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Emerging Biotechnology Case Study: Deep Brain Stimulation Studies *

Shakima Gregory was recently awarded a post-doctoral fellowship to work in one of the most prestigious neuroscience labs in the country after finishing a doctoral thesis on the use of deep brain stimulation (DBS) techniques to treat patients with Parkinson's disease.

Deep brain stimulation is an invasive neurosurgical intervention that involves the implantation of an electrode in the brain. The electrode is connected and stimulated by a device called an *implanted pulse generator* (IPG), which is inserted in the patient's chest (Bell *et al.* 2009). DBS was approved by the FDA in 1997 and is now an established therapy for many neurodegenerative disorders. It can be turned off in cases where the patient experiences adverse effects or no effects, and the effects are thought to be reversible. DBS has recently been extended to treat psychiatric disorders, such as major depression and obsessive-compulsive disorder, as well as obesity (Dunn *et al.* 2011, Halpern *et al.* 2008).

During her doctoral studies, Shakima became aware of some of the risks and concerns about DBS therapy. As a neurosurgical procedure, DBS carries risks of haemorrhage, infection, and even death (Schermer 2011). It can also have other deleterious side effects, such as cognitive impairment, memory impairment, aggression, and depression (Schermer 2011). However, Shakima was proud to work on research that could contribute to the betterment of the quality of lives of individuals who suffered from Parkinson's disease.

Shakima now has the opportunity to be a post-doc in a lab that uses DBS in an entire new context. The Defense Advanced Research Projects Agency (DARPA) is funding the principal investigator, Dr. Daniels, to examine whether DBS can be used to treat posttraumatic stress disorder in veterans. Dr. Daniels has offered Shakima a position where she would lead a new, related research project in the lab. Her task will be to investigate whether DBS can be used on soldiers to modulate emotions, such as reducing or blocking the sensation of fear, in order to make them more effective in high-stress environments.[1]

Shakima has some hesitation about her research assignment. After discussing her research assignment with a more experienced colleague, Shakima realizes that there are many social and ethical concerns about the use of DBS technology: What if the research is successful and soldiers are forced or coerced into undergoing this kind of invasive neurosurgery? What if DBS interventions develop to the point of creating super soldiers that kill indiscriminately? What if the technology interferes with a soldier's sense of morality?[2] As a pacifist, Shakima is deeply troubled by these possibilities and wonders whether she, as a research scientist, has a social and moral responsibility to raise and/or address these issues.

Discussion Questions:

1. Should Shakima take this post-doctoral fellowship?
2. What are the social and ethical responsibilities of engineers and scientists in conducting defense-related work?
3. Some would argue that defense work often results in "spin-offs" for the civilian economy. Should this factor into Shakima's decision on accepting the offer?[3]

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[1] This hypothetical scenario is based off Liao (2014).
[2] These concerns are also raised by Liao (2014).
[3] Thanks to Joe Herkert for these discussion questions.

Content Commentary

Scientists and ethicists have raised several ethical concerns about Deep Brain Stimulation (DBS) technology and its potential applications. The use of the technology in neuro-surgical interventions itself raises important moral questions about autonomy, identity, authenticity, and responsibility, with respect to potential immediate impacts on the individual. Broader social and moral considerations of applications of the technology in different contexts, such as military use, raise even more concerns about justice, human enhancement, and moral responsibility.

In its therapeutic context, DBS is being used to study and treat neuro-degenerative diseases, while initial research on applications of DBS to treat psychological and psychiatric disorders is also being pursued. Ethicists and clinician have made efforts to balance the risks and benefits of DBS treatment, and have discussed the issue of autonomy for individual patients or subjects who have a reduced capacity to provide fully informed consent (Schermer 2011, Unterrainer & Oduncu 2015). They have also urged that more attention be paid to the broader psycho-social impacts of DBS treatment and the effects those impacts may have on an individual's personal identity.

For example, Schermer argues that it is possible for DBS therapy to disrupt a patient's personality, mood, behaviour, or cognition, so that her entire personal narrative identity – i.e. her "self-conception, [her] biography, values, and roles as well as [her] psychological characteristics and style" – is disrupted (Schermer 2011). This can affect a person's normal "narrative flow of life" and bring about behaviour that can lead to harm to herself and to others in her social milieu. Issues about identity and authenticity also invoke questions about a patient's personal responsibility for disruptive or harmful behaviour. Accordingly, Unterrainer and Oduncu have suggested that health professionals ought to use a Ulysses Contract as a cautionary ethical and legal measure against these possible negative impacts from DBS on an individual's sense of identity (Unterrainer & Oduncu 2015). A Ulysses Contract refers to a scene in Homer's tale of Ulysses' quest, where Ulysses ties himself to the mast of his ship in order to protect himself against the Sirens' seduction. The term represents the idea of an autonomous individual deciding, in advance, to restrict her autonomy in a future setting. However, the authors' suggestion does not completely resolve ethical questions pertaining to identity and autonomy in DBS treatment and research because there remain the challenges of predicting the loss of autonomy in a patient/subject after brain stimulation, given that patient's/subject's initial disease state, and deciding whether or when physicians and/or legal representatives should intervene in terminating stimulation (Unterrainer & Oduncu 2015).

Ethicists have also considered the potential role of neuro-surgical technologies, like DBS, in the military (Liao 2014; Tracey & Flower 2014). As presented in the hypothetical scenario described above, the Defense Advanced Research Projects Agency (DARPA) is currently investigating DBS as a way to treat post-traumatic stress disorders (PTSD) in veterans, but it is not unrealistic to consider ways that the technology might be developed and applied to enhance soldiers in the same way that many drugs, like Benzedrine and Modafinil, are already being used by the US Forces to increase focus and alertness in soldiers (Tracey & Flower 2014).

Such potential applications raise ethical concerns about coercion and personal or moral responsibility. Because the military is a hierarchical organization, some have questioned the ability of individual soldiers to freely consent to neurological interventions. In addition to the possibility of being coerced by superiors, soldiers may also be subject to subtle forms of coercion to accept interventions in order to be considered fit for duty and reliable by their peers. Additionally, if it's possible for neurological interventions, like DBS, to change or interfere with an individual's capacity for judgment, then it's unclear whether we can

ascribe personal or moral responsibility to soldiers who have had the intervention for the call of duty in the same way that we ascribe personal or moral responsibility to the drunk driver who causes an accident (Tracey & Flower 2014).

Neurological interventions as an enhancement tool in the military context raises particular ethical issues, but even its suggested use as a therapeutic method to treat PTSD also brings into question the extent to which painful memories may be repressed without consequences on the brain's other functions. Whether DBS and other emerging neuro-technologies will influence the brain's capacity for resilience or amplify its vulnerability remains unknown (Tracey & Flower 2014).

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