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How does the brain know what the right hand is doing?

A new experiment has shed more light on the multi-decade debate about how the brain knows where limbs are without looking at them.

You don't have to watch your legs and feet when you walk. Your brain knows where they are. For decades scientists have debated two options for how the brain achieves this:

(1) the outflow hypothesis says that the brain monitors signals it sends to the muscles telling them how strongly to contract, and uses this to predict where the limb has moved to;
(2) the inflow hypothesis suggests that the brain relies on information from sensors within tissues that say how far a limb has moved.

While there has been plenty of evidence that inflow plays a role, no one before has been able to show definitively that outflow is also important.

Now research just published in The Journal of Physiology provides evidence that outflow is involved. Working at the Prince of Wales Medical Research Institute in Sydney, the Australian research team asked subjects to sit at a bench and place their right hand through a screen so they couldn't see it. The hand was clamped so that the researchers could move it, but the subjects could only push against a fixed plate. The researchers then moved the hand and the subjects had to say which way it was pointing. The researchers then asked the subjects to push against the plate, and say where they thought the hand had moved to. The researchers inflated a cuff around the arm, cutting off blood flow and temporarily paralysing and anaesthetising the arm. They then repeated the tests.

Before the cuff was inflated, the subjects accurately indicated where their hand was pointing, both when they were resting and when they were pushing against the plate. After the arm was paralysed and anaesthetised, the subjects were unable to detect

when researchers moved their hand, but incorrectly thought that they were still able to move it themselves when they tried to push against the plate.

'The fact that the person thought they had changed the position of their paralysed hand, even though they hadn't, shows that the perception of limb position is at least partly driven by outflow commands going to the muscles. There were no incoming signals from receptors, so this cannot have been responsible for the illusion,' says Dr Janet Taylor, one of the authors of the paper.

The experiment provides a new and intriguing illusion that sheds light on how we learn to move accurately, as well as indicating why some people who have had limbs amputated still feel as if they can move their 'phantom' limb.

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