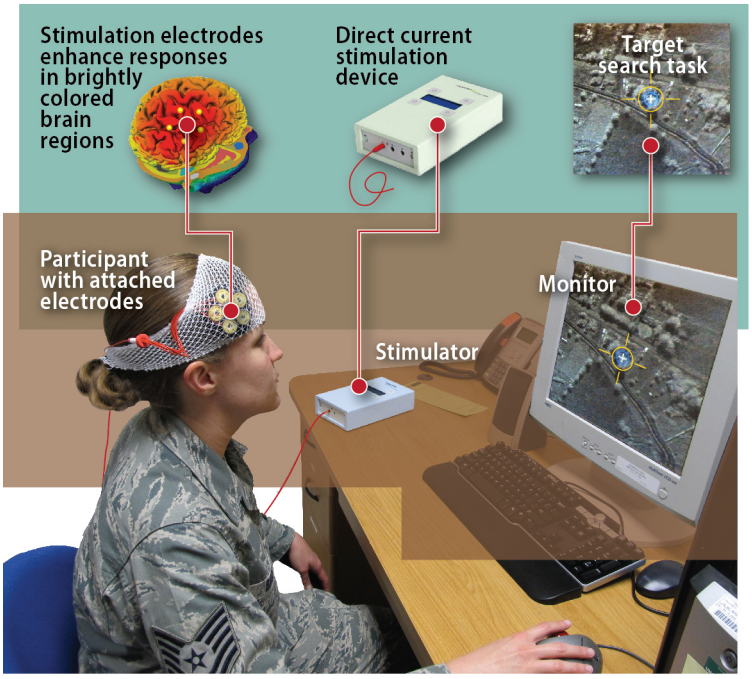
The Mind RESEARCH NETWORK
For Neurodiagnostic Discovery

Hello! Thanks for your interest in the work in our lab. Let me tell you about what we have done so far and what we haven't done yet. In short, the work in our lab has focused on augmenting the abilities of healthy individuals. We have expertise in deciphering how brains work using sophisticated neuroimaging techniques and advanced data processing methods. We apply these methods to learn about the mechanisms of learning and memory in the brain. We have developed methods to enhance training by altering brain physiology naturally (by structuring sensory inputs) or unnaturally (with TDCS and other brain stimulation methods). We believe that TDCS holds great promise. However, our laboratory has not demonstrated TDCS to be an effective treatment for any brain disorder.

What we have done:

Safety: At present, we have tested the effects of TDCS (transcranial direct current stimulation) on more than 500 healthy human subjects. With our technique and carefully trained technicians, TDCS is very safe. Only one person showed any adverse effects of TDCS (panic attack). TDCS is often applied with moistened sponges. This can cause redness and burning of the skin in some people. We developed a safer method of TDCS that uses EEG electrodes and a conductive gel, as seen on the episode of "Through the Wormhole". These electrodes are not yet available to the public, but we are working on it. We invested a huge amount of time into ensuring that our techniques were safe. However, not everyone out there who is trying to sell TDCS has done their homework in terms of safety. I strongly caution you against do-it-yourself TDCS. If used improperly, TDCS can cause severe burns to the skin. I have scars from testing different kinds of electrodes on myself during the development of our electrode array.



Stimulation with TDCS enhances the brain responses to the image being viewed, enabling more rapid memory formation.

Strategy: Neuroscientists know a lot about how different parts of the brain respond to highly simplified stimuli or tasks. For example, a part of the brain that is roughly midway between the top of the ear and the center of the forehead is called the dorsal lateral prefrontal cortex (DLPFC). We know that if you are asked to remember information for a short period of time, the activity in the DLPFC increases while you are actively remembering, and decreases when you are no longer trying to remember. In a typical task like this, a subject is shown a few numbers or letters and after some delay, is asked if a letter or number they

Pete & Nancy Domenici Hall
1101 Yale Blvd. NE
MSC11 6040
Albuquerque, NM 87131
505-272-5028
www.mrn.org

remember is on the computer screen. However, this is very different than detecting threats in complex grainy images. Before we began the studies, the parts of the brain that worked together to perform this task were unknown. We used three techniques to examine the brains of individuals engaged in searching for targets in complicated images; magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI), and magnetoencephalography (MEG). fMRI and MEG measure the brain activity while MRI gives a picture of the brain structure. By combining these techniques, we can see both when and where things happen in the brain during complicated tasks like image analysis. These analyses were used to examine the brain while subjects performed an image analysis task as a novice and - after some training - at an expert level of performance. We looked at the differences between the subjects in their novice and expert states to determine the parts of the brain that changed when a person became an expert. We then targeted the areas that change the most between novice and expert for stimulation with TDCS. This strategy proved quite effective. However, moving the electrode to target different brain locations was not effective. Compare this to the do-it-yourself strategy for TDCS: place an electrode at some location on your head for all tasks. I am quite certain that this "one size fits all" strategy for brain stimulation with TDCS will find limited success and might even be detrimental.

Results: Under laboratory conditions, we can accelerate learning by a factor of two. This means that people who received TDCS, combined with training, learned twice as much as those who were not stimulated. This effect appears to be bigger in people who are learning something for the first time compared to people who have some previous training. Further, TDCS combined with training helps people to achieve a higher level of performance than those who are not stimulated. We can also inhibit learning and memory by changing the position or polarity of the electrodes. These effects on memory last for at least hours after the stimulation is turned off. However, when subjects who received stimulation were retested one month after training, we saw no enduring enhancement on performance. We have tested a variety of electrodes to create a procedure that can safely apply TDCS to individuals for up to 30 minutes at a strength of 2 mA once per day. The safety of uses for longer durations or repeated uses within a single day is not known. We have also noted that TDCS changes the way brain areas communicate with one another. This change has been observed in both brain structure and function. The duration of these changes in brain structure and function continue for a period of minutes to days after the stimulation is turned off. Thus, 30 minutes of stimulation may provide benefits that last up to an hour. Additional detail about the results described above can be found in the following papers:

Bullard, LM, Browning, ES, Clark, VP, Coffman, BA, Garcia, CM, Jung, RE, van der Merwe, AJ, Paulson, KM, Vakhtin, AA, Wootton, CL, Weisend, MP. Transcranial Direct Current Stimulation's Effect On Novice vs Experienced Learning. Exp Brain Res. 2011 Aug:213(1):9-14. PMID: 2170600.

Plis SM, Weisend MP, Damaraju E, Eichele T, Mayer A, Clark VP, Lane T, Calhoun VD. Effective connectivity analysis of fMRI and MEG data collected under identical paradigms. Comput Biol Med. 2011 May 16. PMID: 21592468.

Pete & Nancy Domenici Hall
1101 Yale Blvd. NE
MSC11 6040
Albuquerque, NM 87131
505-272-5028
www.mrn.org

Plis SM, Calhoun VD, Weisend MP, Eichele T, Lane T. MEG and fMRI Fusion for Non-Linear Estimation of Neural and BOLD Signal Changes. Front Neuroinformatics. 2010 Nov 11;4:114. PubMed PMID: 21120141.

Clark VP, Coffman BA, Mayer AR, Weisend MP, Lane TD, Calhoun VD, Raybourn EM, Garcia CM, Wassermann EM. TDCS guided using fMRI significantly accelerates learning to identify concealed objects. Neuroimage. 2012 Jan 2;59(1):117-28. PMID: 21094258.

Coffman BA, Trumbo MC, Flores RA, Garcia CM, van der Merwe AJ, Wassermann EM, Weisend MP, Clark VP. Impact of tDCS on performance and learning of target detection: interaction with stimulus characteristics and experimental design. Neuropsychologia. 2012 Jun;50(7):1594-602. PMID: 22450198

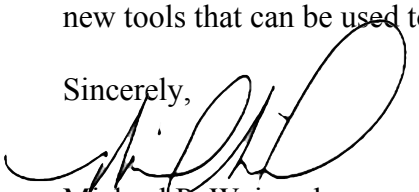
What we have NOT done:

Moving TDCS from the laboratory to the clinic is a complicated problem. It requires trained PhD scientists, like myself, and medical doctors working together to ensure that the effects of TDCS are positive and safe. We have thought long and hard about moving TDCS to clinical practice and are gaining ground in on two common problems: age related memory decline and attention deficit hyperactivity disorder (ADHD). We have also proposed to do work using TDCS in aiding the recovery from traumatic brain injury and in treating autism. Our work on these problems is only beginning. It is too early to tell if our work will bear fruit or not. However, there are other laboratories that focus on the use of TDCS for treating clinical disorders. To find out the latest, you can look up the following article:

Brunoni AR, Nitsche MA, Bolognini N, Bikson M, Wagner T, Merabet L, Edwards DJ, Valero-Cabre A, Rotenberg A, Pascual-Leone A, Ferrucci R, Priori A, Boggio PS, Fregni F. Clinical research with transcranial direct current stimulation (tDCS): Challenges and future directions. Brain Stimul. 2012 Jul;5(3):175-95.

Again, thank you for your interest in our work and for allowing me the opportunity to share information from our laboratory about the neuroscience of learning and memory. I look forward to answering additional questions you may have. Please note, however, that I am a scientist, not a medical doctor. Be forewarned that I am not qualified to comment on any medical problem from which you or a loved one is suffering. Likewise, I am unqualified to comment on any treatment that you may be receiving. That said, my colleagues and I continue to work tirelessly to provide medical doctors with new tools that can be used to combat brain disorders.

Sincerely,



Michael P. Weisend
The Mind Research Network

Pete & Nancy Domenici Hall
1101 Yale Blvd. NE
MSC11 6040
Albuquerque, NM 87131
505-272-5028
www.mrn.org