

Learning & Memory

Background

The aim of this session is to introduce students (aged 12-18) to learning and memory. Students will have the opportunity to discuss what they already know about the brain, understand what learning and memory are and the different types of memory. The session takes approximately 20 minutes and should be used in conjunction with the 'Secondary– Learning & Memory' PPT.

Introducing the Brain

(Slide 1) Title slide. **(2)** A great way to start any session is to get students to assign an activity to various pictures (dance, sing, sport, maths..). Ask them what part of the body they think is responsible for carrying out these actions. 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!

(3) Ask the students what else they know about the brain. This is also a good opportunity for you to tell them 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'.

(4-5) Inform the students about the anatomy of the brain. The brain is split into two sides called hemispheres. Each hemisphere controls functions on the other side of the body. The left hemisphere will control the motor functions of the right side of the body, like moving the right leg and arm and vice versa with the right hemisphere and the left side of the body.

(6) 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 up of specialised cells, called neurons. 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. Inform the students that there are billions of these in our brain.

(7) Ask students how they think scientists study the brain and its cells. Take suggestions and discuss.

Some techniques used to look at the brain and brain cells:

- **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)** enables scientists to observe different parts of the brain and shows which parts carry out different functions. How does it work? A Scientist asks 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. When a part of the brain is activated, it 'glows'.

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.



What is learning & memory?

(8-9) Ask students how they know where their house is located? Take suggestions and encourage the answer of memories. Ask them to suggest what a memory is. Inform the students that memory is the way in which the brain stores information, and learning is the process of gaining new information and skills.

Ask: Why do we store memories? What are they useful for?

(10) Memories are very important, but does anybody know how we create them? Inform the students that memory is about connections between brain cells or neurons, like tiny pathways or roads. To make a memory they have to talk to each other and make connections. Neurons communicate through electrical activity and send electrical impulses to one another. These impulses are sent via connections between neurons known as synapses.

(11) But, how does the brain store memories and information? When a stimulus is detected (for example, when we see something with our eyes), neurons fire electrical impulses to one another, creating a connection or pathway. If this stimulus is large enough or happens many times, the pathways in your brain become stronger (imagine a motorway). If you don't do something very often, the pathways become weak (imagine an old path filled with grass and weeds). The strengthening of a connection is essential to start a memory.

Some memories will involve many neurons talking to each other in something called a network. When you remember something, that neuronal network starts 'talking again' and becomes even stronger.



There are different types of memory

(12) Start asking students to think about how we interpret the world? How do we collect information from the environment?. Lead the students to the idea of senses.

The first stage of memory forming is **sensory memory**. This is the information we take in from our senses, this memory store has a large capacity and is processed by different parts of the brain, mainly the cortex. You can take in a lot of information, but it only lasts half a second!

Usually, we ignore a huge amount of sensory information that comes in, but if something seems unusual, new or something we are paying attention to, that information moves into the next memory store: **short-term or working memory**, located mainly in the cortex.

Working memory can last up to 20 seconds and we can only cope with around 7 items at a time.

Activity - Working memory game

(13) In this activity, inform students that they will play a game to test their memory. Eleven items will travel across the screen and they have to remember as many as they can. Once the last item has finished, the students have 1-2 minutes to write down as many as they can. (Do not allow them to write down anything while items are still travelling across the screen)

(14) Once complete, show the students what the items were.

(15) Using the graph, edit the data by clicking on 'Chart Tools', 'Edit Data' and counting how many students remembered each item. Complete this for all items. If you are presenting to multiple classes or carrying out this session more than once, you can average all the data you collect.

Looking at the graph, inform the students that when you carry out a similar task with many students, you will start to notice interesting patterns.

For example, our brains tend to remember things at the beginning and end of a list. The brain also remembers unusual items, like Harry Potter.

(16) Once the students have understood how sensory and working memory functions, continue with to the next step of memory formation: **long-term memory**. Ask students for long-term memory examples (e.g. how to read or ride a bike...).

To recap, if the event is unusual or striking enough and we keep it in our working memory by repetition, these experiences travel to a different region: the hippocampus. We can access this information in days, months or years later.

(17) *For example, mention the London 'brainy cab drivers' study. London cab drivers need to pass an exam called 'the knowledge' that consists of memorizing the London city map. They spend years re-visiting every single corner and street. They develop tricks to learn all the paths so they can create a mental atlas of the city to successfully pass the test. Researchers, intrigued by the huge memory capacity of these professionals, used the MRI scanner (remind what it is) and found out that they had a larger hippocampus compared with other people.*

(18-19) Finally, the long-term memories are stored in neural networks but the networks are not static. They will change with time, some will be lost if we do not use the information and others will change a little bit every time we recall this memory. So it is worth taking into account that a memory you have now may be very different from the original!

Additional information: What techniques can we use to be better learners?

Now that you understand a bit about how memories are formed, let's use this information to help you learn and study in a more effective way.

Repeat to the students that long-term memories are formed by strengthening of connections by going over information again and again. As an example, when revising for future exams, the more you study one piece of information, the more likely you are able to remember it.

However what happens if you hear something again and again? Lead students to the idea that you start to lose interest.

After a while that information can start to lose its novelty and lose your attention.

Some techniques to avoid this:

- Repeat information but in different ways, so they retain novelty. As an example, reading, watching videos about the topic, drawing diagrams, etc
 - Learning the same material in different environments (e.g. in different rooms)
 - Making the information relevant to yourself and your life, relating the new information to your own experiences or something is relevant to you.
 - Chunking information into meaningful categories
 - Creating the information yourself, making cards or for example in the form of a mnemonic
 - Long-term memories are consolidated and stored while we sleep, so make sure you get plenty of it. Don't stay up late the day before an exam.
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