Nervous System

British Neuroscience Association

BNA is a registered charity (no. 1103852)

Background

The aim of this session is to introduce students (aged 12-18) to the nervous system. Students will have the opportunity to discuss what they already know about the brain and learn that the brain communicates with the rest of the body using the nervous system. The information sheet should be used in conjunction with the 'Secondary –Nervous system PPT' PowerPoint presentation.

Introducing the Brain

(1) Introduce yourself and the topic you are going to discuss briefly.

(2) Ask the students what they know about the brain and discuss. This is also a good opportunity for you to tell the students some interesting brain facts, including:

- 'The human adult brain is just a bit heavier than a bag of sugar' (1.3kg).
- 'The top of the brain looks similar to a walnut with a wrinkly part on top. If the brains wrinkles were spread out, it would be about the size of 4 pieces of paper' (A4).
- 'The brain is a very hungry organ, takes up to 20-25% of your calories'.

.....

(3) Start with some simple brain anatomy. The brain is split into two sides called hemispheres. Each hemisphere controls functions on the other side of the body. So the left side will control motor functions on the right side of your body, and vice versa. For example, your left hemisphere enables you to move your right arm and your right hemisphere enables you to move your left arm.

(4) Explain that the brain is made up of different areas. Give examples (cortex, cerebellum, etc). Different areas with different functions work together, like different members of a football team.

The brain is made of a special type of cells, called neurons, and glial cells. Neurons talk to each other and work as a huge network connecting different areas. Neurons carry out the functions associated with the different brain parts. Glial cells have many functions, mostly related to the support and protection of neurons. There are billions of neurons in our brains.

To perform actions such as walking, the brain needs to be able to communicate with the rest of the body. Ask the students how they think the brain communicates with the rest of the body. When asking students questions, it is best to allow them a couple of minutes to discuss ideas with each other, and then take suggestions.

(5) Inform the students that the brain communicates with the rest of the body through the **nervous system**.

(6) The nervous system has two major subdivisions:

- **Central Nervous System** or **CNS**: Brain + spinal cord
- **Peripheral Nervous System** or **PNS**, a vast network of nerves branching out from the brain and spinal cord to the rest of the body i.e. the PNS is formed of all the nerves outside of the brain and spinal cord.

(7) Tell the students that the CNS and PNS have bidirectional communication (explained below).

(8) Communication can happen in both directions; the brain and spinal cord (CNS) can send messages to the body (PNS), and body can send messages to the brain and spinal cord too.

(9) The PNS has two main divisions:

- Sensory (afferent division): messages are sent from the PNS to the CNS
- Motor (efferent division): messages are sent from the CNS to the PNS

For example, if an insect lands on your hand (PNS, sensory division), a signal is sent to your brain (CNS). Then, the brain (CNS) sends a message to the hand to shake and remove the insect (PNS, motor division).

.....

Roche

This activity has been supported by a grant from Roche Products Ltd

(10) The motor (efferent) division of the PNS, is further subdivided into:

- The voluntary division: **voluntary actions** control movement of the skeletal muscles. As an example, moving your hands or feet.
- The involuntary division: **involuntary actions** are responsible for critical actions that we do without thinking, such as breathing or our heart beating.

(11) The involuntary subdivision is additionally divided into:

- The **sympathetic 'fight or flight'**, generally starts things going and increases things e.g. it will increase your heart rate when you exercise.
- The **parasympathetic 'rest and digest'** slows things down e.g. after exercise, when you are resting, it will cause your heart rate to go back down.

(12) Explain that for all of these actions to happen, messages have to travel from the peripheral system to the brain and back.

For this reason, these electrical messages need to be sent very quickly - up to 150 metres/second - approximately 3-4 times as fast as your car on the motorway (at 70mph). (*N.B. You could calculate how long it would take to get to the nearest large city for context*).

But, sometimes we need a quicker response. Ask the students if they can think of any instances where a nerve impulse would need to take less time. Take suggestions. Lead the students to think about dangerous situations, such as putting your hand on a hot cooking hob, where you would immediately move your hand away.

Ask the students if they know what the term is for when this occurs? (Reflexes)

(13) The majority of the messages are sent to and from the brain. But even though this is very rapid, some actions need to be even faster, such as reflexes, and they help us survive.

Explain that reflexes travel from the sensory site such as the hand and only go to the spinal cord before the message travels back to a muscle. This is a reflex arc or a simple reflex. No conscious thought is required, so the brain is not involved.

To see what we have learnt about the nervous system in action, here are some activities:

Knee Jerk Reflex

(14) In this experiment, students can test how a simple reflex works. Try it! Instruct students to get a partner and take in turns sitting on a chair while the other partner taps just below their knee. They will kick out immediately (if you hit the right place).

The knee jerk reflex is called a monosynaptic reflex because there is only one synapse in the circuit needed to complete the reflex.

It only takes about 50 milliseconds between the tap and the start of the leg kick. That is fast! The tap below the knee causes the thigh muscle to stretch. Information is then sent to the spinal cord. After one synapse in the ventral horn of the spinal cord, the information is sent back out to the thigh muscle that then contracts.

How fast are you?

(15) This experiment will measure your response time for a message that has to travel from the PNS to the brain and back.

1. Get a long ruler and hold it at the top (see diagram below and on the PowerPoint presentation). Have another person put their hand at the bottom of the ruler (but not touching it) and have them ready to grab the ruler.
2. Tell your partner that you will drop the ruler sometime within the next 5 seconds and that they have to catch the ruler as fast as they can. Write down the level (in or cm) at which they catch the ruler.
3. Repeat 3-5 times, varying the time of dropping the ruler within the 5 second window.

Students can use the table on the PowerPoint presentation to convert the distance on the ruler to reaction time. Who has the shortest reaction time?