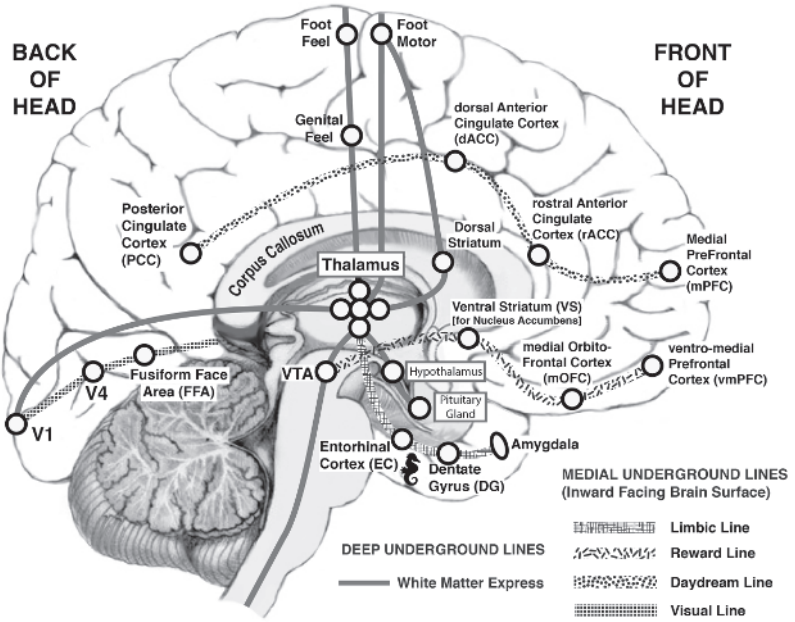
Your Amazing Brain

The word "amazing" seems to be used pretty loosely these days to describe a lot of things, many of which often turn out to be disappointingly mediocre, but in the case of your brain there really is no other word that does it justice.

This wrinkled pink lump of pulsating wetware has a texture not dissimilar to blancmange, is composed of around 80% water, 11% fat, 8% protein, 3% vitamins or minerals and weighs in at around about 1.5kg. It is a densely woven meshwork of 86 billion brain wires (neurons) along with a further 86 billion support cells (glial cells), all neatly packed away in the cavity between your ears. It is *truly* amazing.

As the ultimate supercomputer, your brain is currently light years ahead of anything that humans have so far managed to create. It works relentlessly, nonstop, around the clock, continuously reshaping to adapt our skills and behaviours to suit an almost infinite variety of different real and potential future circumstances, receiving and delivering data, analysing information, performing billions of complex, multifunctional tasks in parallel and monitoring millions of functions, all at a breathtaking speed. Its capabilities really are quite staggering.



When it comes to high performance, what does your brain look like?

The map in the illustration above shows some of the stops on the underground system that runs right down the middle of your brain, level with your nose. This particular image is referred to as the "Inward-Facing Brain Tube Map" because it shows the inner brain surface, where the left and right hemispheres rub up against each other along the midline. It's duplicated at the back of the book – in the Appendix – so you can find it again more easily. You'll also find an "Outward-Facing Brain Tube Map" there too. Both maps are also available at www.sortyourbrainout.com for anyone listening via audiobook.

No benefit would come from overloading you with unnecessary information by talking about every area of your brain, but it *would* be useful to start by pointing out three key areas that are most relevant to what we'll be discussing in this book. The hippocampus includes the DG (Dentate Gyrus stop) and EC (Entorhinal Cortex stop) on the lower part of the Limbic Line, a particularly dense area of networked brain wires connected with virtually every other part of your brain.

Why a seahorse?

You may be wondering why there is a seahorse in the illustration of this medial surface (inward-facing) tube map of the brain. If your brain's hippocampus was surgically removed from the inward-facing surface of each of your temporal lobes, you'd see that they actually look very much like a seahorse. Indeed, the word "hippocampus" comes from the ancient Greek *hippos* ("horse") and *kampos* ("sea monster").

This part of your brain performs three key roles:

1. It helps you to keep track of where you are – a GPS system of sorts that gives you a sense of where you are and how to get where you're going.

2. It enables you to create and recall memories of events and pieces of information, so it's essential for the accumulation of knowledge and the ability to learn from experience.

3. It's even vital for our ability to imagine the future!

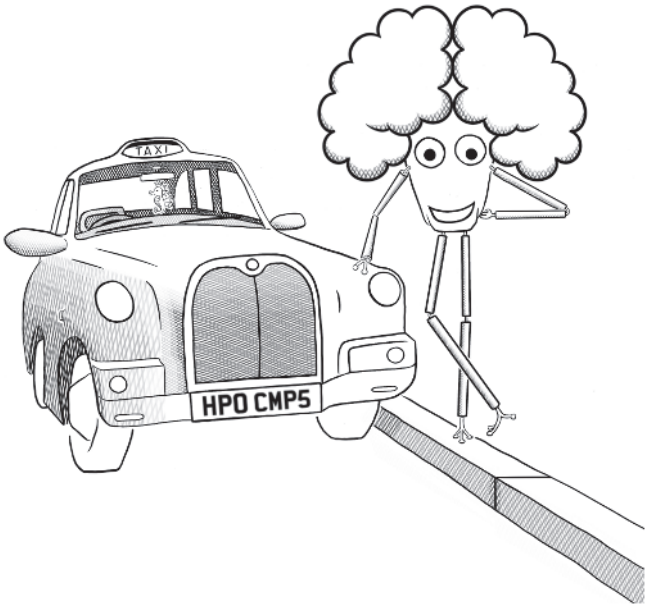
The first two of these functions are intimately related, as many of our memories of life events are closely intertwined with the places in which they were experienced. This is why, when you return to that place, the most relevant memories will be triggered. Hence a visit to your old primary school can produce a surge of long-forgotten memories. The hippocampus cluster of tube stops in your brain is buried deep down within each of your temporal lobes. These run along the left and right sides of your brain, from just above and behind the ears to the temples of the skull.

Taxi!

The drivers of London's famous black cabs spend, on average, 2.2 years learning "The Knowledge," a seemingly unconquerable mountain of information to commit to memory by anyone's standards. Without looking at a map, they need to be able to describe how they would use the 20,000 major routes *and* the whereabouts of 25,000 places of interest that a fare-paying passenger, having hopped into the back of their cab, might want to visit.

During this period of exhaustive information ingestion, the rearmost parts of the hippocampi of these wannabe cabbies grow physically larger due to all the extra connections required to retain that information – only to return to their normal size shortly after retirement. It really is a case of use it or lose it!

What this shows is that your brain not only adapts to take on new challenges, but it physically restructures itself to meet them. As yet, there is no computer capable of reconfiguring itself in this way to cope with new demands asked of it. Not bad for a design that first appeared on the scene back in the Stone Age and which still outcompetes the most complex computing systems of the modern age (for the time being at least)!



Just beside the DG stop you'll find the amygdala tube stop. This ever-alert brain area is responsible for, among other things, generating various emotions and constantly monitoring the sensory information being captured from your surroundings for signs of potential danger. Like a military listening post for your brain, it is forever looking out for possible threats to your well-being, always primed and ready to push the "big red button" that orchestrates the feeling of fear a split second after possible danger has been detected. This is the part of your brain that, within less than a semiquaver of time, having heard a loud bang or spotted a rapidly approaching object coming your way, causes you to freeze in your tracks, duck out of the way or simply jump out of your skin – before you're even fully aware of what it is you're dodging. With your heart now pounding and your muscles flooded with blood, you're all set: ready for a confrontation or a hasty exit.

During early pregnancy 250,000 new neurons are created in the foetal brain every sixty seconds!

Just above the amygdala tube stop is the Reward Line. It evolved to trigger pleasurable sensations whenever you engage in behaviours that promote the survival of the species (i.e. eating, drinking and having sex). Known collectively as the reward pathway – the VTA (Ventral Tegmental Area), VS (Ventral Striatum) and OFC (OrbitoFrontal Cortex) stops – are also critical to decision-making.

The VTA stop in the midbrain – just above the brain stem – is the starting point of the Reward Line and is where all of the brain's dopamine is manufactured. While dopamine is involved in helping the right messages reach their intended destinations in many separate brain pathways, each playing a different role in overall brain function, the VTA itself is reliably activated by life's pleasures.

The responses of the next stop on the Reward Line – the VS stop, which contains an important structure called the nucleus accumbens – are a bit more sophisticated. Rather than just being involved in triggering rewarding feelings in the moment of doing something pleasurable, it provides a *prediction* of which of a range of available options is likely to trigger the greatest reward in the *future*. This means that the Reward Line is not only instrumental in helping us make every single decision we make, but it is also fundamental to the process of learning to make better decisions. Whenever our decisions deliver a reward that is smaller than or greater than the anticipated reward, the Reward Line system updates its predictions accordingly. Without the reward pathway, we would never learn from our mistakes!

> There are more connections between brain wires in your head – 150 trillion synapses – than there are stars in our galaxy (the Milky Way).

To help give you a clearer perspective on what we're looking at here, the London Underground proudly boasts a combined track length of 250 miles, with hundreds of tube trains travelling between the 270 stations at a top speed of about 70 mph. But that's a damp squib compared to the information-transporting networks you're packing deep inside your skull.

If all your brain wires were laid out end to end, they would be approximately 100,000 miles in length, with hundreds of thousands of trillions of trains (electrical messages) travelling up and down, bang on time, at up to 250 miles per hour, shuttling information towards the 0.15 quadrillion connections (synapses) that reside in your grey matter. And, if all these wires – your brain's white matter – were laid out as an underground train network, it could cover an area of around 560,000 square miles, a surface area larger than the whole of South Africa, all tucked into a space smaller than your average pumpkin.

What really makes the human brain so very special is NEUROPLASTICITY – its ability to physically alter its pathways, as you learn new skills and, perhaps even more importantly, its ability to adapt to unexpected changes, under widely varying circumstances, in new and creative ways.

Your brain can send these one hundred, thousand, trillion messages per second using the same amount of power as your average fridge light bulb. For a human-made supercomputer to send and receive that many messages per second it would require its own small power plant to provide the 10,000,000 watts needed to power it. Less than a litre of blood passing every minute through the brain of chess grandmaster Garry Kasparov was sufficient to keep his forehead merely warm to the touch, whilst his opponent – the IBM supercomputer Deep Blue – needed a vast fan-driven cooling system to stop it blowing up.

It doesn't come with a guarantee or any warranties, but if you look after your brain, it should remain fully functional and in good working order throughout your entire lifetime. And if you're ever worried about running out of memory space, please don't! You'll be relieved to hear that it comes with the equivalent memory space of a one million gigabyte computer chip. That's enough memory to record over three million hours' worth of your favourite TV programmes.

When we sleep, our brain cells shrink. This makes the concentration of the substances swimming around in the fluid *inside* the cells higher than those in the fluid *outside* them. This flushes out the metabolic waste materials that accumulate each and every day within our brain cells, which are then banished from the brain via the newly discovered "glymphatic" waste removal system. More sleep, more toxin removal.

Your brain is a phenomenal, unimaginably brilliant piece of kit and, please note, the emphasis is on *your* brain – we all have more or less the same make and model. Provided you are of this planet, do not have an exotic neurological condition and your name isn't Albert Einstein, there will be very little, if anything, to tell your brain from that of the person next to you.

Yours may be broadly the same make and model, but when it comes to how your own personal brain connections differentiate your individual performance from that of others, there are three very big influencing factors:

1. The environments in which you spend most of your time

2. What you are exposed to in those environments

3. What your time in those environments is actually spent doing

The environments we've spent most of our lives interacting with so far will have slowly but surely shaped our brains. But we humans are very unusual in the sense that we have immense power to shape our environments. We build both the physical environments that we interact with every day and the virtual ones. So we humans are fairly unique in that we can alter the environments that then go on to shape our brains. This means that if we are clever in how we organise our local environments, we can positively influence how our brains are shaped! To encourage

our brains to adapt in a positive way, the challenge for each of us is to try to spend more time in environments that are stimulating and less of it in others.

Yes, our brains are all amazing, but it is how we have made use of them over our lifetime so far that makes each of us unique. More importantly, when it comes to improving performance, it's what we choose to do with them from here on that will determine just how well they continue to serve us in dealing with the daily demands of our own lifestyle.