a group of **murderers** who have **pleaded not guilty by reason of insanity (NGRI)**. The expectation was that the murderers would show evidence of brain dysfunction in their prefrontal cortex as well as in other areas that are thought to be linked to violent behaviour.

It is hypothesised that these seriously violent individuals have relatively localised brain dysfunction in the prefrontal cortex, angular gyrus, amygdala, hippocampus, thalamus, and the corpus callosum, brain areas previously linked empirically or conceptually to violence. Conversely, no dysfunction is expected in other brain areas (caudate, putamen, globus pallidus, midbrain, cerebellum), which have been implicated in other psychiatric conditions, but which have not been related to violence.

The method is a laboratory experiment using an independent measures design. The main independent variable is whether the participant had **committed murder or not**. The dependent variables were the **results of the PET scans**. This design is sometimes referred to as a quasi or natural experiment because the researchers do not have total control over the independent variable.

The study used PET scans to examine the brains of 41 people (39 males and 2 females) who were charged with murder and were pleading Not Guilty for Reasons of Insanity (NGRI) and compared them with 41 controls, whom were all normal individuals. All the NGRIs were referred to the imaging centre for legal reasons, such as obtaining evidence for the defense. They were all tried in the state of California and were referred to the University of California to obtain evidence for diminished responsibility.

The reasons for the referrals were:

- **Schizophrenia (6 cases)**
- **Head injury or organic damage (23)**
- **Drug abuse (3)**
- **Affective disorder (2)**
- **Epilepsy (2)**
- **Hyperactivity or learning difficulties (3)**
- **Personality disorder (2)**

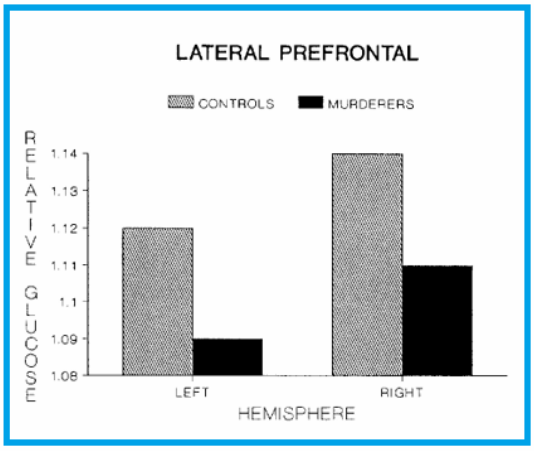
The mean age of the NGRIs was 34.3 years. The controls were selected to match for age and sex and the six NGRIs who were diagnosed as schizophrenic were matched with six other people with the same diagnosis but no history of murder. All the controls were further screened for their mental and physical health. All offenders were in custody and were kept **medication free** for the two weeks before brain scanning. The control group was also medication free.

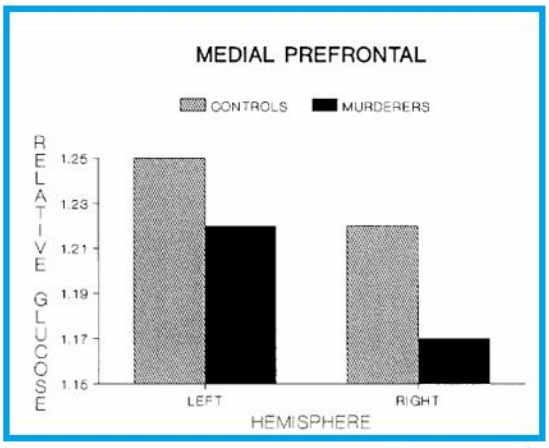
All the participants were injected with a **glucose tracer** (fluorodeoxyglucose; FDG), required to work at a **continuous performance task** (CPT) that was based around target recognition for 32 minutes. Ten minutes before the FDG injection, participants were given a chance to practice trials on the CPT. Thirty seconds before injection, the task was started so that initial task novelty would not be FDG labelled. After 32 min of FDG uptake, the participant was transferred to the adjacent PET scanner room.

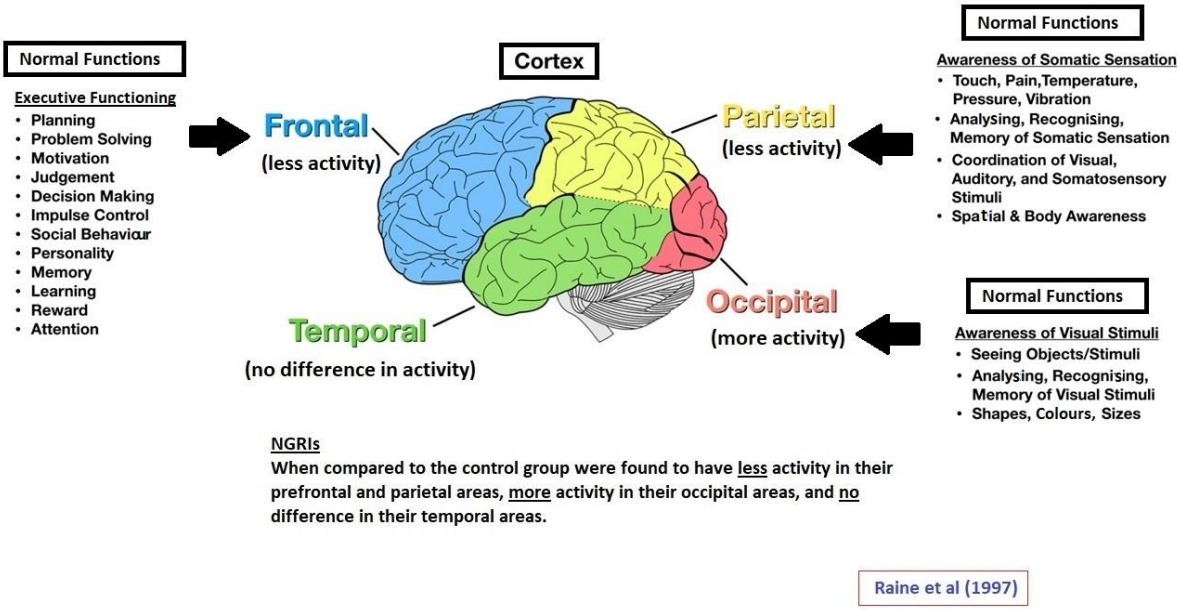
The NGRIs were compared with the controls on the level of activity (glucose metabolism) in the right and left hemispheres of the brain in **14 selected areas**. The researchers looked at activity in **six cortical areas** (part of the cerebral cortex which is the outermost layer of nerve tissues of the cerebral hemispheres) and **eight sub-cortical areas** (brain structures inside the cortex).

Cortical	Subcortical
Lateral prefrontal	Corpus callosum
Medial prefrontal	Amygdala
Parietal	Medial temporal lobe and hippocampus
Occipital	Thalamus
Temporal	Caudate
Cingulate	Putamen
	Globus pallidus
	Midbrain
	Cerebellum

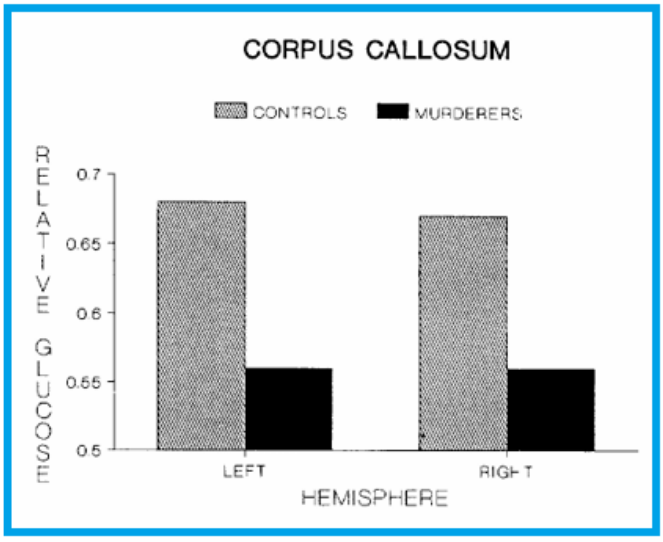
The cerebral cortex is commonly described in terms of four areas or lobes: the prefrontal, parietal, occipital and temporal. In this study, when comparing the **cortical areas** with the control group, the NGRIs were found to have less activity in their prefrontal and parietal areas, more activity in their occipital areas, and no difference in their temporal areas.







When comparing the results from the **sub-cortical areas** found less activity in the corpus callosum (which joins the two halves of the brain; see Sperry). They also found an imbalance of activity between the two hemispheres in three other sub-cortical structures. In the amygdala and the hippocampus, compared to the controls, the NGRIs had less activity in the left side and more activity in the right side (therefore less likely to experience emotion).



Sub-Cortex

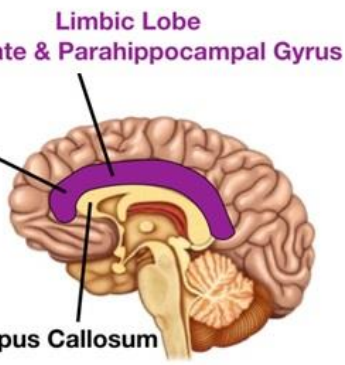
Limbic System

Structures:

- Limbic Lobe
- Amygdala
- Hippocampal Formation
- Thalamus
- Hypothalamus

Function:

- Learning & Memory
- Emotions & Behaviour
- Smell



NGRIs

Compared to the control group, the NGRIs had differences in the functioning of the amygdala and the hippocampus - with less activity in the left side and more activity in the right side (therefore less likely to experience emotion/ feel remorse for their actions).

Raine et al (1997)

This study shows that there are structural differences in the brain of a murder and non-murder by confirming deficits in the prefrontal cortex. These in turn provide both some general support for pre-existing biological theories of violence and suggest new perspectives for understanding the type of brain dysfunction that may predispose to violence in this specific group of offenders. However, the question of whether comorbid psychiatric conditions in the murderers could account for PET findings needs to be considered. The most important psychiatric condition in this sample of murderers was schizophrenia. This may have played a part in the brain functioning of their brains.

Raine et al (1997) argue that their research supports previous findings about the role of certain brain structures in violent behaviour. They suggest that the difference in activity in the amygdala (which is part of the limbic system) can be seen to support theories of violence that suggest it is due to unusual emotional responses such as lack of fear. They also comment on the differences in corpus callosum activity between the NGRIs and the controls and suggest this can be matched up to evidence of people with a severed corpus callosum which show they can have inappropriate emotional expression and an inability to grasp long-term implications of a situation.

However, it is important to note that Raine et al (1997) are cautious about the implications of their findings. They note that the findings:

· Cannot be taken to show that violence is only caused by behaviour.
· Do not show that NGRIs are not responsible for their actions.
· Do not say anything about the causes of the brain differences.
· Cannot be generalised from NGRIs to other types of violent offenders.
· Cannot be generalised to other types of crime.

Reference:
Raine, A, Buchsbaum, M & LaCasse, L. (1997) Brain abnormalities in murderers indicated by positron emission tomography. Biological Psychiatry, 42 (6), 495 - 508