Brain Myth-busting

Do we only use 10% of our brains?

Many people think that we only use 10 per cent of our brains and that we can harness the rest to boost our mental abilities

This is the most popular myth about the brain, and there is no scientific evidence for it – we almost certainly use all of it. The brain is a very hungry organ, consuming nearly one-quarter of the body's energy, despite accounting for just 2 per cent of body mass. From the point of view of evolution, it just doesn't make sense to have a large organ that consumes so much energy if only 10 per cent of it is actually needed.

Do neurons map to specific memories?

While examining the brains of people with epilepsy who were about to undergo neurosurgery, researchers discovered neurons that respond specifically when people look at pictures of celebrities like Jennifer Aniston and Halle Berry or famous landmarks like the Eiffel Tower.

The cells also fired when the patients thought about the celebrities. They are located near the hippocampus, which is crucial for memory formation. Each cell is probably part of a network that encodes the memory, or concept, of the celebrity or landmark and probably contributes to hundreds of other networks, each of which encodes a different memory or concept. It is unlikely that single neurons map directly and uniquely onto single people or objects.

It was once thought that having a bigger brain makes you more clever, but that isn't true

Women's brains are, on average, 9 per cent smaller than men's (and so contain fewer neurons), but women are not less intelligent than men; the size difference just reflects the fact that women's bodies are generally smaller.

Brain size and intelligence are definitely linked, however, but we still don't know exactly how. While human brains are large, weighing in at an average of 1.4 kg, they pale in comparison to the brains of elephants (2.8 kg), yet human intellect is still uniquely advanced. What seems to be more important than overall size is which areas of the brain are enlarged and how the neurons are connected to each other.

Studies of Albert Einstein's brain illustrate just how complicated the relationship between brain size and intelligence is. Einstein is often said to be one of the most intelligent people that ever lived, and researchers naturally believed his brain might provide important clues about what made him so clever. When he died, they were surprised to discover that his brain was actually quite small. It weighed 1.23 kg, or about 200 g lighter than the average of 1.4 kg, and the temporal lobes – which contain areas that are specialised for speech and language – were also smaller than average.

Scientists who examined Einstein's brain also claim to have found some unusual differences that help to explain why he was so intelligent. For example, his parietal lobes, which are important for mathematical abilities and visual and spatial functions, were about 15 per cent wider than average. They also had an unusual pattern of grooves and ridges, and certain regions of the parietal lobes had more glial cells per neuron than normal.

However, many researchers disagree with these claims; they point to the fact that the original studies tested seven different measures in four brain areas, and only one (number of glial cells per neuron) produced a significant result. In context, they state that this may not mean there's anything special about Einstein's brain, as statistically, one out of 28 studies might be expected to produce a result by chance. In terms of size and shape, they argue that it is bad science to look at one individual and state that they are abnormal simply because they deviate from the population average. In reality, the differences noted in his brain are likely to be within the normal and expected range.

This debate highlights many issues that scientists need to be aware of, for example the problem of 'confirmation bias' – the phenomenon where a person has a pre-existing belief or theory, and then views anything they see as confirming that view. In this context, such a belief might be: 'Einstein was very intelligent, and there must be structural differences in his brain that underlie this intelligence.' Therefore, when something does appear different from the average, it is assumed that this is a cause of intelligence, rather than it being simply down to chance.

The debate over Einstein's brain demonstrates how complex researching the brain is, how little we know about how the physical brain structure produces intelligence, and the many pitfalls scientists can fall into when producing research. It also further proves the point that linking brain size and intelligence is very simplistic; a bigger brain does not necessarily mean a cleverer brain!

Are we born with all the brain cells we'll ever have?

Neuroscientists had always believed that the adult brain could not produce new cells and that we are born with all the neurons we will ever have. This viewpoint slowly began to change in the 1970s, when scientists discovered that the brains of rats and songbirds produce new cells throughout life. This is now widely accepted as being correct, but whether the same is true in humans has long been a divisive subject.

Up until recently, there was very little evidence for human neurogenesis (the production of new neurons). According to the latest estimates, the brain contains about 86 billion neurons and roughly the same number of glial cells. As far as we know, the vast majority of these cells are produced in the womb – during early pregnancy, about 250,000 brain cells are produced every minute. The majority of the remaining neurons are produced during a short period of time after birth – maybe as little as a few months, or as much as a year. As a result, the brain produces at least twice as many cells than it actually needs to work properly.

Neurons begin to die before we have even been born and continue to die every day of our lives. Researchers have estimated that about 85,000 neurons die every day in the cerebral cortex. That's equivalent to one every second.

However, new evidence suggests that in a specific area of the human hippocampus, known as the dentate gyrus, new neurons are produced continuously into adulthood – around 1,400 a day. With age, the number of new neurons being produced decreases, but at a much less dramatic rate in humans than in mice.

The most interesting difference, though, is that in mice, new neurons survive for a long time, meaning that the hippocampus grows as they are produced. However, in humans new neurons do not live for long and, with age, the hippocampus shrinks as more neurons die than are produced. The reasons for the differences in neurogenesis between humans and other mammals are not known; studying neurogenesis is difficult and requires ingenious methods of measurement, so it may be a while before more conclusive facts are established.

Can learning physically alter the brain?

Neuroscientists believe that learning and memory change the physical structure of the brain.

Animal research shows that forming a new memory involves the strengthening of synapses in a network of neurons. The same is probably true of humans, although we still do not have the techniques to observe these changes directly in the human brain.

Learning can cause other changes in the brain, some of which can be seen in the human brain using various imaging techniques. In 2004, for example, researchers used MRI to show that learning to juggle for three months increases the density of grey matter in parts of the visual cortex specialised for processing complex visual motion.

More recently, another group of researchers showed that learning to juggle also leads to changes in the brain's white matter tracts. Using diffusion tensor imaging, they found that it increases the density of white matter underneath the intraparietal sulcus, which is involved in several mental functions, including memory for where things are in space and perceptual–motor skills (such as hand–eye coordination).

Learning to read as an adult also causes significant changes in brain structure. In a unique study, researchers in London and Spain examined the brains of former Colombian guerrillas who learned to read Spanish after returning to mainstream society. Using MRI, they detected increases in the volume of grey matter in the left frontal and temporal lobes, both of which contain areas specialised for processing language.

Can abuse and love change the brain?

There is plenty of evidence that childhood neglect and abuse can cause changes in the brain that have long-lasting effects. Most of it comes from research on animal behaviour, but there is evidence for this in humans as well.

In recent years, it has been found that growing up in poverty has a direct effect on children's mental abilities. One study showed that children raised in impoverished conditions have a reduced capacity for working memory – the ability to store small amounts of information for short periods of time – in comparison to better-off children. A follow-up study showed that this is probably because stress affects the way in which children's brains develop. More recently, it has been found that childhood abuse stunts growth of the hippocampus, part of the medial temporal lobe that is crucial for memory formation.

Do the sides of our brain do different things?

Another popular myth about the brain is that the left hemisphere is 'logical' and the right hemisphere is 'artistic'.

This probably comes from early studies of people with brain damage and from work on 'split-brain' patients, in whom the connections between the left and right hemispheres were destroyed to prevent epileptic seizures from spreading throughout the brain. It's true that the left and right hemispheres each contain areas that are specialised for different functions, but most things we do involve the coordinated activity of the two hemispheres.

Split-brain patients

A year or so after surgery, split-brain patients are often able to lead very normal lives and are generally not aware of a difference in their behaviours and abilities. However, in studies where information is conveyed to one side of the brain and not the other – for example flashing a word in front of the left eye and not the right – the lack of communication between the two brain hemispheres becomes obvious.

For example, the left hemisphere is largely responsible for producing language, so if a word is flashed in such a way that only the right hemisphere is able to perceive it, the patient will not be able to articulate the word they saw, but they are able to draw it. This demonstrates how each hemisphere has certain 'specialisms', but in no way supports the claim that either hemisphere is 'creative' or 'logical'.

Do we each have a 'learning style'?

At some point in your school life, you may have been told that you learn best by seeing images and diagrams, making you a visual learner, or that you need to hear things explained to really take them in, as you're an auditory learner.

You might even have been told that you need to physically do things, such as roleplays, to understand and retain information, because you're a kinesthetic learner. You may have been given specific tasks or split into groups based on which type of learner you are, and maybe it worked for you; however, it's more likely that it didn't.

There is no neuroscientific evidence for the visual-auditory-kinesthetic (VAK) model of learning styles, despite how popular the idea has become. Study after study has found little to no beneficial effect on students' learning using these styles, yet research has found that 76 per cent of British teachers have used learning styles at some point in their teaching.

The VAK model is just one of many different learning-style theories. There are about 70 different models, most of which have been widely discredited, including the 'left brain versus right brain' theory. VAK just happens to be the one that gained traction in British schools.

Negative effects of the learning-style myth

There are many problems with promoting the idea of learning styles. If people believe they have one optimum way of learning and thinking, it may discourage them from developing new skills that they are more than capable of achieving, as they may think that these are outside their 'style'.

And many schools have invested time and money in either training their staff to use these styles or hiring external 'experts' to demonstrate how they can be used in the classroom – even though they likely offer no real benefit.

You may well have a method that you prefer using – for example, when you're revising you may draw diagrams, or use different coloured pens, or write out your notes over and over again. However, studies show that a preference does not necessarily mean that's the only or even the best way that you might learn, and it may even be good for you to use a variety of methods.