Neuroethical Considerations Regarding **Transcranial Magnetic Stimulation**

1. **Introduction**

Neuroethics is quickly becoming a popular area for philosophers, neuroscientists and psychologists. In addition to specialized conferences, the editor-in-chief of the journal *Science* recently announced the "arrival" of this field of study (Kennedy, 2004). Within the broad area of neuroethics lie many ethical issues surrounding neurocognitive enhancement. Some of these issues are common to other discussions of enhancement technologies generally, such as issues of distributive justice and safety, while some are perhaps of unique importance to neurocognitive enhancement. For example, in manipulating a person's brain to alter their cognitive abilities, it is important to consider issues of privacy that present themselves. There are also important questions about personhood and what it is about certain cognitive and behavioral achievements that make them valuable. In a brief perusal of some of these issues, Martha Farah et al. (2004) urge the importance of investigating ethical issues at play in neurocognitive enhancement. This paper is an attempt to do this in respect to one particular technology: transcranial magnetic stimulation.

The study of the brain and cognition has profited enormously from advances in technology. Recently, fMRI, PET, and many other technological developments have played crucial roles in determining brain topography and function. One rather new method of investigation is the use of transcranial magnetic stimulation (TMS). Whereas many imaging techniques only allow investigators to view active areas of the brain during various cognitive tasks, TMS allows scientists to intervene in activity in the brain, allowing for more refined investigations into causal relationships and hypotheses of brain function.

The purpose of this paper is to examine what TMS is, how it works and to explore some of the ethical issues arising from applications of TMS. More specifically for enhancement, if TMS does have positive effects on normal subjects, should we encourage its common use? I suggest that though it should not be discarded as a treatment for states like major depressive disorder, the justification of use of TMS in normal cases needs to be decided on a case by case basis as there are likely to be a variety of important factors that play into each case. Particularly important issues to consider in regard to cognitive enhancement are those of personhood and achievement.

2. TMS and Applications

Using electricity and magnetism to affect living organisms is not new. The Roman physician Scribonius Largus used electric rays to treat headaches in 46 A.D. (Post and Keck, 2001), and Luigi Galvani studied animal electricity in 1771. The 19th century saw much research into the properties of electricity and magnetism with Helmholtz, Duchenne de Boulogne, and Bartholow all performing studies involving the electrical stimulation of the body, the latter examining the excitability of the human brain while stimulating the exposed cortex of a subject. In 1896 Arsenne d'Arsonval found that a subject could be made to perceive phosphenes and vertigo when the subject's head was placed into a strong magnetic field (d'Arsonval, 1896).

Recently, the use of electromagnetism has become more focused, and modern transcranial magnetic stimulation is an exciting new investigative technology in cognitive neuroscience. TMS is a noninvasive technique that can alter electrical activity in the brain via a magnetic field. TMS utilizes the phenomenon of induction as an electric charge is produced in a hand-held coil hovering over the scalp. The electric charge creates a magnetic field which emanates from the coil and passes through the skull into the brain. When this magnetic field interacts with a

conductive material such as nerve fibers, another electrical current is induced. This acts to change the membrane potential in neurons within the brain, causing action potentials to occur. The strength and intensity of the magnetic field can be manipulated to produce varying effects including whether or not the targeted neural population produces an excitatory or inhibitory response.

fMRI, PET, EEG and other technologies in the brain sciences' toolkit play something of a passive role in their interaction with the brain. TMS, however, is an active investigative device given its ability to create what some refer to as virtual lesions. By stimulating a particular area of the brain, it introduces noise into the system and is able to disrupt the activity of that area and thus the area's functional interaction with other brain areas. This ability to disrupt fairly particular brain activity gives cognitive neuroscientists a powerful method to investigate functional localization. Moreover, TMS can be used in concert with imaging techniques like fMRI to better study connectivity in the brain and to more easily locate areas of stimulation. Given this method of investigation, it is not surprising that TMS has been used in a wide variety of fields. In function-mapping, it has been utilized to study vision, motor representation, memory, plasticity and linguistic abilities. It has been suggested that TMS even be used as an aid in neurosurgery to localize speech areas.

Aside from its use in these investigative/exploratory studies, TMS is being probed as a therapeutic tool as well and is being applied to a wide range of disorders including Parkinson's Disease (Pascual-Leone et al, 1994), Obsessive Compulsive Disorder (Greenburg et al, 1997), schizophrenia (Hoffman et al, 1998) and Posttraumatic Stress Disorder (McCann et al, 1998; Quirk and Milad, 2002). The most common area of treatment studies centers on major-depressive disorder. These studies strongly suggest that stimulation can reduce depression ratings of subjects (Figiel et al 1998; Pascual-Leone et al, 1996) for whom anti-depressant medication does not work well and commonly rely on electro-convulsive-therapy (ECT). ECT, however, has negative side-effects such as potential cardiac arrest, headaches, muscle pain, nausea, delirium, memory loss, and a risk of death (Datto, 2000). TMS lacks these negative side-effects but shows promise in retaining the efficacy of medications and ECT (Szuba et al, 2000). Because of this, there is good reason to pursue further research with TMS as a treatment procedure. In addition to treating disorders, TMS can also have effects on normal subjects. I describe some of these in the next section. It is these effects that are more relevant to issues of enhancement.

3. Cognitive and Affective Effects

Some of the more interesting effects of TMS involve neuropsychological effects. Researchers have often encountered effects on mood in subjects, such as sudden crying, when performing TMS sessions (Wasserman, 2000). Normal subjects have demonstrated an increase in self-rated sadness when their left dorsal-lateral prefrontal cortex (DLPFC) is stimulated and an increase in self-rated happiness when their right DLPFC is stimulated (Martin et al, 1997).

In addition to mood, there are indications that TMS can affect reasoning skills. In one study, stimulation of the prefrontal cortex while trying to solve a puzzle designed to test analogic reasoning (comparing shapes for similarity) helped to increase the speed of puzzle completion by subjects (Boroojerdi et al, 2001). Similarly, stimulation in normal subjects performing tests such as delayed and immediate story recall tests, verbal fluency tests, and letter identification tests showed improved verbal memory and shorter reaction time (Pascual-Leone et al, 1993). Yet another study suggests that conceptual tracking and flexibility can be improved with the aid of

TMS (Moser, 2002).

TMS seems to have the capability, given particular settings of frequency, site of stimulation, etc., to have positive, if limited, effects on the performance of many different tasks. In a recent New York Times article, Lawrence Osborne writes about his visit to cognitive neuroscientist Allan Snyder's lab at the University of Sydney. While Snyder stimulates Osborne's brain, he asks Osborne to draw pictures of cats. After a few minutes of chicken-scratch, the drawings become more detailed and mature. The cats take on semblances of personalities and fill out in ways one would suspect could only be achieved by an accomplished artist. With students at his university, Snyder has been able to replicate findings that TMS enhances the ability to draw, proofread and do complicated mathematical problems in 40% of his subjects. These are cases of the power TMS holds to change the way we think, act, feel, and even, who we think we are. Osborne, himself, even notes in regard to his cat drawings that he could "hardly recognize them as my own drawings."

With TMS, it could be possible to change our performances, abilities and psychological states. Truckers who need to stay alert could hover the TMS coil over their scalp. Students who have been having trouble in their calculus class could stimulate themselves to gain insight into problems. An artist experiencing a creative block might need a "push" to release their artistic flow. The applications of a device that could provide the services of enhancement in abilities would be vast. Beyond revitalizing those operating machinery or artists looking for inspiration, there could be TMS parlors where people stop in for a quick stimulation before heading off to a social engagement. Or perhaps theaters could zap movie-goers to make them more amenable to the present feature. Or people tired of being bored could shock themselves into excitement.

These instances of enhancing stimulation might not seem that shocking or condemnable. After all, these are people who are only refreshing an ability that they already seem to have. The trucker just needs to stay awake a little longer, the student is doing well but is stuck, and the artist is creative but is just "blocking" right now. Moreover, these results could be obtained by other, fairly unobjectionable means. The trucker could take some type of stimulant, the student could change their study habits or ask the teacher for help, and the artist could enter an inspiring love affair.

I think there are at least two general reasons why some of these applications/enhancements may seem to cross the line. The first is because of how we tend to naturally think about our mental states. The second is due to the ways we judge certain sorts of accomplishments. In regard to the first type of reason, there is a sense in which TMS reveals our emotional and cognitive states to simply be the effects of a complicated mechanism: the brain. While it may be the case that these states are such effects, and that, in some sense, we know this to be true, TMS drives home this point. It proves the possibility of producing mental states, or attitudes, by doing nothing more than mechanically tinkering with the brain. The reason this is difficult to swallow is that we are most familiar with our mental states in a 1st person, subjective way. The phenomenology of our mental lives is such that they exist, if not entirely, at least primarily as personal, private events imbued with meaning. Furthermore, our sense of identity is intimately connected to these states. "We" seem to be wherever and whatever our minds are in the sense that we see, live and experience our lives through the veil of our perspectives. This is colored by our cognitive and affective states. When these types of mental states can be created in a moment's time by sending magnetic pulses through the scalp, it suggests that we might be mistaken about the personal importance these states play in creating our sense of self. To admit, to ourselves, that our emotions and thoughts are nothing more than mechanical effects, leaves us grasping for the

meaning of our lives that we have pieced together to understand ourselves.

The second reason TMS enhancement may seem odd has to do with matters of means and ends. There are many who would willingly embrace such an avenue to their desired ends, but one might wonder whether they in fact should so willingly embrace such a means. It is not that any of the ends mentioned above are poorly chosen or bad in themselves. It is perfectly acceptable to want to be alert, to reason well, to excel in ones studies, to feel happy or social, and be artistic. An important question, though, is why we value these ends. Some of them seem admirable in part because of the difficulty in achieving them. That is to say, some of the states or ends we might envision TMS being used as a tool to gain are the sorts of ends that seem to be worthy precisely because they are achieved in a certain way.

Take art for example. Perhaps artists can be said to have a natural gift. They might be able to see, hear or envision things in a way that most cannot. But artists still must learn to shape their talents and usually go to some effort to understand the context of their own art within that of others. They are the better for learning the history of their particular medium and subject matter, and their own art is often the better for experiencing and living the material they express in their work. Hemingway's stories are paradigms of well-crafted adventures because he, first of all, wrote about things he had experienced and lived, and second of all, spent hours everyday working and reworking the language in which he was to tell his stories. In addition to this, Hemingway was a part of a group of writers and artists (whether he acknowledged it or not) who saw themselves as exploring new artistic grounds in relation to other literary and cultural movements before them. Now, these things might have contributed to making Hemingway a great writer, but they also affect how he is judged as a writer. We see him as a respectable writer because he struggled to hone his work and strived to feed his hunger for writing by working hard at it.

Of course, we might admit that there is talent in a person who is able to simply whip out a manuscript or who simply spills some paint on a canvas that happens to fall in an interesting pattern, but there seems to be something important missing in this sort of achievement when compared to that of an individual who struggles with and understands, to a certain degree, their own work. I would urge that this difference is a type of moral worth in the achievement, gained by the process of achieving the particular goal, and that this worth is inherent in the connection between the means and end and the appropriateness of that means to that particular end.

In the case of art, TMS would most likely be an inappropriate means to achieving creativity or artistic ability if it is true that the way in which one becomes artistic, presumably by creating good art, is via a certain type of process. Counterfeit paintings, though the same in every detail as the original, are not 'good' art. And those who create them are less artistic and less creative, even if technically gifted, than those artists who make an original contribution. This does not show conclusively that art created by a person enhanced by TMS stimulation is less artistic, but it does indicate that there is something about the way in which art comes about that is important to the evaluation of it. There is a difference between the person enhanced by TMS who cannot draw or paint and yet who draws an interesting figure, and the person who has been able to paint interesting scenes for quite some time before the use of TMS. The latter person is artistic while the former is not generally artistic. That is why we say that their abilities have been enhanced; they are not normally that good. That person is not an artistic person, they have merely been manipulated in a momentary fashion.

The importance of the process that embodies an achievement and the amount of worth we are inclined to attribute to that achievement is not limited to art. Being an excellent athlete, and being recognized as such, involves hard work and practice. Being an accomplished

mathematician requires time, practice and loads of study. More importantly, being genuinely happy is less likely to be accomplished in a quick-fix manner as opposed to being built up piece-meal through a life filled with other struggles and accomplishments.

TMS is probably not going to guarantee results of enhancement in circumstances where the desired end is one which requires, for its own worth, a different type of means to that end. However, it may be possible that there are some ends or goal-states which can be genuinely attained via routes such as magnetic stimulation. Being free of undesired muscle tremors or stimulating a soldier to keep them alert may be such types of goal-states. Furthermore, on my analysis it may be that treating some disorders like major depression with TMS is appropriate. This is because once the end is characterized as a treatment, or cure of the disorder, the means of using TMS to accomplish this is appropriate. Moreover, if TMS is safer than ECT and more effective than medication alone, the case for using TMS to treat mental disorders is made stronger.

A problem arises, though, when one thinks that means such as TMS can lead to making one a better person. Often times, the thing that is expected to make one a better person is the type of thing that can only do so if it is achieved in the proper way. In deciding on whether TMS is a sufficient method for such purposes, care should be taken to pay attention to the details involved in the end desired and in the way in which that end gains the type of value we attribute to it. Some things are more appropriately treated in very particular manners.

Related to some of these concerns are questions about the identities of the people involved in cases of enhancement generally and TMS in particular. If it is true that our identities are partially determined by our abilities, then when we change our abilities, we change who we are. Moreover, if those abilities are in some ways gained on the cheap, as it were, then what does this say about our identities? Generally, we may think of many goals and ends as laudable and just, but this does not thereby justify, warrant or legitimate *any* means to a just end.

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