Brain size matters when it comes to remembering

August 26 2014, by Joel Pearson

Want more working memory? Then you need to expand your brain. Credit: Flickr/Elena Gatti, CC BY

Before we had mobile phones, people had to use their own memory to store long phone numbers (or write them down). But getting those numbers into long-term memory could be a real pain.

People had to write the number down, say it over and over again to

themselves. With each verbal iteration, something annoying would happen, and the number would often fade out of memory. To get the number into long-term memory you had to keep repeating the number fast enough to beat the fade-away.

This short-term, fast-fading memory is called working memory. It's like the RAM in a computer: it holds everything in your mind ready for action, simulation or a decision.

Working memory capacity has been linked to IQ and even to some mental disorders, but we don't know why some people can fit a lot more information into their working memory than others.

In a recent paper published in the journal Cerebral Cortex, we showed that the size of the part of the brain responsible for processing vision is linked to working memory capacity.

How much can you remember?

Some people can hold huge amounts of information in their mind and even manipulate it, trying out different ideas, while other people can only hold small amounts.

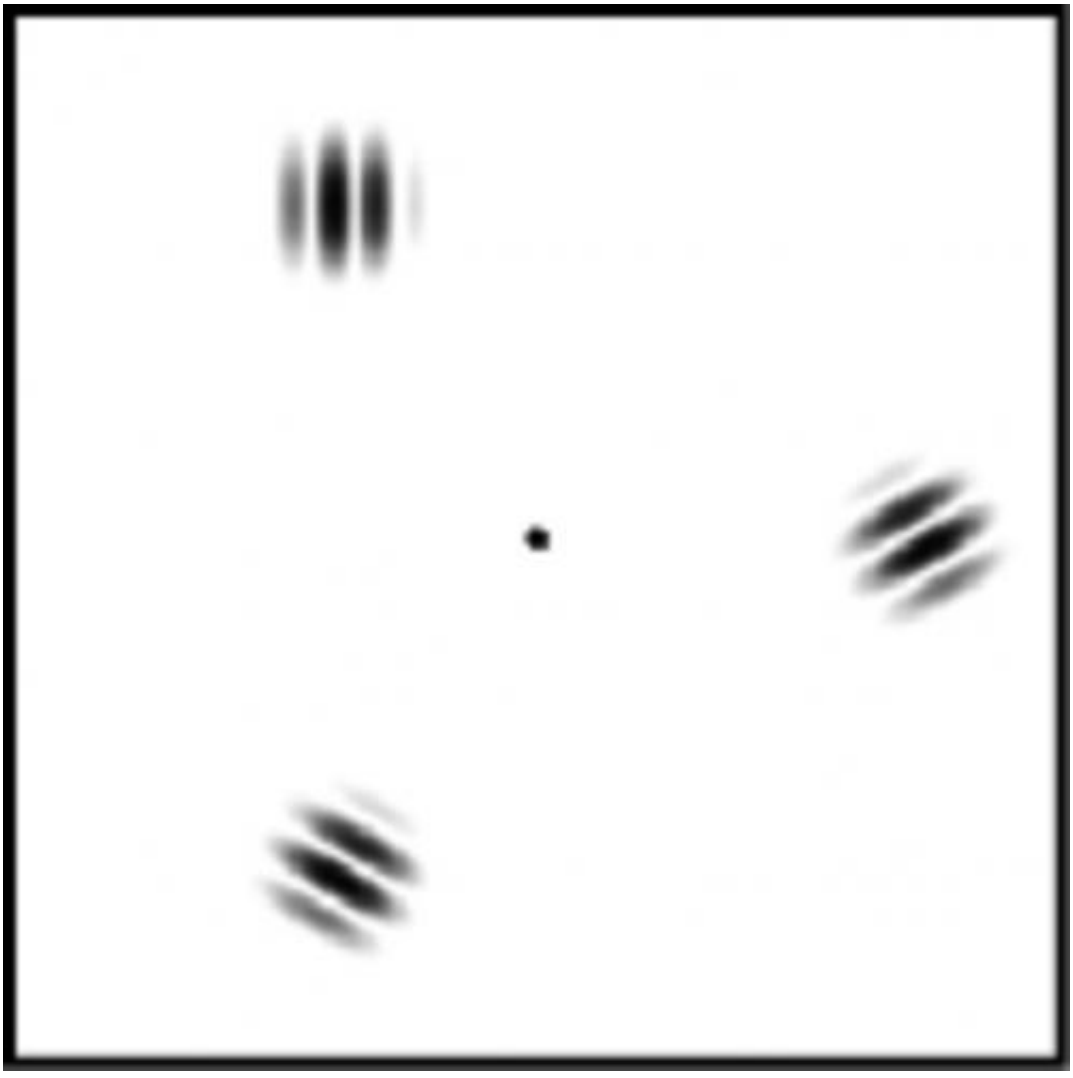
Why do people have the particular capacity they have? How can we investigate these differences between people? It turns out the key to answering these questions is to get people to remember information in only one of their five senses, for example, vision.

By doing this we narrow down the field of things to investigate. We can look at the precise brain anatomy related to just that one sense in different people and figure out which parts of their brain allow for greater information capacity.

This is exactly what we did in our Cerebral Cortex paper. We found that people with a physically larger visual cortex – the part at the back of the brain that deals with what we see – could hold more temporary information in their memory.

This is interesting for a number of reasons because it suggests that the physical parameters of our brains set the limits to what we can do with our minds.

An easy way to think about this is to picture the visual cortex as a bucket: the larger the bucket the more water it can hold.



Just three patterns in this example. Credit: Joel Pearson

The larger your visual cortex the more visual information it can hold. But the "visual cortex bucket" has to actively hold on to the information. It takes voluntary effort on your behalf to continually hold this information and then use it.

This was one of the surprising things from our study. Most research suggests that voluntarily holding information in your mind like this is done by high-level brain areas such as the frontal cortex, not the earliest stages of sensory processing such as the primary visual cortex.

Until recently it was thought that these early stages of processing ran on autopilot, "mindlessly" processing incoming information from the senses. But our study and other recent papers now suggest that high-level processing such as voluntarily holding things in mind crucially depend on the earliest levels of processing.

The memory test

We used a computer-based visual memory test in which our participants were shown between two and four small visual patterns for just one second before they were removed.

They had to try to remember all the patterns for nine seconds before a second single "test" image was shown again, but this time slightly rotated. The test was to see if they could remember all the patterns well enough to know which direction that single pattern had changed.

This allowed us to measure each participant's capacity for visual working

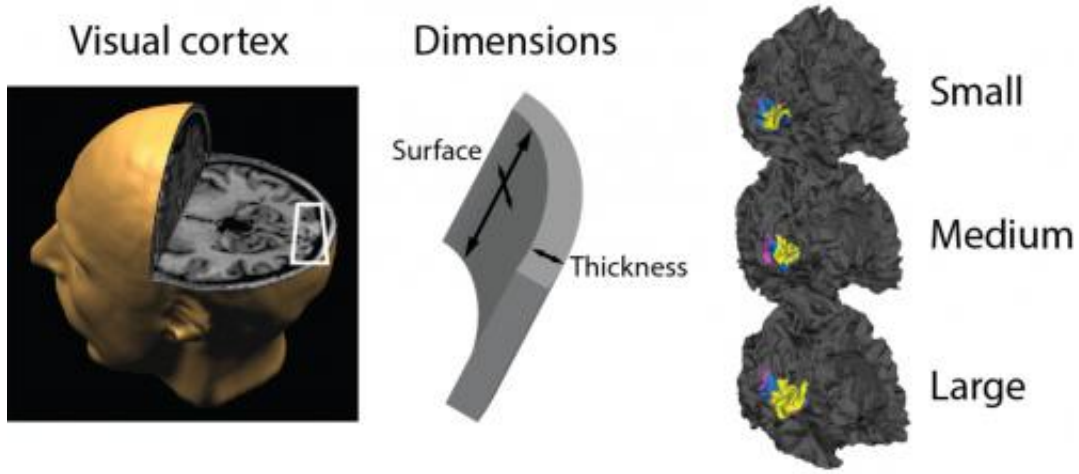
memory for the nine seconds. To make sure this test was reliable we did this again in each person two weeks later.

After these behavioural tests, we put each person in a brain scanner (functional Magnetic Resonance Imaging: fMRI) and mapped out the visual parts of their brain. This allowed us to directly compare how much each person could hold in memory and the size or volume of his or her visual cortex.

It is worth noting that size is not everything. Many other brain factors can and will influence your mental life and indeed your working memory capacity.

These factors include the degree of internal connections between different brain areas, the level of neural transmitters, the hormones in your body and brain, and of course the amount of stress you are under.

But all this doesn't make it any fairer for those that can't hold much "in mind".



The visual cortex, at the back of your head (left), panel showing the two dimensions of the cortex thickness and surface size (middle), and three different participants' brains (right) with the primary visual cortex shown in yellow (note the different sizes). Credit: Joel Pearson

How big is your brain?

The next logical question is: why do I have a large or small visual brain? When it comes to the visual cortex the data suggests that our genes play a role.

The cortex, the outer layer of the brain, is like a gooey grey sheet that is all wrinkled up on itself. In fact, there are two different components to the size or volume of the primary visual cortex: thickness and surface area.

These two different measures seem unrelated to each other – they are not correlated – but both have a heritable component.

In our study, we found that both the thickness and the surface size of the visual cortex independently predicted how much people could hold in visual working memory. So indirectly at least, it seems that your parents or ancestors might have passed their visual cortex down to you, or at least its size.

So does all this come down to luck? Well, as with most things, yes and no. Some promising research is now looking at how training or practice can literally change the architecture of your brain.

A few studies have demonstrated that learning and practising juggling

can induce anatomical changes in some parts of the visual cortex. But exactly how such changes might affect visual working memory is still unknown.

For now, things might have to remain a little unfair, although many people do subscribe to the notion of use it or lose it when it comes to the brain.

A simple hack to get around any capacity limits in short-term memory is to use physical props, such as a smartphone, whiteboard or even pen and paper as a form of mind-extension.

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