

Brain Scans: CAT/CT, PET and fMRI

One of the goals of biological psychology and neuroscience is to explain experience and behaviour in terms of the structure and functioning of the brain. This presents a serious challenge, because the brain is locked away inside the skull, within numerous protective layers. Early neuroscience had to rely on studies of brain damaged patients, post mortems and studies using non-human animals, all of which have limitations. But with the development of brain scanning in the late 1970s, it became possible to study the structure and functioning of healthy brains in living people. There are now several forms of scanning in use. Three important ones are CAT/CT, PET and fMRI.

The general procedure for obtaining a brain scan is similar for all three types of scan. The participant is typically lying down inside the scanner, keeping as still as possible. Detectors circle the participant's head, obtaining information about one, thin 'slice' of the brain at a time. The detectors are then moved, and another 'slice' examined. A computer is used to translate the information from the detector into an image on a screen. By imaging multiple slices, a picture of the whole brain can be built up. With today's powerful computers, this can include a 3-dimensional model of the brain on the screen. The difference between the scanning techniques is in how the information is obtained. In a CAT/CT scan X-rays are used. In a PET scan, it is radioactive emissions from a tracer injected into the participant. In an fMRI scan it is the response of water molecules in brain tissues to a strong magnetic field.

CAT/CT scans give a grey-scale image showing a high level of detail of the structures of the brain. Unlike other types of scan, CAT/CT can image bone, soft tissue and blood vessels simultaneously. CAT/CT does not convey any information about brain activity or function. This limits its usefulness in psychology compared to PET and fMRI, both of which record brain activity. However, CAT/CT's very detailed images can be useful to psychologists when trying to relate brain damage to changes in psychological functioning. CAT/CT is also faster and somewhat cheaper than PET and fMRI. Unlike PET it is non-invasive: usually, nothing enters the body, although sometimes a radiographer will inject a dye to make certain features stand out better. The X-rays used in CAT/CT are potentially harmful, but usually not in the dosage involved, although children should have their exposure limited.

In a PET scan, the participant is injected with glucose with a radioactive tracer attached to it. The glucose travels round the body, including the brain. Brain areas that are more active take up more glucose, and so the radioactive tracer concentrates in the more active brain areas. The scanner thereby builds up an image of which brain areas are most and least active during a particular period of time. The computer uses different colours to represent different levels of activity. Its ability to investigate brain activity makes PET potentially very useful to psychologists as brain activity can be compared between people doing different types of mental task e.g. thinking of words versus doing mental arithmetic. This might indicate which brain areas are responsible for different mental processes. The pictures of brain structure produced by PET are less detailed than CAT or fMRI, and it is an invasive procedure. A higher dose of radiation is given than with CT/CAT, and the tracer remains in the body, although it decays quickly.

Like PET, fMRI measures blood flow to different parts of the brain and uses this to generate images of which brain areas are more active than others. This gives it many of the applications and strengths of PET scanning, particularly where it comes to understanding the role of different brain areas in different mental processes. fMRI has a finer spatial resolution than PET, so the images it produces are more detailed. fMRI is now the favoured technique by many researchers because it is non-invasive and there is no exposure to radiation. It is also cheaper and more practical in many cases because there is no requirement to prepare the radioactive tracers needed for a PET scan. However, small movements by the participant can badly affect fMRI scans whereas PET scans are not so affected. Additionally, PET can be used to map different types of neurotransmitter receptor in the brain, whereas fMRI cannot so PET can be used to investigate a wider range of brain functions and behaviours than fMRI.