ARE YOU RESPONSIBLE?

Brain structure and function

Inside your head is an amazing organ made of billions of tiny cells. It enables you to sense the world around you, to communicate, to feel emotions, to live your life.

Different areas of the brain are specialised for different functions.

This is called 'localisation of function'.

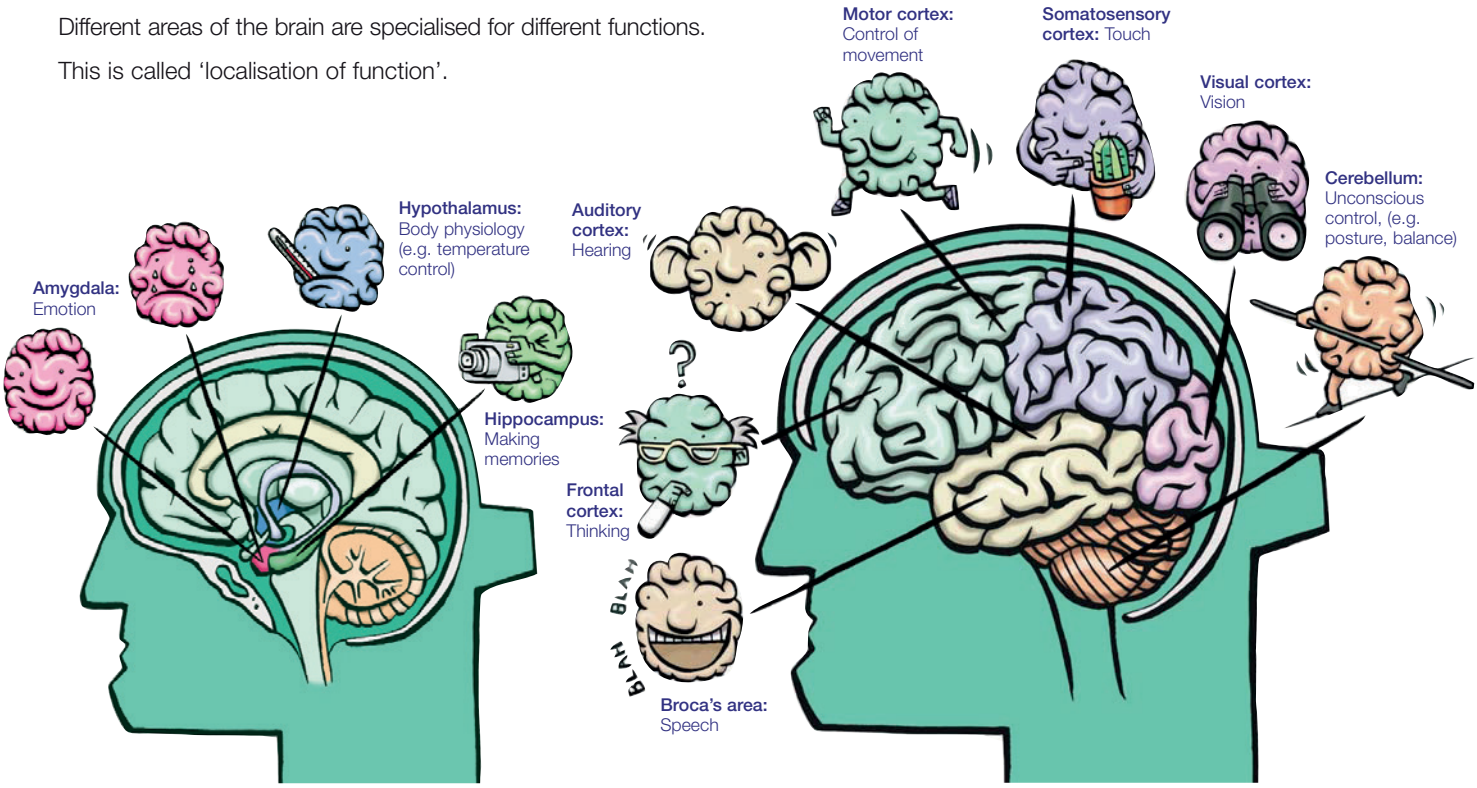


Illustration @ Glen McBeth

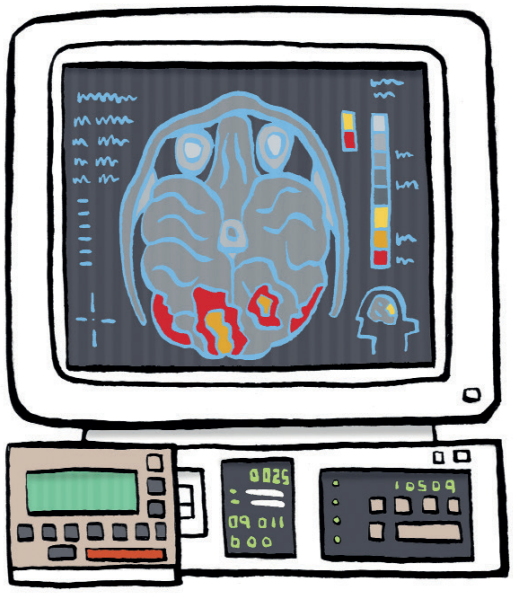
Frontal cortex
The front section of your cerebral cortex, the frontal lobe, is involved in planning, reasoning, social control and some aspects of speech. Most purposeful behaviours begin here. It is also involved in attention, planning, decision making and control of your emotions.

Orbitofrontal cortex
The orbitofrontal cortex, the part of the frontal cortex just above your eye, appears to be involved in the regulation of socially appropriate behaviour. This area is also responsible for self-control.

Prefrontal cortex
The prefrontal cortex lies just behind the frontal cortex. Examination of people with early damage to their prefrontal cortex shows that they do not develop appropriate moral responses. For example they lie and cheat without feeling guilt or regret.

These areas of the brain are involved in controlling our behaviour.

wellcome trust



Brain function can be investigated in a number of ways, including:

- neuropsychological tests
- brain imaging.

Neuropsychological tests
Neuropsychological examination is a way to formally assess brain function. Neuropsychological tests cover a range of mental processes including complex reasoning and problem solving.

NEUROPSYCHOLOGICAL TEST	EVIDENCE OF FRONTAL LOBE IMPAIRMENT
Word generation	Patients name as many words as possible beginning with the letter C in one minute. Patients with frontal lobe damage have difficulty with this task.
Writing and drawing	Frontal lobe damage can cause handwriting to be illegible. Some patients are unable to copy simple diagrams like clock faces and squares.
Sense of smell	Patients with frontal lobe damage may lose their sense of smell.
IOWA gambling task	This test involves risk – people with frontal lobe damage lose the game, as they seem to follow their impulses to take riskier options.

Brain imaging
Modern neuroimaging techniques allow us to look inside the brain. Scientists use these techniques to try to piece together which parts of the brain do which tasks.

Changes in blood flow and energy metabolism of certain areas during tasks can identify which areas of the brain are involved; we can start to piece together the structure and functions of the brain.

CT – computerised tomography
CT scanners rotate around the head taking a series of cross-sectional X-ray 'slices'. A computer combines the slices and builds them into an image of the brain.

CT scans display a good contrast between brain tissue and bone, and between ventricles and fluids such as blood.

MRI – magnetic resonance imaging
MRI scanning uses radio waves and magnetic fields to produce 'slice' images through the brain. This technique reveals much more detail about the structures within the brain than CT scans.

MRI scans are most likely to be used to detect brain tumours.

PET – positron emission tomography
PET scanning measures metabolic activity in areas of the brain. A radioactive tracer is injected into the bloodstream and used by active tissues of the brain.

PET scans show level of function of brain tissue. They can also identify neurotransmitter activity in the brain.

Functional MRI
Functional MRI reveals active areas of the brain by detecting where oxygen is being used. It does this by comparing the levels of oxyhaemoglobin (in oxygenated blood) to deoxyhaemoglobin (in deoxygenated blood). It has largely replaced PET for the study of brain activity.

Patients with damage to areas of their frontal cortex have shown extreme changes in their behaviour, temper and impulses.

PHINEAS GAGE

Phineas Gage was a railroad worker in 1848. An accidental explosion drove an iron bar through Gage's head. It entered his left cheek, passed upwards into his brain, through his frontal cortex and out of the top of his head.

Before the accident he had been conscientious, friendly, with good business sense. His bosses and co-workers found him hardworking and competent at his job.

After the accident his personality and mood had undergone severe changes. He became rude, impatient, insensitive, lazy and aggressive.

FRONTAL LOBOTOMY

In the 1940s and 1950s a surgical procedure known as frontal lobotomy was tried on tens of thousands of patients (mainly in the USA and UK) to treat severe behaviour disorders.

A sharp instrument resembling an ice pick was pushed up through the eye socket into the frontal cortex. It was moved back and forth and swirled around, effectively destroying many brain cells and connections in the frontal cortex.

In many cases it did relieve emotional anguish, but also took away the essence of the person, making people childlike, irresponsible, unable to plan and unemployable.

CROSSBOW THROUGH THE SKULL

A man who attempted suicide with a crossbow lived, but succeeded in injuring his left prefrontal cortex. This is the area of brain near the centre of his forehead, close to the orbitofrontal cortex.

This man had a prior history of pathological aggression and violent behaviour. After the crossbow injured his brain, he was docile, indifferent to his situation and inappropriately cheerful.

Scientists do not understand why damage to the frontal cortex can make some people more aggressive and others more passive.

Law

If we commit a crime, and are later found to have a brain injury or lesion, are we still responsible for our actions?

HOMICIDE

Homicide is the killing of a human being by another human being. The different categories of homicide, e.g. murder, manslaughter and infanticide, all have the following points in common:

- **unlawful killing – the killing must be unlawful, e.g. self-defence will make a killing lawful**
- **death must occur within a year and a day of the incident**
- **causation – the defendant's actions must cause the death.**

DIMINISHED RESPONSIBILITY

Diminished responsibility is a partial defence, which, if successfully pleaded, reduces liability from murder to manslaughter. The defendant must prove that:

- **he/she was suffering from an 'abnormality of mind'**
- **this resulted from a condition of arrested or retarded development of mind; or any inherent causes; or was induced by disease or injury**
- **it substantially impaired his/her responsibility for the killing.**

INSANITY PLEA

(McNaughton rules)

In summary, these rules state that a person cannot be held responsible for a crime if they did not know that what they were doing was wrong.

FACTS AND ISSUES

Mental illness
Are you responsible if you commit a crime and have a mental disorder?

Examples:

- depression
- schizophrenia
- personality disorder
- anxiety disorder.

Controllability
How can you measure how much in control someone was during an action after it has occurred?

Men and crime
Men commit 90 per cent of violent crime in the UK – so are they genetically predisposed?

Alcohol and drugs
Are you responsible if you commit a crime while drunk or on drugs?

Alcohol and drugs affect the brain and body.

The effects of drugs can vary wildly from one person to another. Many drugs are illegal and very dangerous.

The law often sees drugs and alcohol as an aggravating feature rather than as a reason or excuse.

Nature vs nurture
Behaviour is complex. No single gene encodes for it, but genetics can influence certain behaviours.

Our social and cultural upbringing may also affect our behaviour.

Our brains are sculpted by our experiences through life. Both genes and our environment play a part.

Sleepwalking
There have been cases of murder during sleepwalking. The sleepwalker is said to be an automaton, and therefore not responsible for his or her actions.

Science in the news

The public learns about science news by many different routes, including newspapers, magazines, books, radio, television, the internet, electronic news services and films.

Scientists
Scientists may use the media, both professional and popular, to publish or publicise their discoveries or theories.

The primary place scientists wish to publish their findings is in scientific journals. The language used in these journals is very factual, with little for the reader to identify with.

The media are the main way scientists can keep the public informed of their work.

Journalists
A journalist's role is to report things they think their audience or readers will be interested in. Reputable journalists strive to report everything in a fair and balanced way. Many publications employ specialist science reporters who usually have a better grasp of the subject.

News stories
- In news stories the important information is at the beginning of the piece.
- The first sentence tells the whole story and includes as many key facts as possible.
- Removing scientific language makes the piece more accessible to the public.

WHO **WHAT** **WHERE** **WHY** **WHEN**

BROADSHEET VS TABLOID

The way a story is written depends on the publication, and science stories are no different.

A specialist science programme might assume some prior knowledge or at least a basic interest in science.

A Radio 1 news bulletin would keep the same story simple but nevertheless factually accurate.

- **UK radio and TV broadcasters are regulated by law to report news in an unbiased way.**
- **This isn't true of newspapers or online media. Provocative headlines are popular. Most national newspapers have views on issues and particular political attitudes.**

1.4 Average weight of the human brain in kg

10 Percentage of your brain made of fat

100 billion Number of neurons in your brain

2 Percentage of your body weight that is your brain

75 Percentage of your brain made of water

20 Percentage of oxygen travelling round your body that your brain uses

15 Times more neurons in your head than there are people on the planet

1/4 Proportion of people who will have some form of mental health problem in their life

2500 Surface area of cerebral cortex in cm^2

Websites for further information

www.bigpictureeducation.com/thinking

www.bigpictureeducation.com/brain

www.youramazingbrain.org
Award-winning website where you can explore your brain, take part in real-life experiments and test yourself with games, illusions and brain-benders.

www.howstuffworks.com/brain
How your brain works.

www.pbs.org/wnet/brain/3d/index.html
Take a 3D tour of the brain.

www.dana.org/edab
European DANA alliance for the brain.

www.bbc.co.uk/science/humanbody/mind/index.shtml
Interactive tours of the brain plus facts and figures.

www.brainsource.com/nptests.htm
Tests commonly used in a neuropsychological examination.

sentencingcouncil.judiciary.gov.uk/sentencing-guidelines.htm
Government guidelines produced to encourage consistency in sentencing.