Transcranial Magnetic Stimulation.

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The brain has always been a very complex and mysterious organ. A new area of study has emerged involving how the brain operates like an electrical circuit through neural impulses, and how these impulses can be manipulated through magnetic field stimulation (b-field stimulation). Through experimentation with Transcranial Magnetic Stimulation (TMS) it has been found that the neurons of the brain can be altered creating a depressive/excitatory response using magnetism.

TMS involves a non-invasive magnetic device to dispense the magnetic field, unlike many other electrical stimulatory procedures which involve implanted probes. This paddle shaped device has the potential to transmit a b-field intensity of 1.5 Tesla. In comparison to the earth's magnetic field of $< 10^{-4}$ Tesla, TMS is 10,000 times greater in intensity. TMS uses an extremely powerful, rapidly changing and focused magnetic wave in which bone and skin does not effect. Due to its power it is only active for a burst one microsecond in duration. A similar device, repetitive TMS (rTMS) follows the same idea but uses multiple controlled bursts.

Due to the nature of magnetic waves, the distance it can effect is proportional to its power. In this case, the device can only penetrate 2-3cm into the cortex of the brain. Research is being conducted into deep TMS to treat such diseases as Parkinson's. It was found that attempting to go deep into the brain with TMS with the available technology causes discomfort and more seriously, seizures.

The device transmits a magnetic wave into a specific area (varies with treatment) and stimulates resting nerve cells, inducing small electrical currents within them. It is found that stimulating a neuron with low frequency electrical signals can produce long-term depression (LTD) which diminishes the efficiency of intercellular links. In comparison, high frequency excitation over time can generate long-term potentiation (LPT). These cell level behaviors are involved in learning, memory and dynamic brain change. It is believed that by altering certain areas TMS can be used to treat/re-teach damaged cells from a stroke, or tone down overactive areas causing such things as epilepsy.

TMS has shown promise in everything from treating severe depression to having uses in stroke patients. The Defense Advanced Research Projects Agency (DARPA) are investigating rTMS to energize sleep deprived individuals to perform better, such as military pilots involved with long flights. TMS is currently used in European nations, and is under consideration with the FDA for approval in this country.

-http://www.musc.edu/tmsmirror/intro/layintro.html

-http://www.ists.unibe.ch/sciam.pdf

-http://web.sfn.org/content/Publications/BrainBriefings/BrainBriefings_Feb2002.pdf