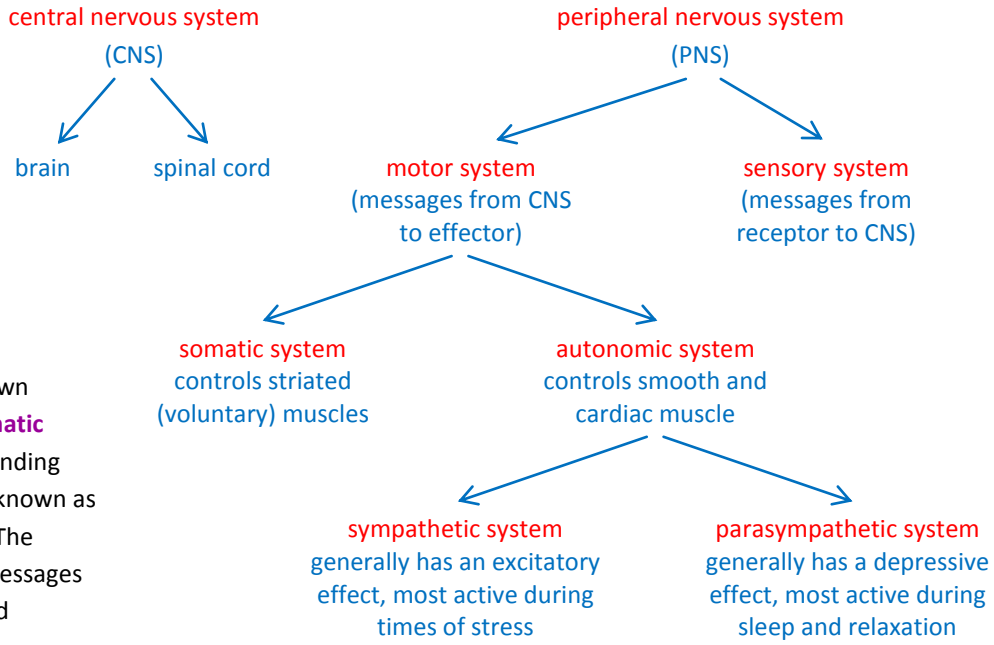
8.1 The nervous system

Organising the nervous system and understanding the human brain

Organising the nervous system

There are a number of elements to the nervous system. The **central nervous system** (CNS) comprises the *brain* and the *spinal cord*, and is made of white matter and grey matter. The **peripheral nervous system** (PNS) is made up of all the neurones which carry nerve impulses into and out of the central nervous system.

The peripheral nervous system can be broken down into two subcategories: the *sensory system* which involves receptors detecting change in the environment, and sending messages to the CNS; and the *motor system* which takes messages from the CNS to the effector tissue.

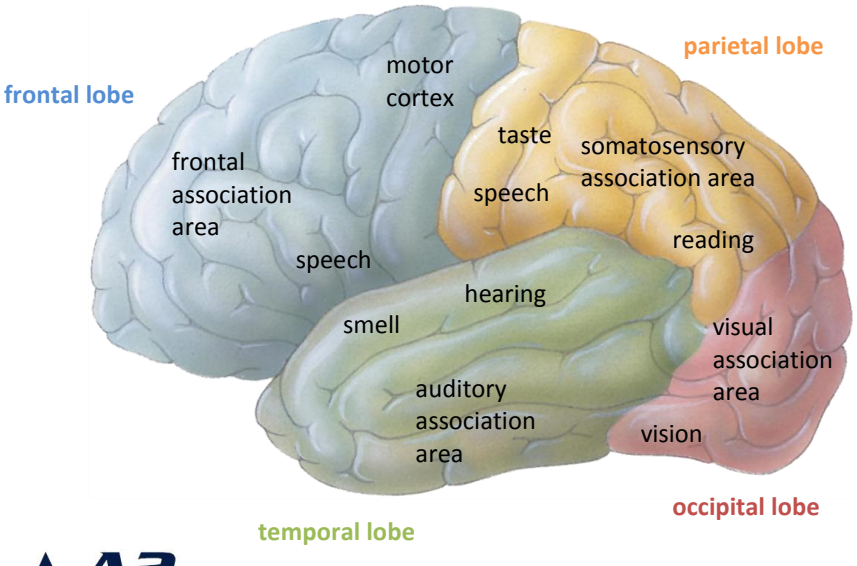


The motor system can be broken down further into two categories. The **somatic nervous system** is responsible for sending messages to *voluntary* muscle (also known as skeletal muscle or striated muscle). The **autonomic nervous system** sends messages to all *involuntary* muscle (cardiac and smooth).

Once again, the autonomic nervous system can be broken down into to final subcategories. These are the **sympathetic nervous system** and the **parasympathetic nervous system**. These two systems are antagonistic, whilst the sympathetic system is most active during times of stress (involved in the *fight-or-flight response*) and has an excitatory effect; the parasympathetic system is active when the organism is relaxed, and has an inhibitory (depressive) effect.

The brain

The brain is one of two core components of the central nervous system. The largest part of the human brain is the **cerebrum**, which is divided into two hemispheres, the right and left. The cerebrum is also split into four separate lobes. The diagram below shows the lobes and what they are most associated with:



The cerebrum contains a very large number of areas, which fit into three categories: **sensory areas** receive indirect impulses from receptors, **association areas** (such as those shown) use what has been learnt from past experiences to interpret the message and decide on an appropriate response, and **motor areas** which send out the nerve impulses to the effectors (muscles and glands).

The brain is involved in muscular movement, and voluntary muscular movement is initiated in the cerebrum,

but *fine motor control* of muscular movements requires more nonconscious thought. These coordinated motor responses require the involvement of the **cerebellum** (which lies just beneath the occipital lobe of the cerebrum). Nerves from the cerebellum carry impulses to the motor areas of the cortex, so that motor output to the effectors can be adjusted, depending on the requirements.

There are five areas of the brain you need to be familiar with, all outlined in the table below:

cerebrum (cortex)	Involved in a wide range of 'higher functions', this four-lobed part of the brain is enlarged in humans. It has been associated with personality, emotions, language, reasoning, visual processing and also possibly consciousness
cerebellum	Responsible for **fine motor control** (for example, gripping objects and playing the piano), as well as posture, balance and walking (movement). It has also been connected with memory
medulla oblongata	Responsible for the control of basic vital functions, such as breathing and heart rate; the medulla is something we have in common with all vertebrates, and is also involved in producing the 'fight-or-flight' response
hypothalamus	Involved in various homeostatic mechanisms, and contains different receptors (for example, for water potential – osmoreceptors – and temperature – thermoreceptors), and is connected with the **pituitary gland** (for example, in *osmoregulation*)
corpus callosum	Connects the two hemispheres of the brain, this is bigger in human females who use each side equally, and smaller in males who have *lateralised brains*, using the right hemisphere more effectively

Autonomic nervous system

The autonomic nervous system has two neurones running to each effector which join at a junction called a **ganglion**. The sympathetic branch has ganglions found within its target organs, having very long **pre-ganglionic axons**. In the parasympathetic branch, the ganglions are all close to the spinal cord, and so have shorter pre-ganglionic axons (and larger **post-ganglionic axons**). At nerve junctions, two different types of neurotransmitter are used:

- parasympathetic neurones use **acetylcholine**
- sympathetic neurones use **noradrenaline**

Both sympathetic (excitatory) and parasympathetic (depressive) are always sending out signals, but the overall effect of the signals is determined by the frequency of each – for example, if there are more sympathetic signals being sent, the effects might include increased heart rate, pupil dilation and increased breathing rate; and if the parasympathetic sends out stronger signals, the effects will be depressive, such as decreased breathing and heart rates and pupil constriction.