Transcranial Magnetic Stimulation (TMS): Brain Science Breakthrough.

By Max Sutherland

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Everyone knows about brain scanning, but most of us have never heard of a new device called transcranial magnetic stimulation (TMS). Non invasive and painless, it can temporarily inactivate an area of the human brain to let brain scientists study the effect.

TMS at Bern Germany

Twenty years ago we began the scientific dream of peering into the human brain while it is working. Brain scanning devices such as fMRI and PET scans can pinpoint precisely which brain regions are active as people respond to stimuli (including brands and advertisements) or as they go about making decisions (including brand choices).

It is fascinating to see just what areas of the brain light up in response to a stimulus or a particular decision task but still we have to ask, what exactly can we conclude from this? Because an area of the brain lights up doesn't mean that it is causal in that behaviour or decision. After all, ice cream sales correlate with drownings but they don't cause them. You cannot conclude causality from correlation because there is no way of knowing if some other, unaccounted-for variable (like weather) may be involved. To sort out causality you need to be able to do experimentation.

Brain scientists must do more than just observe the brain at work; they have to be able to experiment on it, but there are definite limits to the extent that brain scientists can intervene with, and physically play around in, someone's brain.

Now, this limitation has been partly lifted by a breakthrough in technology in the form of a device that can harmlessly and temporarily knock out targeted brain areas and thereby help brain scientists sort out causality. It is called Transcranial Magnetic Stimulation (TMS)**.**

TMS at Princeton

TMS uses a powerful magnetic field to stimulate or inhibit areas of the brain. It requires the generation of an electromagnetic signal at a specific frequency, and a coil to focus that magnetic field on a specific brain region. The stimulating coil is held close to the scalp so that the field is focused and can pass through the skull. What is felt is merely a kind of tapping on the skull as the current starts to flow.

The magnetic field used in TMS can temporarily knock out a brain function or artificially stimulate one. It appears that low frequencies (lower than 1 Hz) inhibit brain activity, while higher frequencies stimulate the targeted brain area, although no one is sure why.[1] After magnetic stimulation of a brain region, even at higher frequencies, an area usually becomes temporarily unresponsive to the normal input from the rest of the brain. So with this newer technology, instead of merely watching the brain in action, experimenters

can intervene to transiently inactivate an area and evaluate the behavioural consequences. This enables researchers to more easily test hypotheses about the human brain.

Although TMS devices have been around since 1985, it is only recently that it has become possible to use TMS simultaneously with other brain scanning techniques. It can now be used in combination with these, and this means we can examine the brain at work with (fMRI or PET) brain scanning while simultaneously applying TMS to knock out a key brain area and watch the effect. In other words, it gives us more in insight as to what role that part of the brain seems to be playing.[2]

A Potential Therapeutic Tool

TMS is more than an exciting research tool; it is also shaping up as a treatment tool for some psychological problems. For example, by applying it to the temporal lobes (just above the eyebrows) it alters a person's mood. Applying it above the right eyebrow produces euphoric happiness while above the left eyebrow produces apathy and sadness.[3] There is considerable research under way to turn this from a temporary effect into a longer lasting treatment for depression.

Mind Control

People understandably worry about the prospects of mind control with such brain science techniques and their fears seems justified when claims for the techniques are subjected to commercial hype often by consultants wanting to sell their services. TMS is currently only possible if a volunteer's head is in close contact with the magnetic source so why should we be afraid of mind control with it? The answer according to Steven Rose, the noted British professor of biology writing in The Observer (5th Feb. 2006), is that TMS at a distance is now under active military investigation.[4]

TMS can be used to prevent people from seeing a visual stimulus[5], make it hard for them to speak, or induce involuntary movements. Pulses directed to different spots on the motor cortex can make a thumb twitch, an arm jerk, or a leg kick[6]. If TMS application at a distance becomes a possibility, it could potentially be used by the military to disable an enemy by controlling their mood, vision, or physical responses.

It is also easy to see how it could be used unscrupulously to make converts and win recruits to almost any 'spiritual' cause. In the laboratory, the work of Michael Persinger showed that TMS stimulation of the right temporal lobe results in people reporting a "sense of presence."[7] This "sense of presence" is sometimes experienced as the presence of God or angels or something else supernatural. Imagine what targeted TMS could do for a recruiting rally for fundamentalist causes, an Islamic Jihad rally or a modern Billy Graham type evangelical crusade.

All this of course is only *imaginary* provided TMS cannot be delivered at a distance, and hopefully it will never eventuate.[8] However, if the military's current quest does succeed, we will certainly need non-proliferation policies and laws to severely curtail its use, both inside and outside the military.

Stimulating Creativity

Besides the potential to treat depression mentioned above, there is a further application - perhaps the most exciting for this new technology. The evidence is growing that TMS can be used to stimulate creativity in a most fascinating way.

About 10% of all autistically handicapped people are said to exhibit some type of extraordinary savant-type ability. Think of the movie Rain Man and the autistic savant character Raymond, played by Dustin

Hoffman, who was capable of memorizing entire phone books. Professor Alan Snyder at the Centre for the Mind in Sydney believes that not only autistic savants have these extraordinary abilities, but that everyone does. However, he suggests that in normal people it is suppressed by the other natural forces involved in the brain's operation. Snyder uses TMS to try to recreate the same brain state in normals that is observed in autistic savants and so stimulate the same type of creativity.

The mental handicap of autistics means less competition between internal brain functions. Snyder's theory is that in normal people, the competition that takes place between various brain functions as they compete for our limited mental resources is what prevents our savant type abilities from emerging. All this sounds rather counter-intuitive until you think of how people, who after they lose their eyesight, can develop compensatory supersensitive hearing as a result. Snyder believes that by temporarily inactivating some parts of a person's brain and lessening the competition, the other creative parts are temporarily enabled to soar more freely. It all sounds quite fanciful until you see some of the results achieved by his Centre for the Mind in Sydney. Hooked up to the TMS machine, 40 percent of test subjects are said to exhibit sometimes extraordinary, newfound, mental skills and usually within about 15 minutes.[9]

Conclusion:

So - a treatment for depression, a tool for war, or a chance for us all to exhibit our more creative side? You decide. However one thing is for certain. TMS is an exciting breakthrough in brain science that you are going to be hearing a lot more about.

"The future's already arrived; it's just not evenly distributed yet."
William Gibson (science-fiction writer.)

Notes/References:

[1] http://www.erowid.org/spirit/devices/devices_article1.shtml
[2] It has already revealed that the TMS effect is not confined necessarily to one part of the brain. It can spread. The effects depend on whether two regions are communicating at the time of TMS or not. See http://www.newscientistjobs.com.au/insider/article.action?article.id=insider156&focusId=usa
[3] http://www.erowid.org/spirit/devices/devices_article1.shtml
[4] Funded by DARPA, the Defence Advanced Research Projects Agency, the research department of the Pentagon and the US army. See http://www.fondationroibaudouin.be/files/db/EN/PUB_1466_Connecting_Brains_society.pdf
[5] Noticing change critically depends on activity in the parietal cortex. When that region of the brain is effectively switched off by TMS, 'change blindness' (a failure to notice large changes in a visual scene) occurs. http://www.sciencedaily.com/releases/2005/08/050824081237.htm
[6] http://www.erowid.org/spirit/devices/devices_article1.shtml
[7] Chris McGillion, Sydney Morning Herald, 29 April 2003 "Religion Versus Science Might Be All in the Mind"
[8] However, I am mindful that when Radio Frequency ID tags were first developed, they could be read by a scanner no more than a meter away. Now they can be read at 20 meters or more. (See Wake Up Call: The future of RFID is dawning.)
[9] For example, within 15 minutes, a number of subjects seem to be able to sketch-draw in dramatically better fashion than they can when the TMS is switched off. See http://www.cognitiveliberty.org/neuro/TMS_NYT.html)