News

the BIG ask

What is TMS and how can it be used? We found out from a scientist who uses the technique in his daily research

Rogier Mars using TMS to stimulate the brain of a volunteer

Rogier Mars lectured on neural interactions during action reprogramming and their related white matter pathways at the Magstim TMS Summer School in Oxford last year. Part of his research involves using transcranial magnetic stimulation to study the neural mechanisms of decision making, action selection, and social interaction.

We caught up with Rogier – a research fellow from Matthew Rushworth's group in the department of experimental psychology at the University of Oxford – to find out a bit more what he's been up to since the summer.

LN What is transcranial magnetic stimulation?

Transcranial magnetic stimulation (TMS) is a technique to briefly and non-invasively stimulate a small group of neurons in the brain. It was first developed by Anthony Barker in Sheffield. TMS works on the principle of electromagnetic induction. We place a coil over the scalp of a volunteer, above the brain region we would like to stimulate. An electric current through this coil creates a brief magnetic field underneath the coil, which in turn causes a very weak electric current in the brain, sufficient to activate the neurons directly underneath the coil. For instance, if we hold the coil above the part of the brain that controls the movement of your hand muscles, it produces a small twitch in your hand.

LN How do you use it in your work?

By activating a select part of the brain this way and measuring the effects on activity in other parts of the brain, we can examine which other brain areas our area is 'talking' to and how it influences activity in those other areas.

LN What are your main research interests?

I am interested in how different parts of the human brain interact with one another. We know that the brain consists of a large number of regions that each have a relatively specialised function. However, to produce our behaviour, these brain regions need to pool their work together, without the help of a central director. As neuroscientist Randy McIntosh once described this: 'The brain works as an orchestra without conductor'. The challenge is to find out how the brain achieves this feat.

LN What are you currently working on?

Imagine you're driving home from work. It's probably a route you drive most days and you can do it completely on auto pilot. Most of the time you arrive home without actually remembering much of the journey. Now imagine there's an unexpected diversion on your route. Suddenly your auto pilot isn't good enough anymore and you have to divert attention from your day dreaming and pay attention to the road.

In my work I use TMS to try to examine how the brain achieves this switch from a fully automatic process to concentrated non-routine work. To do this, we ask volunteers to perform a computer task in which most of the time they have to simply press some buttons in response to information on the screen; quite a boring task that doesn't require much effort. Every now and then, however, the task becomes a bit more difficult and they need to divert their attention to it. We know the frontal part of the brain has a role in signalling that this change is needed. We use TMS to try to find out how the frontal part of the brain communicates this need to the motor cortex, the part of the brain that is concerned with performing the computer task. To do this, we apply brief pulses of TMS to the frontal cortex and measure their effects on the motor system.

Once we've established that there is ongoing communication between these brain areas we use another technique, diffusion-weighted magnetic resonance imaging, to explore which routes the signals from the frontal cortex take to the motor system. Using this technique, we recently found that the frontal cortex talks to the rest of the brain via multiple routes, a direct route through the cortex and a longer route via evolutionary older structures. This way, we can get try to get a map of the nodes of the brain network involved in any particular task and how, when, and via which routes they communicate.