A head for languages

Pavitra Baxi looks at the neurological connections that happen in the brains of interpreters and translators – and at how these differ from those of other people who are fluent in using more than one language

All interpreters and translators are bilingual or multilingual. But not all bilinguals or multilinguals can interpret. And it is no wonder that learning interpreting skills takes time and effort, because this work requires the brain to learn new connections and fire up different regions from the ones we are used to.

Pop culture wants us to believe that being a superhuman and performing extraordinary feats requires radioactive intervention or a genetic mutation. Yet when you look at the neurological feats involved in comprehending in one language and responding in another – and doing this in real time – simultaneous interpreters look pretty superhuman to me.

Using the language we habitually employ is a skill we generally take for granted. It's only when we are faced with the prospect of switching to a language that we have learnt but we don't habitually use that we realise how difficult it is to string together simple sentences. And this is precisely the reason why simultaneous interpreters belong to the superhuman category.

When I was training to be a translator, I became increasingly intrigued by how the brain handles words

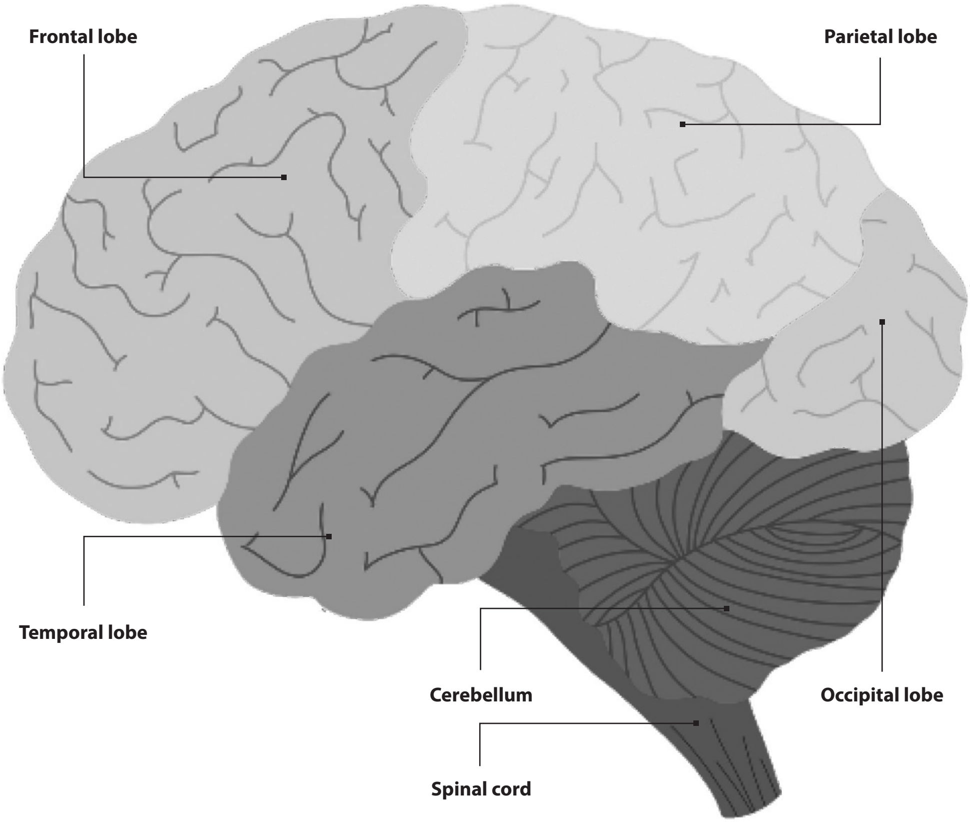
From human to superhuman

So how are these superhuman qualities acquired? There is, of course, the 'nature' part of it: some studies have shown that people with a certain genetic make-up are better suited to language learning than the general population. Yet this just indicates that some find it easier than others, nothing more. And plenty of people have of course no option about learning more than one language: which is also the case for most of us in India, where I live.

When it comes to simultaneous interpreters, 'nurture' plays a larger role in acquiring superhuman abilities. These are skills that are learned. And research has found distinct structural changes in the brain of simultaneous interpreters, which are direct results of the extensive training and practice that are an integral part of any interpreter's professional life.

When I was training to be a translator, I became increasingly intrigued by how the brain handles words and strings them together into comprehensible sentences and paragraphs; which is why I turned to neurolinguistic research to get my answers. Thanks to new brain-imaging techniques such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) scans, researchers have been able to uncover some of the answers to how this happens.

PARTS OF THE BRAIN



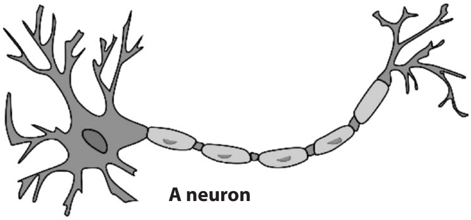
The humble, complex brain

Simply put, our brain is a cluster of billions of neurons. Each neuron is made up of the neuronal cell body, dendrites and axon. Information is perceived and processed in the neuronal cell body and then transmitted through the axons to a different part of the brain.

In brain scans, the neuronal cell bodies appear as grey matter and bundles of axons appear as white matter. And although there are no clear-cut demarcations, specific parts of the brain are responsible for specific functions.

Where it all happens:

- ▲ The frontal lobe is what makes us a 'person'. Our thoughts, emotions and behaviour – it's all shaped here.
- ▲ The temporal lobe is the part of our brain which is next to the ears. It plays the biggest role in language processing and also in hearing.
- ▲ The parietal lobe is the attention centre and also helps in language processing.
- ▲ The occipital lobe perceives and processes the signals sent to the brain from our eyes.
- ▲ The cerebellum, responsible for motor control, ▷



A neuron

coordination and spatial navigation, is the lowest part of our brain.

Two or more brain regions are said to be *structurally connected* when a physical connection, such as the electrical connections that fire off between cells all over our bodies, exist between them. A *functional connection* is said to exist between different brain regions when similar patterns of activation are seen, regardless of the physical connection between them.

Making the words work

For most people, language processing takes place in the left hemisphere of the brain. The Wernicke's area, located in the left temporal lobe, processes the language data we receive (including by reading) and makes sense out of it. A bundle of nerves called the arcuate fasciculus carries this information to Broca's area, which is located in the left frontal lobe and controls language expression of different kinds.

Some studies suggest that languages are stored in Broca's area and that those learned in childhood are stored close to each other, which is why it is easier to recall the ones from those years. According to this research, languages learned as an adult are stored further apart, which is also why it takes more time and effort to recall newly-learned languages.

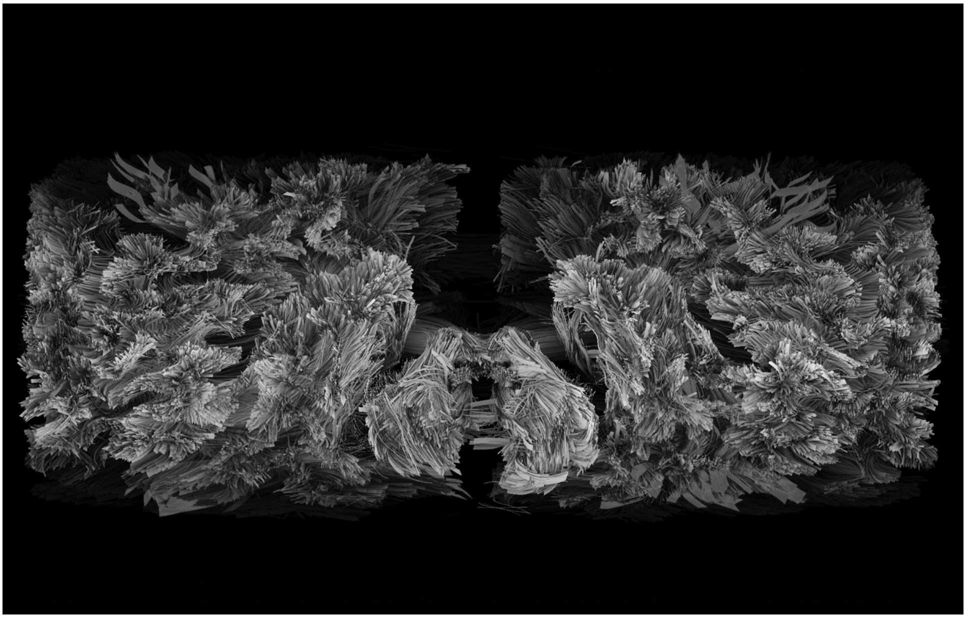
To make matters even more complicated, language processing is not an isolated activity. In addition to the specific regions mentioned above – the ones whose job is to do with language in particular – the brain's control centre also has to direct attention and resources to multiple brain regions, and activate these at the same time. The prefrontal cortex, basal ganglia and thalamus work together to carry out executive functions – both organisational (paying attention, planning, problem-solving, selecting relevant sensory information and so on) and regulatory (such as inhibitory control, decision-making, self-control, action initiation and emotional regulation). These areas are located in different sections of the brain, but they are all both structurally and functionally connected. More on this below...

To make matters even more complicated, language processing is not an isolated activity

Adding new languages

Perhaps it is not surprising, given all that's going on, that learning a new language puts huge demands on the brain – and as a result, it adapts to this demand by increasing the grey matter and forming new neuronal connections. The brain is a dynamic and flexible organ that makes adaptive structural and functional changes to itself when faced with new cognitive challenges. (Though this does come at a cost: real estate is as precious a commodity in the brain as it is in a crowded city. In order to accommodate new knowledge, the brain routinely culls structural and functional connections that are not in regular use. Information isn't 'pushed out' – Homer Simpson was wrong on this – but our access to it changes. When it comes to information which we routinely draw on, the brain retains the most efficient pathways and removes the rest.)

However – and this is where it gets particularly interesting – brain scans have revealed that interpreters and translators process language in a



Wernicke's area is located in the left temporal lobe. Nerves carry this information to Broca's area, located in the left frontal lobe . Languages may also be stored in Broca's area, some studies suggest

different way from people who use more than one language but don't interpret or translate for others. Instead of one language, two languages are active in the language centres – the source language and the target language. Unlike someone who uses different languages consecutively, the interpreter's brain needs access to both languages simultaneously.

The interpreter's brain needs access to both languages simultaneously

Making the brain work

Put simply, bilinguals switch on, or activate, the language they're using and switch off the other(s). Interpreters switch on the source language first, activate the target language to carry out cross-language lexical matching and then switch off the source language again.

When a bilingual switches over to their non-dominant language, their brain diverts the majority of its resources – including working memory – towards processing that language.

By contrast, interpreters and translators train their brains to keep both the source language and the target language active and enable effective switching between them. They become better at multitasking and dividing their attention efficiently between comprehending source language input, matching source to target and producing the target language output.

Unsurprisingly, interpreting training also builds a larger and more active working memory, since ▷

both source and target language are active during linguistic processing at word, sentence and paragraph level.

In brains handling two or more languages at the same time, frenzied activity takes place. The language centres, Broca's area and Wernicke's area, are alert and ready; the caudate nucleus (part of the basal ganglia) busies itself activating the desired language and ensures that we don't get distracted by other stored languages; and this information is sent to the prefrontal cortex via the thalamus. The prefrontal cortex and thalamus populate the working memory with all possible audio and/or visual cues and discard thoughts that might divert the interpreter's attention to any activity that's not related to the task at hand. Once the person who is being interpreted starts signing or speaking, the caudate nucleus signals the Broca's area and the Wernicke's area to comprehend the cues (both visual and audio) to produce the target language equivalent.

This work is intense and requires considerable mental exertion

The cerebellum is in a heightened state of activity here; it constantly communicates with the language centres and is pretty much on its own when producing continuous and coherent interpretation, because the interpreter needs to focus everything on their work. An interpreter's target language capabilities are so advanced that they can output clear and coherent speech without overtly relying on the usual feedback mechanisms that the brain would usually employ. A robust functional connectivity between the frontal cortex and the language areas also ensures continuous and coherent language output.

As language input, processing and output take place simultaneously instead of sequentially, the working memory is filled almost up to its full capacity, and at any given time up to 70 per cent of the working memory is in use (an average person would be using 20 to 30 per cent of working memory at any given time). This, of course, is intense and requires considerable mental exertion!

What makes us special

As a result of all of this, brain structures not usually related to language processing – the anterior cingulate cortex and basal ganglia – show more activity in interpreters' and translators' brains. These structures regulate the 'executive functions' (such as paying attention, prioritising and problem-solving) flagged up earlier.

It's this, in particular, which makes us different; and, I'd argue, special. This work isn't just a matter of just earning and memorising the lexical, syntactic and semantic aspects of a language. In addition, several linguistic processes take place simultaneously (for instance, searching for the contextually correct terminology, adhering to the grammar norms of the target language, ensuring that the meaning is not lost, and so on). It is a complex, higher-order, problem-solving activity and something that results in continuous improvements to the brain's executive functions.

It continues to amaze me how the brain works: and I've gained a new respect for the profession and my colleagues. This is a higher-order cognitive skill that enhances all faculties of the brain: executive function, reasoning, inhibitory control and motor control.

A simultaneous interpreter's brain undergoes such structural and functional changes that I think these really are superhuman powers. And in addition, this has a positive impact on other aspects of their life too.