RIGHT LEFT RIGHT WRONG?

An Investigation of Handedness - Some Facts, Myths, Truths, Opinions and Research

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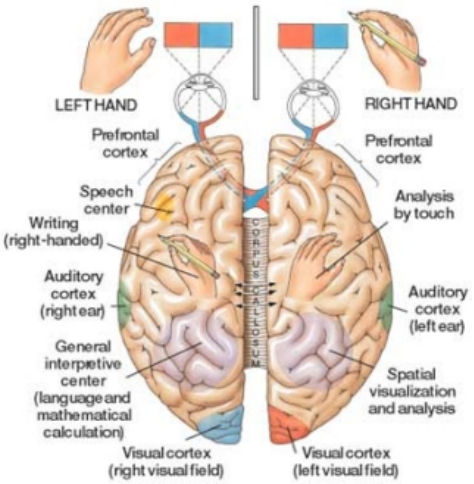
Handedness and the Brain



As is quite well-known, the brain is split into two roughly similar **hemispheres**, separated by the deep longitudinal fissure. Also well-known is that the brain is **"cross-wired"**, with the **left hemisphere** controlling movement on the **right side of the body**, and the **right hemisphere** controlling the **left side of the body**. Most, but not all, of the different structures, lobes and organs of the brain have a left and right hemisphere element, and **communication between the hemispheres** is achieved by means of a thick bundle of nerve tissues known as the **corpus callosum**, which effectively makes a full brain out of two half-brains.

But the two halves of the brain are **not exactly alike**, and each hemisphere tends to have some **functional specializations**, where the neural mechanisms of a particular brain function are localized primarily in one half of the brain. A good example of this is the two areas of the brain where **speech production** and **language comprehension** are processed (known as **Broca's area** and **Wernicke's area** respectively), both of which are usually located in the **left hemisphere** of the brain. **Mathematical, analytical and logical processing** are also usually carried out in the **left** hemisphere, while **spatial recognition, face recognition, sense perception, emotion processing and artistic functions** usually occur in the **right**. This **lateralization** and specialization of different areas of the brain is much more marked in humans than in animals, and becomes increasingly marked as we progress for early childhood to adulthood.

Handedness and Language Processing

It was the French physiologist **Paul Broca** in the 1860s (as well as his less well-known countryman and near contemporary, **Marc Dax**, almost 30 years earlier) who noted that, at least in general terms, a person's handedness tends to indicate a **specialized hemisphere on the brain's opposite side**, so that a right-handed person probably has a left-hemisphere **language specialization**, and *vice versa*. Indeed, for almost a century, until the **Wada test** (a technique involving the anaesthetizing of one side of the brain using a drug such as sodium amytal or sodium amobarbital) was introduced in the 1960s, a person's handedness was just about the only clue an operating **neurosurgeon** had about which hemisphere of a patient's brain was probably the one **specialized for language**.

Following Broca's findings, it was initially assumed that **handedness and the hemispheric dominance of speech processing** were inextricably and intimately connected. However, it soon became apparent, even to Broca, that **exceptions and mismatches** existed, and that perhaps the association was **not as fixed** as he had initially thought. Although the incidence of right-hemisphere language dominance **does** increase more or less linearly with the degree of left-handedness, it turns out to be not quite as simple as that.

In fact, after the work of Springer & Deutsch, Damasio & Damasio, and others in the 1990s, we now know that, although about **95% of right-handers** do have **left-hemisphere dominance for language functions**, only around **19% of left-handers** have **right-hemisphere language dominance**, with another **20%** or so processing language functions in **both hemispheres** (the incidence of language distribution in **ambidextrous people** is broadly similiar to that found in left-handed people). Other studies report percentages for left-handers of 70%, 15% and 15% (rather than 61%, 19% and 20%), but the finding all suggest that, perhaps unexpectedly, some **60% - 70% of left-handers process language in the left hemisphere**, just like right-handers! Indeed, around 93% of all people have left hemisphere language dominance.

Brain Hemisphere Differences

In the **"standard"** right-hander's brain, the dominant left hemisphere is **physically larger and more developed**. In particular, **Broca's area** and **Wernicke's area** are significantly larger (up to three times larger) on the left side. The **primary motor cortex** - the brain region most directly involved with movement control - is also bigger, denser and more sensitive in the left hemisphere of the standard brain. The more developed motor cortex in the left hemisphere of right-handers is also marked by a deeper and more dramatically folded **central sulcus** (the deep groove between major folds of the brain). In fact, the left hemisphere is typically **altogether more complex**, with a greater cell-packing density, and its neural links more tightly connected, leading to a **faster response time** and a greater facility to process rapid stimuli.

Interestingly, though, the brain of a left-hander is **not just a mirror image** of a right-hander's brain. With left-handers, the motor cortex does tend to be larger, and the central sulcus deeper, in the opposite right hemisphere than the left to some extent, as might be expected, but the differentiation is **not as marked** as with right-handers. In fact, the brain hemispheres of left-handers tend to be much **more symmetrical and balanced** than those of right-handers, and the differences between the hemispheres less pronounced.

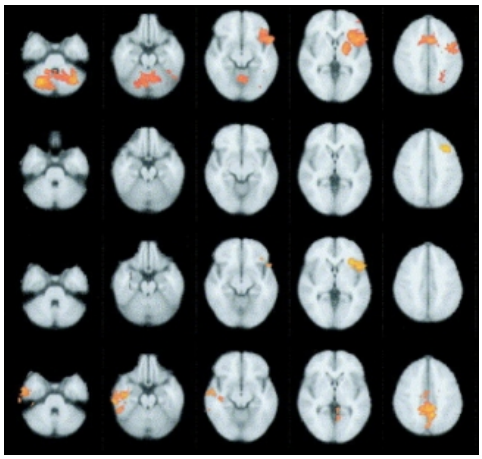
With improvements in neurological techniques in the 1950s, and particularly with **Roger Sperry**'s ground-breaking **"split-brain" experiments** of the 1960s and the practice of anaesthetizing one side of the brain using the **Wada test**, it became possible to pinpoint with ever increasing accuracy the various functions of specific parts of the brain. Many of the **generalizations, simplifications and myths** about handedness (e.g. that left-handers are inventive, artistic and emotional, while right-handers are typically logical, analytical and cool) had their genesis during this period.

The advent of **functional Magnetic Resonance Imaging (fMRI) scanning** in the 1990s has enabled our picture of the way the brain functions to be sharpened still further. But, rather than clarifying the situation, recent research has if anything muddied the waters still further, and it seems that the more we find out the less clear-cut brain lateralization appears to be. For instance, Dutch research in 2009 showed that **face recognition**, normally a right hemisphere function, usually occurs in the left hemisphere of left-handers. However, the research also showed that the ability to **order or sequence a list of manual activities** appears to be an exclusive specialty of the left hemisphere, **regardless** of whether a person is left- or right-handed. Other findings appear to have little or no logic to them. For example, there is some evidence that **women** in general tend to process language **more evenly** between the two hemispheres (which also seems to fly in the face of the finding that more men than women are left-handed).

It is also becoming clear that there is a certain amount of **redundancy** built in to the brain's systems. For instance, one eye is able to perceive **both sides** of a view if necessary; most but not all of one side of the body may be **paralyzed** after a one-sided brain injury; etc. In fact, if a **whole brain hemisphere** is removed at a young age, this redundancy and the brain's innate **plasticity** can mean that higher mental functions can develop almost completely **unimpaired**.

Thus, it appears that, while there may be some **general rules** about hemispheric function specialization, the actual situation is **much more complex** than we ever thought. Rather than firm rules, they should be seen more as indicators, and the **plasticity and complexity** of the brain appears to allow for **significant variation** from these indicators.

The Wiring of the Left-Handed Brain



Although most left-handers may still have strong left-hemisphere dominance, the **"wiring"** of the brain is perhaps **less strict and confined** than in the case of most right-handers, and even everyday tasks can generate activity in unexpected places in the brain, exhibiting what British psychologist **Chris McManus** calls **"random cerebral variation"**. In fact, left-handers and mixed-handers in general tend to exhibit **more varied, unpredictable and diffuse cerebral activity** than right-handers, even if their overall brain organization largely follows the more "standard" right-handed model.

The **language functions** of left-handers in particular are more diffuse and less restricted to one hemisphere than those of right-handers. In fact, **Dr. Dan Geschwind**, who pioneered brain comparison studies between twins, suggests that this distribution of language functions across the hemispheres in left-handers may actually put them at some risk from **neurological disorders** such as **dyslexia**, although it may also afford them **some advantages**. For example, **left-handed war veterans** recovering from brain injuries are more likely to regain speech and movement quicker than right-handers, perhaps due to the left-handed brain's greater **"plasticity"** (its ability to reconfigure itself and its neural connections).

Interestingly, in the brain of **"converted right-handers"** (natural left-handers who switched to the right, usually at a young age), most of the activity in the **motor and sensory integration input** occurs in the left hemisphere of the brain, the same as for most innate right-handers. But there also appears to be significant activity in **"hot spots"** in the motor, sensory-somatic and audio-visual perception areas of the right hemisphere, which some scientists have interpreted as the brain's attempts to **suppress** unwanted left-hand movement, suggesting that the brain is perhaps more **hard-wired** for handedness than previously thought.

Another promising model for hemispheric simplification was put forward by the British-German team of **John Marshall** and **Gereon Fink** in the 1990s. They posited that the left hemisphere of the brain focuses on **detail** while the right hemisphere is more concerned with the **broad background picture**. Thus, the left brain (and, by extension, it may be argued, a right-handed person) is better adapted to mental skills requiring a series of **discrete steps** or to focus on a **small fragment** of what we perceive. The right hemisphere (and a left-hander), on the other hand, is better able to represent the **relative position** of objects in space and to handle the **emotional and metaphorical aspects** of speech. Initially, the model had **strong experimental support**: when looking at a **"navon"** (for example, a large letter "R" composed of many small letter "L"s), focusing on the small "L"s triggers activity in the left hemisphere, while focusing on the large "R" predominantly creates mental activity in the right hemisphere. However, inexplicably, if the navon is **object-based** (e.g. a large anchor shape made up of many small cup shapes), the **exact opposite** brain activation pattern occurs. It appears that little about the brain is ever straight-forward.

Whatever a person's handedness, the **non-dominant hand** also needs to have a fairly active motor-output centre in the brain, especially as many **two-handed activities** actually require quite complex manipulation of both hands (think of playing a violin, for example, or even peeling a potato). Modern fMRI imaging has shown the extent to which **both hemispheres** are involved in almost all activities, often in different ways but usually working together simultaneously. One possible explanation for the more balanced hemispheres in the brains of left-handers, then, is that they are **more likely to use their non-dominant hand** than right-handers in order to cope with right-handed tools, appliances, etc.

The Function of the Corpus Callosum

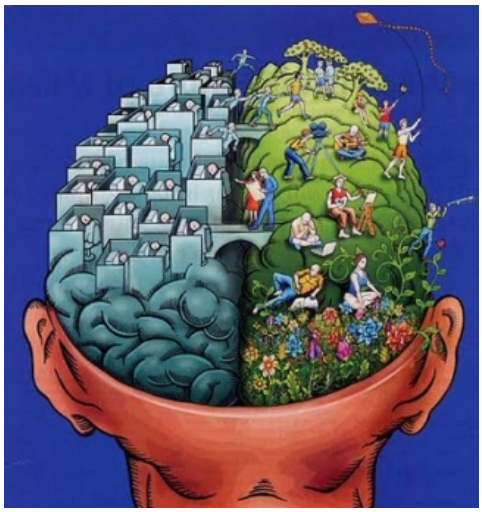
Given that, as we have seen, many (if not most) activities require **both hemispheres**, at least to some extent (e.g. the right hemisphere remembers musical melodies, but rhythm and absolute pitch comes from the left hemisphere; sexual arousal activates the right hemisphere, but the involuntary sexual response occurs in the left; etc), the **corpus callosum** becomes of paramount importance.

Some studies suggest that left-handers and mixed-handers have a physically **thicker and more developed corpus callosum** connecting the two hemispheres, in order to facilitate the additional **inter-hemispheric communication** or **"cross-talk"** their brain organization requires.This has been dramatically illustrated in patients whose **corpus callosum has been severed** for medical reasons, and whose right hand can make neat well-formed drawings but with no concept of **three-dimensional space or perspective**, while their left hand can only make messy malformed figures that neverthless exhibit a complete understanding of three-dimensional space and form.

It should perhaps come as no surprise, then, that **musicians** who play two-handed **wind and string instruments** are much more likely to be **mixed-handed or left-handed** than the average citizen. Piano players, on the other hand, need their two hands to act **independently**, and so accomplished pianists are more likely to have **one dominant hand**, whether it be left or right. As an interesting aside, there is at least **anecdotal evidence** that left-handed pianists have more trouble keeping **rhythm** (rhythm is typically controlled by the left-side of the brain).

As psychologist **Stephen Christman** points out, though, there are **potential drawbacks** to having a highly developed corpus callosum. Part of the job of the corpus callosum is to **filter out cross-talk** in order to **prevent stimuli overload**, so the elevated levels of hemispheric interaction in left-handers and mixed-handers can lead to more trouble with tasks requiring **multi-tasking and independent processing** by the hemispheres (for example, the childhood game of simultaneously patting and rubbing the tummy, interpreting the word "blue" written in green ink, etc).

Stereotypes and Simplifications



The corollary of all this complexity and inconsistency is that many of the **common claims and stereotypes** regarding handedness (and left-handedness in particular) arise from a **simplified, outdated and unrigorous view** of the left-handed brain which is just not borne out by the findings of modern science. The brain organization of left-handers **may or may not** manifest itself in the kinds of **advanced intuitions and outside-the-box thinking** that are often claimed for them, although such leaps of imagination may of course occur (as indeed they may in right-handers).

The psychologist **Stanley Coren** was particularly influential in establishing some of these stereotypes. He described **two modes of thinking**: one he called **convergent** ("a fairly focused application of existing knowledge and rules to the task of isolating a single correct answer"), which he associated with the **right-brain dominant left-hander**; and the other he called **divergent** ("moves outward from conventional knowledge into unexplored association"), which he associated with the **left-brain dominant right-hander**.

Ed Wright, in his popular but rather suspect book *A Left-Handed History of the World*, goes further in listing among the **dominant traits** of left-handers: intuition, empathy, visual-spatial ability, lateral thinking, hot-temperedness, solitariness, iconoclasm, risk-taking, experimentalism and fantasy. All this is presented in a **pseudo-scientific** manner but, given that Wright also **incorrectly** identifies several famous left-handers in the book, all of this should be taken with a **pinch of salt**, and merely indicates Wright's apparent ability to find "typically" left-handed traits in individuals who are actually right-handers.

Any kind of **left brain-right brain dichotomy** of this type is at best a **gross simplification**. But, more importantly, as we have seen above, linking handedness with **hemispheric brain dominance** is even more suspect in the light of recent research which shows that, contrary to earlier assumptions, **only about 20% of left-handers have right-hemisphere language dominance**. Thus, while left-handers may be largely right-brain dominant in terms of **motor control**, this may or may not be associated with any of the commonly-claimed **right-brain attributes** (such as intuition, creativity, imagination, etc), which themselves may not be as rigorously associated with the right hemisphere of the brain in the first place.

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