'Right Brain' or 'Left Brain' - Myth Or Reality?
By John McCrone
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Turn to the small advertisements in many a Sunday magazine, says John McCrone, and you'll find something rather like this: "Are you good at logic, great at analysis and working out maths problems? Then you're probably a left-brainer . . . Want to get in touch with your intuitive, creative right brain and find a whole other you . . . "

Many a myth has grown up around the brain's asymmetry. The left cerebral hemisphere is supposed to be the coldly logical, verbal and dominant half of the brain, while the right developed a reputation as the imaginative side, emotional, spatially aware but suppressed. Two personalities in one head, Yin and Yang, hero and villain.

To most neuroscientists, of course, these notions are seen as simplistic at best and nonsense at worst. So there was general satisfaction when, a couple of years ago, a simple brain scanner test appeared to reveal the true story about one of neurology's greatest puzzles: exactly what is the difference between the two sides of the human brain? Fortunately, or unfortunately, depending on how you like your theories, the big picture revealed by that work is proving far less romantic than the logical-creative split, intriguingly complex and tough to prove.

The people behind the scanner test, clinical neurologists Gereon Fink of the University of Düsseldorf in Germany and John Marshall from the Radcliffe Infirmary in Oxford, had been pursuing the idea that the difference between the two hemispheres lay in their style of working. The left brain, they reckoned, focused on detail. This would make it the natural home for all those mental skills that need us to act in a series of discrete steps or fix on a particular fragment of what we perceive--skills such as recognising a friend's face in a crowd or "lining up" words to make a sentence.

By contrast, the right brain concentrated on the broad, background picture. The researchers believed it had a panoramic focus that made it good at seeing general connections; this hemisphere was best able to represent the relative position of objects in space and to handle the emotional and metaphorical aspects of speech. So, in a neat and complementary division of labour, one side of the brain thought and saw in wide-angle while the other zoomed in on the detail.

Good response

To test this idea, the pair teamed up with the imaging laboratory at London's Institute of Neurology and scanned the brains of people who were looking at a series of images called letter navons. These are pictures in which a single large letter such as an S is made up of many smaller letters--perhaps a series of Fs (see Diagram, p 29). The researchers asked their subjects to report whether they saw the global image (the big S) or the local elements (the Fs) while a radioactive chemical injected into their bloodstream revealed which side of the brain worked hardest to make each report.

The results seemed beautifully clear. When the subjects concentrated on the small letters, areas on the left side of the brain fired; when they mentally stepped back to take in the overall shape, the right side fired. So wham, bam, and a few months later in August 1996, Fink, Marshall and their colleagues published a neat, tidy paper in Nature (vol 382, p 626). "The study was in the textbooks within a year," says Marshall with a smile. "The only other work that I've done that's got into the textbooks took about twenty years to get there."

Other work appeared to be converging on the same conclusion, which no doubt helped the speedy acceptance of the paper's findings. The popular myth about the hemispheres grew largely from "split-brain" research in the 1960s, such as that which later won Roger Sperry of Caltech a Nobel prize. In a drastic treatment for epilepsy, surgeons had operated on a number of patients by cutting the corpus callosum--the thick bundle of nerve fibres that forms the main connection between the cerebral hemispheres. The surgery revealed what Sperry described as "two spheres of consciousness" locked in the one head, the left-hand side having speech and a rational, intellectual style, while the right was inarticulate, but blessed with special spatial abilities.

Fork or hat?

For example, in a test in which split- brain patients had to match a series of household objects, the left brain would match by function while the right would match by appearance. So, when seeing a cake on a plate, the left brain would connect to a picture of a fork and spoon while the right brain would select a picture of a broad-brimmed hat. This evidence appeared to support the idea of a highly modular brain in which, for example, thinking in logical categories was a strictly left hemisphere function while mental imagery and spatial awareness were handled on the right.

But, says Joseph Hellige, a psychologist at the University of Southern California, this picture changed dramatically as soon as brain-scanning experiments began to show that both sides of the brain played an active role in such processes. Rather, it seemed to be processing styles that distinguished the two halves. Under the scanner, language turned out to be represented on both sides of the brain, in matching areas of the cortex. Areas on the left dealt with the core aspects of speech such as grammar and word production, while aspects such as intonation and emphasis lit up the right side. In the same way, the right brain proved to be good at working with a general sense of space, while equivalent areas in the left brain fired when someone thought about objects at particular locations.

Tests of reaction times also seemed to back up the notion that the two hemispheres differed in their processing styles.

A trick researchers use to ensure that an image goes to one hemisphere first, before crossing over via the corpus callosum, is to flash up a navon in either the extreme left or right of the visual field, from where it passes first to the opposite side of the brain. If the nature of the stimulus and the preference of the hemisphere match up, then the person can respond slightly more quickly and accurately in identifying the local or global letter.

Still more startling, researchers found that the same appears to hold for the brains of chimps and perhaps other primates. The assumption has always been that handedness and brain asymmetry are strictly human traits--part of the great brain reorganisation that allowed our ancestors to use tools, speak and perhaps even think rationally. But handedness is now widely claimed for primates and even birds, amphibians and whales. And in the past few years, psychologists such as William Hopkins of Berry College in Georgia have tested chimps and baboons with navon-type stimuli and suggested their two hemispheres also differ in processing style.

Hopkins carried out reaction tests similar to those performed on humans, but used patterns of small geometric shapes, such as squares, making up a single large shape such as a circle--a local versus global distinction that chimps could recognise. The chimps then had to pick out either the local or global shape from a selection of symbols presented after each trial. He admits that his results are not as clear-cut as those from humans--he could only demonstrate a left brain advantage for local stimuli--but there was some degree of lateralisation.

Hopkins also tested chimps that had been taught to communicate in a picture-based language. He flashed word symbols to one side of the visual field or the other and again measured reaction times. Even though the chimps' language ability was rudimentary, it looked to be the left brain that took on responsibility for handling the "local" task of interpreting meaningful from non-meaningful symbols, says Hopkins (Journal of Experimental Psychology: General, vol 120, p 45). The intriguing conclusion from this work is that a division of labour between the two sides of the brain seems to have been a good thing long before humans came along.

With all this evidence, Hellige says that researchers have come to see the distinction between the two hemispheres as a subtle one of processing style, with every mental faculty shared across the brain, and each side contributing in a complementary, not exclusive, fashion. A smart brain became one that simultaneously grasped both the foreground and the background of the moment.

The next problem was to work out exactly how the brain manages to produce these two contrasting styles. According to Hellige, he and many other researchers originally looked for the explanation in a simple wiring difference within the brain. This theory held that neurons in the left cortex might make sparser, short-range connections with their neighbours, while cells on the other side would be more richly and widely connected. The result would be that the representation of sensations, memories and even motor plans would be confined to smallish, discrete areas in the left hemisphere, while exactly the same input to a corresponding area of the right side would form a sprawling, even impressionistic, pattern of activity.

Supporters of this idea argued that these structural differences would explain why left-brain language areas are so good at precise representation of words and word sequences while the right brain seems to supply a wider sense of context and meaning. A striking finding from some people who suffer right-brain strokes is that they can understand the literal meaning of sentences--their left brain can still decode the words--but they can no longer get jokes or allusions. Asked to explain even a common proverb, such as "a stitch in time saves nine", they can only say it must have something to do with sewing. An intact right brain is needed to make the more playful connections.

Even though this theory has no anatomical backing (just try counting neural connections under a microscope), computer simulations made it seem a decent enough hypothesis. For example, researchers including Robert Jacobs at the University of Rochester, New York, showed that varying the richness and distance of interconnections between neurons in an artificial neural network changes the network's performance. It can be made good at recognising either specific shapes or at grouping shapes generally.

But wiring differences are not the only contender to account for the origin of the brain's hemispheric bias. One of the main reasons why Fink and Marshall's Nature paper attracted so much attention is that it was seen to support a quite different theory: that the bias is orchestrated by "higher" cortex areas.

Visual perception seems to emerge in the brain through a hierarchical process in which "low" areas of the brain send out signals when they detect simple aspects of the image falling on the retina--such as vertical or horizontal lines, or movement in different directions. These signals are then turned into meaningful scenes by "higher" areas. But this is not a passive process. High-level attentional areas can tell low-level sensory areas what they should be concentrating on ("<ns/971213/features.htmlWild Minds", New Scientist, 13 December 1997, p 26). This feedback system can suppress the activity of some cells and increase the sensitivity of others. In effect, the brain can highlight what it wants to see.

Fink and Marshall's experiment appeared to show exactly this. Fink says that areas around high-level regions known to be crucial for directing the brain's attention--the inferior parietal cortex and its junction with the temporal cortex--fired every time attention switched between local and global features.

But they also found flurries of activity at lower levels of the visual cortex--areas known as V2 and V3. These areas on the right side glowed with the effort of seeing the global picture, and the left- side equivalents fired when the demand was to concentrate on local shapes. While brain-scanning images show only that these areas are active, not why, the results fit well with the idea that the brain can direct its attention locally or globally, says Fink.

He now plans to explore this idea using a magnetoencephalography (MEG) system at the University of Düsseldorf that can record the tiny magnetic fields generated by active neurons, and so will be able to follow the exact time-course of events. This should show whether the high-level areas drive the low-level areas into a fleeting state of bias.

But very little about the brain is ever straightforward. And just as a clear picture of locally and globally directed attention was emerging, Marshall had to go and spoil it. He could not resist pushing for a replication--and with a twist. This time, the team used an object navon--an image in which a large shape such as an anchor is made up of smaller shapes such as cups. Naturally, the team expected to get exactly the same result as before.

Marshall remembers the day the results came back and Fink silently handed them over, waiting to see how quickly he would spot that something was very wrong. "Everything went pear-shaped," says Marshall. The pattern of activity was utterly reversed. The scans showed left-brain activation for processing the global picture and right-brain activation for the local elements.

The hot spots were so precisely switched that at first Marshall joked that the subjects must have gone into the scanner lying on their bellies instead of their backs. Then more seriously, he wondered if the image-analysis software had somehow turned positive readings into negatives. But there had been no mistake. The crestfallen team was forced to publish a paper concluding exactly the opposite of their own now famous Nature paper (Proceedings of the Royal Society B, vol 264, p 487, 1997). Then they had to try to find what had gone wrong--the hypothesis or the method. Why should using an object navon reverse the side of the brain that is spurred into activity?

Fink and Marshall have yet to find an answer. They have run a number of further experiments and several more are planned this year. In one unpublished study, they have ruled out differential eye movements as a possible explanation. For a while they thought that subjects might habitually look to one side when picking out smaller shapes and so cause excessive activity on one side. But controlling for that failed to make a difference.

Fink has a strong feeling that the wayward result is something to do with the fact that in the object navon, the local elements are very small--much smaller than the letters making up the letter navons. It could be that the difficulty of discerning such small shapes changes the nature of the task. Instead of the brain increasing the sensitivity of the local pathway, it may be busy inhibiting awareness of the global shape, so apparently creating a metabolic hot spot in the "wrong" hemisphere. This, of course, is speculation and the team plans to run more tests when they find how to match the ease of switching attention between the local and global views of their object and letter navons. This may mean altering the relative sizes of the elements and perhaps using more geometrical shapes.

For some the situation is a mess. The expected result was achieved only to be reversed the following year, leaving the big story about brain lateralisation as far away as ever. But Fink believes the message is quite different. Overall, the bulk of the evidence still suggests that the left brain is orchestrated to a state of local bias, while the right-side processing is tilted towards the global. But just how these attention effects express themselves in terms of the activity of individual brain areas such as V2 and V3 depends rather on the nature of the task, he argues.

Even if attention does shape how the brain chooses to process a signal, it does not mean that the neural wiring theory is necessarily dead, argues Fink. There could still be a wiring bias, formed as the brain develops, that does some coarse initial sorting of the information coming into the brain. Attention would then exaggerate the effect when the call came to focus in a particular way.

Such brain-aching complexities mean that this new line in hemispheric research is still in its early days. But at least there seems no prospect of a return to the old left-right caricatures that inspired so many self-help books exhorting people to liberate their right brains and avoid too much sterile left-brain thinking. As Fink says, whatever the story about lateralisation, simple dichotomies are out. It is how the two sides of the brain complement and combine that counts.