Brain anatomy

British Neuroscience Association

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Background

The aim of this session is to introduce students (aged 12-18) to basic brain anatomy. Students will have the opportunity to discuss what they already know about the brain, understand that the brain is made up of two sides (hemispheres) and consists of different functional regions. The session should be used in conjunction with the 'Secondary- Brain anatomy PPT' PowerPoint presentation.

Introducing the Brain

(Slide 1) Title slide.

(2) A great way to start any session is to ask the students what they already 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'.

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(3) The brain is made up of special cells, called neurons. Neurons talk to each other and work as a huge network connecting different areas. Different parts of the brain have different functions and neurons carry out these functions. Inform the students that there are billions of neurons in our brains.

Ask them if they know how scientists study the brain and its cells. Take suggestions.

(4) Inform them about some of the techniques used:

- **Microscopy** and different dyes to stain cells for visualization allow scientists to study the brain in more detail (structure and organization).
- **Magnetic Resonance Imaging (MRI)** allows scientists to observe different parts of the brain and shows what parts carry out different functions. How does it work? Scientist ask the participants to carry out a task (e.g. singing). When neurons are activated, they require energy in the form of glucose, and oxygen from the blood.

The oxygen rushing to the activated neurons has magnetic properties and can be detected by the scanner. In a more visual way, when a part of the brain is activated, it 'glows' and this can be observed.

(5) With the latest technology we can see how the brain is connected, like in this video.

Summarise by informing the students that the brain is the control centre for the body and incredibly important for everything we do. It makes us who we are! (Make this appropriate for the level of knowledge the students have)

The Brain has Two Sides

(6) Inform the students that the brain is split into two sides called hemispheres.

The two hemispheres are nearly symmetrical. The hemispheres are joined by the **corpus callosum**, a superhighway in the brain that coordinates information from both sides of the brain.

(7) Each hemisphere controls functions on the other side of the body. So the left side will control motor functions of the right side of your body. Your left hemisphere will control the movement of your right arm and right leg and vice versa with the right hemisphere and your limbs on the left side of the body.

Tip: Visual aids (e.g. model of the brain) may help you keep the attention of the students and boost your own confidence. If a screen is available, you could use a 3D brain model such as the one found at brainfacts.org/3d-brain.

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

The brain is composed of different functional regions

Tell the students that the brain is made up of different areas. Ask them if the know the name of any parts of the brain.

You may wish to use the 3D brain (brainfacts.org/3d-brain) or simply place your hands on the associated area of your head. Brain models are also really useful to use if you have one to bring along. Allow students to pass them around the classroom and give them a few minutes to think about any areas they know of.

Point out that different areas with different functions work together, like different members of a football team.

(8) Explain that the outside layer of the brain is called the cortex and it has 4 functional lobes: the frontal, occipital, parietal and temporal lobes. Use your hands to show where they are (on a brain model or on your own head).

Some functions are shared along all lobes such as short-term memory formation and emotions. Some functions such as vision, hearing or taste are located in specific areas. Ask them where they think they are located. Take suggestions. Sometimes, the functions are not located where we expect them to be (e.g. vision in occipital lobe, back of the brain). However, sometimes they are where we expect them to be (e.g. temporal lobe processes auditory information, near where the ears are).

(9) Now, explain the functions of the different lobes.

- **Frontal**: Involved in motor control like moving the leg or arm. Is in charge of decision-making, language production (Broca's area) and the sense of taste. It is also responsible for things like personality and abstract thinking (Extra—could highlight Phineas Gage here as case study)
- **Parietal**: Sense of touch, mathematical reasoning, imagination, self-consciousness
- **Temporal**: Audition (hearing), language comprehension (Wernicke's area) and recognition of objects, places, and/or people.
- **Occipital**: Vision, decoding signals from the eye.

(10) Tell the students that in addition to the cortex, the brain has more regions, such as the limbic system formed by;

- **(11) Olfactory bulb**: Smell. In humans it's very small, but in other mammals it's a huge part of the brain. Ask them for examples. Why do they think these animals have a bigger olfactory bulb?
- **Hippocampus**: the library of memories, stores long-term memory. Ask students if they know what will happen if this region is damaged. Guide them to something along the lines of lack of memory. (Could highlight patient HM here as a case study—plenty of videos on YouTube)
- **(12) Amygdala**: Emotions, ensures threats can be recognised and avoided. Sometimes you might feel a little sad, and other times you might feel scared, or silly, or glad. This is all controlled by the amygdala.
- **Hypothalamus**: It's a small area that controls important functions to help us survive. Ask for suggestions about what actions are governed by the hypothalamus. Example: the hypothalamus makes us feel hungry and thirsty when we need energy and water, and tells us when to go to sleep when we need to recharge.

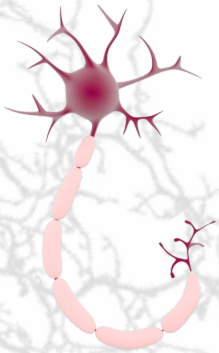
  Also, it acts as the inner brain thermostat, keeping the body temperature at 37 °C. If you are too hot, the hypothalamus orders the body to sweat to cool down. If you are too cold, the hypothalamus makes you shiver to warm up.

(13) Using the slides or the 3D model, show the students that at the back of the brain, we have the **Cerebellum**. Its name means "little brain" and it is in the shape of a cauliflower. It controls balance and motor memory such as playing the piano, drawing or riding a bike.

Ask the students how they learned to cycle? Take suggestions and guide them to the answer 'by practising'. Could you learn that in a book?

Tell them that when first learning the motor movements associated with these skills, it's rare that you will instantly know how to do them. It's not something you can read about in a book. Instead, you have to learn by doing, failing and repeating. This is because you need to train the cerebellum and practice makes perfect!

(14) Finally, at the base of the brain the **Brainstem**, which keeps us breathing and alive.



The brain needs to send messages to and receives messaged from the spinal cord in order to talk to the rest of the body. The brain and spinal cord are connected by the brainstem. The brainstem is in charge of all the functions your body needs to stay alive, like breathing, digesting food, and circulating blood (controlling heart rate).

Mirror Drawing Activity

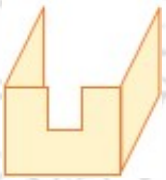
You will need a carboard box, mirror, coloured marker and pieces of paper with a large shape printed on them e.g. a star (students will be required to outline the shape).

To prepare the activity, cut the cardboard box as shown in the figure, and then turn it upside down, with the side cut into a small opening in front of the student. Place a piece of paper with the shape on it inside the box. Where the missing sidewall is opposite the small opening, place the mirror (must stand up, facing the student).

Introduce the writing hand of the student in the small opening in the box and hand them a marker.

The student has to outline the shape by watching the reflexion of their hand in the mirror. How difficult is this? Does this improve with repetition? We recommend you allow each student to carry out the activity 3 times to show the effect of repetition (they should improve).

You could also leave a time gap between repeating the experiment, perhaps doing the activity and the beginning and end of the session.



Once it has acquired a new movement, the cerebellum is very good at remembering it, this is why if you keep trying many times you can improve and be quicker. Our brains are very good at learning new information and adapting to it.

If you wish, the students can race against each other. This video shows the activity: (https://youtu.be/wFoIvB-04YY(and mentions how it was used to study patient HM.

Instead of using boxes, you could have students hold a folder over their friend's hand so that they can't see it when they're drawing, to allow more students to take part.

Brain Atlas Activity– build a brain model

Another good activity for the students is to create a 3D model of the brain with paper. The templates to be cut up by the students and instructions on how to put them together to create the brain model can be found in the 'Secondary– Brain anatomy' folder.

Parietal lobe experiment

The processing of the touch sense occurs in the parietal lobe. We are able to, for example, recognise from touch alone that two objects touching the skin at nearby points are distinct, rather than one object. This process is called **two-point discrimination**.

Different areas of the body have more sensory receptors than others, and so are more sensitive than others in distinguishing between different points. Using callipers or a folded paperclip, and asking a subject to keep their eyes closed, this test can be used to check parietal lobe function.

(Put the two points on the skin/tongue and bring them closer together, asking the student if they can feel two points with each change you make. Record the distance between the two points when the student can no longer detect they are two distinct points.)