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Course of Digital Ethics

How is deep brain stimulation affecting human autonomy?

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Introduction

The term "neurotechnology" refers to a collection of methods and tools that allow for a connection between the technology and the nervous system [1]. Neurotechnology gives us a better understanding of the brain and the nervous system [2].
This technology is both - a fascinating and a controversial field as the technical components directly rewire your brain[3].

Neurotechnology can be invasive or non-invasive. Invasive Brain-Computer Interfaces involve placing physical neurotech instruments into the brain. They are called implants. Implants contain electrodes that release electrical impulses to control abnormal brain activities [4]. These impulses can also balance chemical disparities that cause other diseases [5].

Deep brain stimulation is the most common type of brain implant. This technology uses brain activity readings to modify neural activity. It uses these findings to normalize functions damaged by neurological disorders. Sometimes these techniques are also used to boost cognitive capacities. Most recently we have seen developments in memory enhancement and intelligence improvement neuroscience technologies such as Neuralink by Elon Musk or Neurable which is developing tools to interpret human intention and measure emotion. Neurable is also aiming to become the first company to create a brain-controlled VR game [6].

Neurotechnology can be quite effective in the treatment of brain disorders, and it can often result in significant improvements in the patient's quality of life. It is vital to note, however, that these interventions alter the brain's processes. It can even permanently alter a person's character and personality in rare situations [7].

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[1] Oliver Müller, and Stefan Rotter. “Neurotechnology: Current Developments and Ethical Issues.”
[2] “Neurotechnologies: The Next Technology Frontier.”
[3] Oliver Müller, and Stefan Rotter. “Neurotechnology: Current Developments and Ethical Issues.”
[4] Pilitsis, Julie G. “Deep Brain Stimulation.”
[5] Pilitsis, Julie G. “Deep Brain Stimulation.”
[6] Neurable, https://neurable.com/.
[7] Oliver Müller, and Stefan Rotter. “Neurotechnology: Current Developments and Ethical Issues.”

New developments in neurotechnology are occurring rapidly[8] and the aim to help people with neural and mental disabilities motivated the recent research and advancements in neurotechnology[9]. Neurotechnologies are also a potent research tool for advancing fundamental neuroscience knowledge, in addition to their medicinal and commercial applications.

There are two types of purposes of neurosurgical interventions - enhancement and treatment interventions. Enhancement interventions bring benefits that are more than what is necessary for good health. Treatment interventions are the ones that are conducted to restore the person to a healthy state[10]. However, it is difficult to draw a line between these two definitions. The understanding of what 'good health' and 'normal' means is very subjective and it varies from person to person, across different cultures. Essentially, it is almost impossible to define it.

Some scientists believe that brain-computer interfaces (BCIs) and DBS have the potential to alienate users from their actions and feelings and make their sense of self more unreliable. Moreover, they have the potential to intrude the crucial areas of our privacy that are necessary for preserving a discrete sense of self. These technologies have the potential to change the relationship between the body and the mind, as well as obscure existing mental boundaries [11].

Moreover, using DBS to treat a disease such as Parkinson's may come with side effects such as changed behaviour. All of these side effects make the patient question his sense of self [12]. However, it is believed that DBS is used to support human autonomy when it is used to restore the person to the state they were in before the onset of the disease [13].
When considering whether to undergo such a surgery, it is important to realize that implants make a permanent, or semi-permanent change in people's brains and they are not like drugs that eventually wear off.

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[8] Goering, Sara, Eran Klein, Laura Specker Sullivan, Anna Wexler, Blaise Agüera y Arcas, Guoqiang Bi, Jose M. Carmena, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[9] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"
[10] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[11] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[12] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[13] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."

Some may agree that humanity is on a quest to create superhumans. We have advancements in genetic engineering which are related to various types of neuroscience technologies to improve people's physical disabilities. So, up until now, human enhancement methods were used solely for individuals who had some sort of disability and would use these devices to get back to some sort of "human norm"[14]. But the question is, where do we draw the line?

The type of neurotechnology that I will be exploring in my thesis is deep brain stimulation. Deep brain stimulation is a neurosurgical procedure in which a brain implant is put into the deep structures of the human brain [15]. In treating diseases, deep brain stimulation is mostly used to treat Parkinson's disease, clinical depression, epilepsy and Tourette's syndrome [16]. By releasing electrical signals to the thalamus or subthalamic nucleus of the brain, the symptoms of the diseases can be reduced.

As much as these technologies are helping humans with neurological diseases, they have the potential to alter individual agency and alienate persons who use neurotechnologies from their sense of self, posing fundamental questions about what it is to be human [17].

Deep Brain Stimulation

DBS technology raises many philosophical questions that are related to what we call and define as 'self'[18]. Some may argue that the integrity and dignity of a person are the most relevant criteria for evaluating the ethical aspects of neurotechnologies [19].

According to Wilt, Joshua A., et al., the following are the three main areas of concern about DBS and its potential psychological changes [20].

How can DBS bring changes to us?

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[14]Warwick, Kevin. "Superhuman Enhancements via Implants: Beyond the Human Mind." *Philosophies*, August 10, 2020.
[15] Pugh, Jonathan et al., "Brainjacking in Deep Brain Stimulation and Autonomy."
[16] Warwick, Kevin. "Superhuman Enhancements via Implants: Beyond the Human Mind." *Philosophies*
[17] Goering, Sara, Eran Klein, Laura Specker Sullivan, Anna Wexler, Blaise Agüera y Arcas, Guoqiang Bi, Jose M. Carmena, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[18] Oliver Müller, and Stefan Rotter. "Neurotechnology: Current Developments and Ethical Issues."
[19] Oliver Müller, and Stefan Rotter. "Neurotechnology: Current Developments and Ethical Issues."
[20] Wilt, Joshua A., et al.. "Does Personality Change Follow Deep Brain Stimulation in Parkinson's Disease Patients?"

Physically: DBS targets the motor fronto-subcortical networks which are close to the operational networks of cognitive, social, behavioural and neurological networks. During surgery, these areas can be affected.

Emotionally/psychologically: Living with a technological implant in the brain may affect and question one's sense of identity.

Socially: DBS can bring potential lifestyle shifts and this may affect the person's psychological functioning [21].

It is important to note that other forms of intervention such as education, medicine and others may also alter or support the basic human features of identity and agency. However, neurotechnology poses a bigger risk for its users as it is more precise and effective and this may create bigger opportunities for user manipulation without their awareness [22]. For this reason, we are in a big need of clear regulations of the developing neurotechnologies [23].

DBS is ethically problematic because even though it can improve the patients' symptoms, it can also alter their personality and change or threaten their identity [24]. Thankfully, in recent times, there is more and more research being dedicated to psychological changes in patients with Parkinson's disease who have undergone DBS surgery [25].

Most DBS surgeries are conducted while the patient is awake so that the doctors can adjust the signal correctly. The reason why they can do this is that there are no pain receptors in the brain. About 10 years ago, doctors in the USA conducted a surgery on a violin player with PD. During the surgery, the doctors have given him a violin and he played it. They did this to adjust the right frequency of the electrical stimulator in the patient's brain. The patient, who was not able to play the violin because of excess tremor caused by PD, was able to get back to playing the violin after the surgery.

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[21] Wilt, Joshua A., et al.. "Does Personality Change Follow Deep Brain Stimulation in Parkinson's Disease Patients?"
[22] Goering, Sara, Eran Klein, Laura Specker Sullivan, Anna Wexler, Blaise Agüera y Arcas, Guoqiang Bi, Jose M. Carmena, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[23] Goering, Sara, Eran Klein, Laura Specker Sullivan, Anna Wexler, Blaise Agüera y Arcas, Guoqiang Bi, Jose M. Carmena, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[24] Mackenzie, Catriona, and Mary Walker. "Neurotechnologies, Personal Identity, and the Ethics of Authenticity."
[25] Wilt, Joshua A., et al.. "Does Personality Change Follow Deep Brain Stimulation in Parkinson's Disease Patients?"

The DBS technology consists of four main parts [26]:

1. *The electrode* - inserted in deep parts of the brain
2. *Pulse generator* - a battery-powered machine that sends electrical impulses that alter neuron functioning; implanted under the collar bone
3. *Wire* - connects the electrode with the pulse generator
4. *Controller* - patient turns DBS on/off using this device

If a patient's symptoms happen to change over time, the doctor can alter the stimulation parameters with the controller [27].
The first remote controllers for DBS had the ability for the patients to change their frequency in the brain. With this - their behaviour, personality and mood changed. Everybody's signal in the brain is different and during the surgery, the doctors adjust the right signal of DBS for the person.

By changing the frequency you also change other aspects of one's behaviour such as eating patterns - for example, you can eat less and lose weight by changing the frequency.
Should we allow people to be like machines - to be able to change the frequency of the brain to fit their needs?

A study conducted by Dongning Su et al. indicates that the frequency of the stimulation in DBS is the crucial parameter in treating motor symptoms of PD. The determination of frequency is the crucial part of using DBS. In addition, High-frequency stimulation is more effective in reducing tremors in PD patients than low-frequency stimulation [28].

[26] Spine, Mayfield Brain &. "DBS."
[27] Spine, Mayfield Brain &. "DBS."
[28] Su, Dongning, et al., "Frequency-Dependent Effects of Subthalamic Deep Brain Stimulation on Motor Symptoms in Parkinson's Disease: A Meta-Analysis of Controlled Trials."

History of DBS

Deep brain stimulation technology is not new, it has already helped over 160,000 people with Parkinson's disease, epilepsy and other neurological conditions [29]. The first neural implant was inserted into a patient's brain in 1969 and it restored the sense of sound [30].
Alim Benabid is a french neurosurgeon who is credited with the development of modern Deep Brain Stimulation in the 1980s. It was first invented as an alterna tive to treat Parkinson's disease and other neurological conditions [31].

Dr Benabid was performing brain surgery on a patient with Parkinson's disease. He inserted an electronic probe in the brain and while increasing the frequency, he realized that the tremor had disappeared [32]. Dr Benabid's main finding was the fact that a specific high-frequency range could calm down the tremor [33]. In recent research, it is still believed that high-frequency stimulations are most useful when treating tremors.

Examples of personality and identity changes

Besides its application in PD patients, more recently, scientists are exploring the use of DBS to treat clinical depression.

In his book, Dr David J. Linden mentions a very interesting experiment done in 1953 by Olds and Milner. The book talks about the 'pleasure centre' of the brain. In this particular experiment, they inserted electrodes deep in the brains of rats. The electrodes were attached to specific electrical stimulators that were activated by the touch of the button. After some time, rats would press the electrical stimulators up to seven thousand times per hour. It stimulated the pleasure and reward center of their brains. Several subsequent experiments showed that rats preferred to have their pleasure center stimulated more than having food or water. At one point they had to be removed from the experiment to avoid their death by self-starvation [34]. So what would happen if we would put a brain implant into a person who is

[29] Pilitsis, Julie G. "Deep Brain Stimulation."
[30] Mim, Halima-Tul-Rokeya, Munima Haque, and Salman Khan Promon. "Neural Implants: A Review of Current Trends and Future Perspectives"
[31] Office, European Patent. "Alim-Louis Benabid (France)."
[32] Office, European Patent. "Alim-Louis Benabid (France)."
[33] Office, European Patent. "Alim-Louis Benabid (France)."
[34] Linden, David J. *The Compass of Pleasure: How Our Brains Make Fatty Foods, Orgasm, Exercise, Marijuana, Generosity, Vodka, Learning, and Gambling Feel so Good*

suffering from a mental illness such as depression? The device would regulate the chemical and electrical balance in the brain and it would therefore help relieve the patient's symptoms. But what happens when we allow a person's mood to be regulated by a technological device?

It is very common for patients who undergo a DBS surgery to have problems with social adjustment after the surgery. For example, a journalist after undergoing a DBS surgery reportedly lost her vitality. She was not interested in her work and projects anymore, even though before the surgery she was very passionate about her work. She reported that she feels like a machine and that she doesn't feel like herself anymore [35].

However, in another example, a man who before undergoing the DBS surgery felt dormant and was very passive in his life. He was in good relations with his wife. After undergoing the surgery, he reported that he felt much more energized, confident and 'full of life'. This change brought conflict in his marriage, his wife is unhappy because she preferred his character before the surgery when he was calm and not so full of energy. She describes his condition and current mood as 'self-decieving' [36].

Nevertheless, there are also examples of cases when people undergo DBS surgeries and come out of it healthy and it has a positive impact on their life. Their self-image and self-perception do not change and their personal identity is not put into question.

Ethical concerns - moral

Although a patient, following the surgery, often remains a person in the strict philosophical sense, he or she may be left with a changed personality, new or previously latent behavioural habits, and unusual character features. In many circumstances, when DBS is used in PD patients, altered personality can be diagnosed [37]. In addition, patients often develop a depressive disorder following the surgery. There are various reasons why the depressive disorder occurs in patients after the surgery. It could be caused by the difficulty to adapt to a new way of living without the symptoms and new routines, changes in dynamics of relationships and others [38].

[35] Schupbach, M et al., Neurosurgery in Parkinson disease: A distressed mind in a repaired body?
[36] Schupbach, M et al., Neurosurgery in Parkinson disease: A distressed mind in a repaired body?
[37] Oliver Müller, and Stefan Rotter. "Neurotechnology: Current Developments and Ethical Issues."
[38] Accolla, Ettore A., and Claudio Pollo. "Mood Effects after Deep Brain Stimulation for Parkinson's Disease: An Update."

At times, threats of such neurotechnologies can come from the unintended consequences of their intended uses [39]. Some personality features such as openness and neuroticism may be altered due to neural interventions [40]. Since the neural implant regulates neural impulses, it may also change a person's behaviour and character unexpectedly.

To what extent can we allow ourselves to interfere with the natural processes of our bodies? How badly do my Parkinson's symptoms have to get for it to become ethical for me to get a DBS? What makes DBS and neurotechnology that much different from other ways of treating diseases? One reason for rising concern could be that neurotechnology poses other risks and threats to our identity than the "regular" drugs we have been consuming so far.
Is it ethical to use anti-depressant pills? It alters our mood. What about the side effects of drugs? Drugs wear off, but this technology is here to stay.

Neurotechnology may seem scarier to us as it also comes with some concrete risks to our identity. If our brain data could be read, our innermost thoughts would become an open book.

What comes into question now is: should the definitions be altered to fit the new developments in neurotechnology or should we create laws and the technology ethically to respect the already established ethical morals?
When talking about destiny, if one gets Parkinson's, should one even use the devices that may help them regulate the symptoms? Is it moral to do so, if other aspects of one's autonomy are put in danger?

I have introduced many complex concepts so far, and to better clarify what I am talking about, I will give definitions of some of the most important ones.

Personality

What is personality?

With regards to personality theories, I believe it is most appropriate to mention Sigmund Freud's personality theory of 1923.

[39] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[40] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."

Sigmund Freud tells us that there are three levels/aspects of human personality. Freud names these three aspects: the id, the ego and the superego. Each of these three components of human personality emerges at different points in one's life [41].

These three components of personality could best be depicted by an iceberg, the majority of the iceberg is underwater - that is our unconsciousness. Only the tip of the iceberg is above water - that is our consciousness. This means that our most important motivations are hidden by our unconsciousness [42].

Freud believed that we do not have free will. He believed that our behaviour is predetermined by the motives in our unconsciousness [43]. Freud states that psychological disorders occur when there is an imbalance between the functioning of the id, ego and superego.

In simple terms, the id can be described as the 'devil', the superego as the 'angel' and the ego is in the middle of them, trying to find the balance.

ID

The id is a primitive and innate aspect of our personality. The id is completely unconscious and impulsive. The id contains our most intrinsic thoughts, sexual desires, our most important motivations, violent motives, selfish needs, fears, impulses, urges - in short - passions. The id is also related to and works on the pleasure principle. Compared to the ego which is reasonable, the id is chaotic [44].

Ego

Freud describes the ego as "that part of the id which has been modified by the direct influence of the external world"[45]. Contast to the id, the ego considers etiquette and social rules when figuring out how to behave [46]. It aims to seek and obtain pleasure without causing harm [47]. Ego represents reason and common sense - it is directed to problem-solving [48].

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[41] Cherry, Kendra. "Id, Ego, and Superego Are Part of a Structural Model of Personality."
[42] Walinga, Jennifer, and Charles Stangor. "12.2 The Origins of Personality."
[43] Walinga, Jennifer, and Charles Stangor. "12.2 The Origins of Personality."
[44] Mcleod, Saul. "Id, Ego, and Superego."
[45] Freud, S. (1923). *The ego and the id*.
[46] Mcleod, Saul. "Id, Ego, and Superego."
[47] Mcleod, Saul. "Id, Ego, and Superego."
[48] Freud, S. (1923). *The ego and the id*.

Freud depicts ego as a rider and id as a horse [49]. The rider has to control the superior strength of the horse [50]. Ego allows a person to practice self-control.

Superego

Superego is the direct opposite of the id. It represents our sense of morality. Superego tells us what are the society's expectations and norms. It strives for perfection [51].
Superego knows what our obligations are and 'what is right'. It is also the source of self-criticism and guilt. When we don't live up to the standards of the superego - we experience guilt and self-criticism [52]. The way we deal with these feelings of guilt is called defence mechanisms [53]. Superego consists of the conscience and the ideal self [54].

Agency

Agency is the idea that humans are capable of making their own decisions and that they are responsible for their actions. Identity and agency are central features of human beings. Certain uses of neurotechnology can put identity and agency at risk [55].

We have a fragile sense of our identity and agency [56]. Agency involves being *aware* that one is causing and generating action. An individual who acts in the world compared to just being acted upon. Agency is crucial in one's ability to take responsibility for their actions, but also it gives one a sense of authorship upon their actions as they are the creator of them.

However, with BCI devices, there can be an impairment between the sense of agency and the actual agency. Sometimes, the intelligent devices may operate on their own. This can leave the users feeling like they have control over their actions, when in reality the device control may be implicit [57].

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[49] Cherry, Kendra. "Id, Ego, and Superego Are Part of a Structural Model of Personality
[50] Freud, S. (1923). *The ego and the id*.
[51] Walinga, Jennifer, and Charles Stangor., "12.2 The Origins of Personality."
[52] Mcleod, Saul. "Id, Ego, and Superego."
[53] Mcleod, Saul. "Id, Ego, and Superego."
[54] Mcleod, Saul. "Id, Ego, and Superego."
[55] Goering, Sara, Eran Klein, Laura Specker Sullivan, Anna Wexler, Blaise Agüera y Arcas, Guoqiang Bi, Jose M. Carmena, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[56] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."
[57] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."

For example, when DBS is used for treating depression, after some time it may confuse the user's certainty about what they want. When treating people with depression, the device may confuse the user's sense of self. They may have a hard time distinguishing what is them, what is the device and what is the depression.

Identity

Identity is dynamic. It changes either voluntarily or involuntarily with social interactions or physical changes [58]. Voluntary changes are perceived as good as they can help a person develop and change their identity to their desires, however, when the change is involuntary, it can be perceived as dangerous. A person may voluntarily choose to get a brain implant and undergo surgery for DBS, aware that this will bring a change to themself. However, the problem arises when the neurotechnology creates changes that the person wasn't aware of before.

Dignity

Human dignity is essentially the concept that every human being has value. Human dignity is a metaphysical concept. Human dignity is something that is assumed - it is not physical.

The concept of human dignity is closely related to our religion. Catholics for example, believe that God created every human in his image. They believe that God created them special and that they are different from other living beings. Dignity is the core principle of Catholic social thought. So people who report that they do not feel like themselves, that their dignity is harmed or in danger… It is important what vocabulary we use here and it is also important to see what these people believe their dignity is and where it comes from. For example, if a catholic person undergoes a DBS surgert and afterwards reports that their dignity is harmed - it is important to ask what they perceive as their dignity - how do they define it? Do they suddenly feel like they are ‘playing God’? Or is it something else?
If we believe that humans ‘are above all price’ and cannot be replaced, then no matter what we do, we should remain to have our dignity.

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[58] Goering, Sara, Eran Klein, Laura Specker Sullivan, Anna Wexler, Blaise Agüera y Arcas, Guoqiang Bi, Jose M. Carmena, et al. “Recommendations for Responsible Development and Application of Neurotechnologies.”

I perceive dignity almost as our 'birth right' and something that cannot be altered in the future. It is not like identity or personality that can change throughout someone's life. It is an unchangeable, time-proof right.

Kant gave a proposition that dignity is intrinsic to humans. Kant says that whatever has a price can be replaced by something else, but whatever is above all price and cannot be replaced by an equivalent has a dignity [59].
Kant's categorical imperative essentially teaches us what all major religions do - don't do to others what you don't want unto you. In other words - the obligation to respect other persons.

Since we have dignity we demand respect. We demand respect because we are free, rational beings. We are 'ends in themselves'.

Privacy

Privacy is one's right that others cannot access their personal information or space.

In the words of Mr Paz "Is mental privacy a component of personal identity?"[60]. There have been many debates in neuroethics about the conceptualisation of identity when it is related to neurotechnologies that can do 'mind-writing' [61]. Devices such as DBS can eventually modulate and change our neural computation [62]. Mental privacy is susceptible to outside influence.
Reading and analyzing brain data (neural activity) is very important in understanding and decoding the information about the mental state of the patients. The technologies obtained through the collection of neural activity patterns are crucial in creating new technologies to treat brain disorders and are therefore considered ethical as they are guided by the bioethics principle of beneficence [63].

[59] Debes, Remy. "A History of Human Dignity."
[60] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"
[61] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"
[62] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"
[63] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"

But should mental privacy be treated differently from other forms of privacy? Should we have more strict rules about mental privacy? Wajnerman Paz argues that for mental privacy we should have more stringent measures as it relates to relevant aspects of personal identity[64].

Mental privacy as Paz argues is the key component of psychological integrity [65].

Ethical concerns - cybersecurity threats

Brainjacking/ brainhacking

Brainjacking is another privacy issue of DBS. It refers to unauthorized control over another person's brain implant [66]. Brainjacking is a serious cyber security threat. Hackers may alter the patient's behaviour by stimulating certain parts of the brain, they can steal brain data, increase pain, cause tissue damage or increase patients' impulsivity. They can turn off the brain implant, or drain the implant's batteries. They can also cause emotional disfunction such as causing excessive crying or laughter [67].

It is difficult to make sure what are the consequences of brainjacking on the individual's sense of autonomy since there are various interpretations of autonomy in neuroethical and psychological theories [68].

What happens when the person's behaviour is changed by the device? Is it the person's fault for deciding to undergo the surgery, having accepted the risk that it might bring?

The electrodes which are inserted into the brain can be connected to a computer so that the electrical activity of the brain can be tracked. The brain signals are therefore monitored in real-time and transmitted to a computer. These signals can then be analyzed by the computer which can then generate alternative signals which are transmitted back into the brain [69]. The monitoring computer can be remotely located from the patient. Sometimes this can even

[64] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"
[65] Wajnerman Paz, Abel. "Is Your Neural Data Part of Your Mind? Exploring the Conceptual Basis of Mental Privacy."
[66] Pugh, Jonathan et al., "Brainjacking in Deep Brain Stimulation and Autonomy."
[67] Pycroft, Laurie, et al. "Brainjacking: Implant Security Issues in Invasive Neuromodulation."
[68] Pugh, Jonathan et al., "Brainjacking in Deep Brain Stimulation and Autonomy."
[69] Warwick, Kevin. "Superhuman Enhancements via Implants: Beyond the Human Mind." *Philosophies*

mean that the computer is positioned in a different country from the patient which means that a portion of a person's brain is in another country [70].

Can we still be called 'humans' if part of us is connected to a machine?

Power disparity

Power disparities are an issue of brain data privacy. A power disparity here is between the users whose brain data is collected and companies or individuals who use this data to analyze, collect or share it [71].

Neurocapitalism refers to the capitalisation of data obtained through brain-computer interfaces such as DBS. It is concerned with how to use and utilize brain data and make a profit from it.

For example, social media apps are completely free, but for the exchange of service, in return, we give the companies free access to collect large amounts of our sensitive data. In the future, we might give companies access to our brain data in exchange for some other free services or to upgrade user experience with better recommendation algorithms, for example.

For instance, Mark Zuckerberg was investing in research for a company that aimed to create technology that will translate thoughts into words.

Even now we have the so-called "credit scores" where banks determine whether or not they approve a loan. We can only fearfully imagine what will happen in the future when banks will be in possession of our neuro data.

For this reason, activists such as Rafael Yuste are urging scientists to have ethical debates about this new technology and to create new human rights that will protect humans in the new technological era.

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[70] Warwick, Kevin. "Superhuman Enhancements via Implants: Beyond the Human Mind." *Philosophies*

[71] Goering, Sara, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."

Neurorights

Technology is innocent - the problem is how we use it.

The five key neurorights: [72]

1. the right to personal identity
2. the right to free will
3. the right to mental privacy
4. the right to equal access to mental augmentation technologies
5. the right to protection against bias

1. The right to personal identity

Personal identity refers to the degree to which a person remains the same across time, in addition to their physical identity [73].To answer this question, we would need to define the "sameness" of a person over time. We can presume a person's "sameness" based on narrative identity notions, as humans experience themselves as being the same through the narrative of their life history. Even after undergoing a DBS surgery or after a serious illness, humans still assume this incident as an essential part of their identity and history [74].

2. The right to free will

Free will is a person's ability and capacity to act independently. The capacity of a person to act without the influence of external forces and to make decisions that the person wants to. The right to free will is given to us by nature.

Kant: "a free will and a will under moral laws are one and the same" [75]. A person has free will as long as it is in confinement to the moral laws. A person is not free when we are ruled by our passions [76].

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[72] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"
[73] Oliver Müller, and Stefan Rotter. "Neurotechnology: Current Developments and Ethical Issues."
[74] Oliver Müller, and Stefan Rotter. "Neurotechnology: Current Developments and Ethical Issues."
[75] Schönecker, Dieter. "'A Free Will and a Will under Moral Laws Are the Same': (Chapter 12) - Kant on Moral Autonomy."
[76] "Immanuel Kant." The School Of Life

3. The right to mental privacy

The right to mental privacy entails that we should be able to regulate access to our neurological data as well as the information about our mental processes and states that may be gleaned from examining it [77]. Any data collected from your neural activity should remain private. Selling neuro data should be strictly regulated.

It can be argued that we are already agreeing to sell our data freely without any strict restrictions. Zuboff's surveillance capitalism teaches us how big companies are using and selling our data for commercial purposes. The new field of neuromarketing is also gaining increasing popularity.
But the things that Zuboff discusses in her book are not new to us: data collection, alteration, user-profiling, cookies… Yet, we do not have profound rules that regulate how personal data can be used. Europe attempted to protect users through GDPR but even with this law, big companies and platforms can still find a way to gain users' approval for data collection.

The problem with these things is that we are being increasingly manipulated, our behaviour is being controlled, our shopping patterns and preferences are being reshaped and there are not enough strict laws that protect the customers.

Big online platforms collect our psychological data and later use it to alter our behaviour to fit with the mission of the advertisers. But this does not only relate to online advertising that uses our data. Instagram for example, has a special set of algorithms that know exactly when to send its specific users notifications. They aim to create an addition in us and for us to spend as much time as possible online.
All in all, technology is expanding at an exponential rate, while the laws are growing linearly.

4. The right to equal access to mental augmentation technologies

This is a very controversial point of the neurorights initiative. It obliges nations to provide equal access to mental augmentation technologies to all people. Some countries find it hard to

[77] Wajnerman Paz, Abel. "Is Mental Privacy a Component of Personal Identity?"

even combat hunger and the basic medical needs of their citizens. Is it possible that this will just widen the gap between the rich and the poor [78]? The country will probably have to subsidise mental augmentation technologies for more vulnerable citizens which will put an additional burden on the country's health system [79].

5. The right to protection against bias

This right refers to the algorithmic bias. Algorithmic biases often occur when we input biased data into the machine, from which the machine learns. For example, there were many cases when facial recognition apps were racist toward people with darker coloured skin. The algorithm simply didn't recognise darker coloured people. The reason for this is that the data that the algorithm was given in the training stage probably contained mostly images of light coloured skin faces. The fault is not in the algorithm - it is in the people who create the algorithm. We need more unbiased datasets which will be used for training algorithms.

Neurorights initiative by Rafael Yuste is probably the biggest and most profound initiative of this kind and its aim is to protect how a person's brain data is accessed and used, including a right to mental privacy and free will. Neurorights initiative is all about creating new human rights for the time that is coming. Chile is the first country that passed a neuro-rights law.

Are we just our brains?

Hippocrates teaches that the brain is the centre of intelligence and willpower, analyses the world, and interprets the consciousness [80]. Hippocrates tells us that joy, sadness, grief and laughter come from the brain. Through the brain, we acquire wisdom and knowledge, and we perceive something as good or as bad [81]. This is connected to Freud's theory of personality, where Freud goes into more detail and divides it into three areas where each part is responsible for certain feelings.

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[78] Borbón, Diego, and Luisa Borbón. "A Critical Perspective on NeuroRights: Comments Regarding Ethics and Law."
[79] Borbón, Diego, and Luisa Borbón. "A Critical Perspective on NeuroRights: Comments Regarding Ethics and Law."
[80] Breitenfeld, T., M. J. Jurasic, and D. Breitenfeld. "Hippocrates: The Forefather of Neurology."
[81] Breitenfeld, T., M. J. Jurasic, and D. Breitenfeld. "Hippocrates: The Forefather of Neurology."

Our neurons and biological processes can be thought of as just features of a machine [82]. However, a person is more than their brain and its processes. We have emotions.

Proof 1 of the connection between our brain and body

"Emotions adjust not only our mental, but also our bodily states" prof. Lauri Nummenmaa [83]. From a Finnish study conducted on emotions, there is clear proof that there exists a connection between our minds and our bodies. Humans are more than just their brains as we have emotions.

But where do emotions come from? What are emotions?

Emotions, feelings and moods are three different things and should not be used as synonymously, as we often do.

Emotion is a reaction and it is composed of a subjective experience, behavioural and physiological response [84]. Feelings come from the emotion. They not only come from the present occurrence but can also arise from memories and certain other factors [85]. Mood is a temporary emotional circumstance and usually, it is of low intensity. Moods do not have the stimulus that emotions and feelings have and it is quite uncertain what is the starting point of a mood [86].

The subjective experience varies from person to person and they are unique from a person to a person. Subjective experience is not conditioned by culture, upbringing or religion. Members of the same family, for example, may experience different emotions after losing a loved one.

James-Lange Theory teaches us that emotion is experienced when physiological stimuli make the nervous system react [87]. Behavioural response is our expression of the emotion we are experiencing: crying, smiling, laughing, yelling…

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[82] Jedlička, Peter. "Neuroethics, Reductionism and Dualism."
[83] "Finnish Research Team Reveals How Emotions Are Mapped in the Body." Aalto University
[84] Psychology and Counseling News, UWA. "The Science of Emotion: Exploring the Basics of Emotional Psychology.
[85] Psychology and Counseling News, UWA. "The Science of Emotion: Exploring the Basics of Emotional Psychology.
[86] Psychology and Counseling News, UWA. "The Science of Emotion: Exploring the Basics of Emotional Psychology.
[87] Psychology and Counseling News, UWA. "The Science of Emotion: Exploring the Basics of Emotional Psychology.

As much as subjective experience is unique, the behavioural response is in fact conditioned by social norms, upbringing etc.

So, our brains and bodies are connected as humans experience emotions in their bodies, not just in their brains. In the graphic below we can see in which parts of the body, people feel certain emotions.

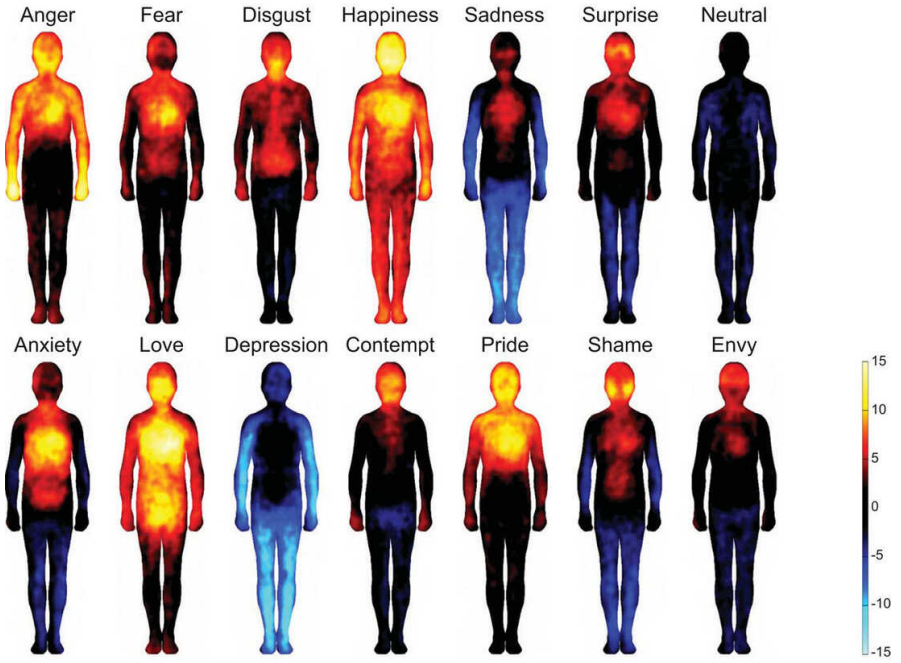

Image courtesy of Lauri Nummenmaa, Enrico Glerean, Riitta Hari, and Jari Hietanen[88]

Proof 2 of the connection between our brain and body

I've recently been very interested in how the food we eat affects our mental state. There is evidence that when our gut is composed of good bacteria our cognitive functions are much better in comparison to when our gut is filled with bad bacteria. This is another example that proves how our bodies and our brain are connected. Gut bacteria have a significant influence on our brain and behaviour [89]. The food we consume influences our brain functions.

[88] Nummenmaa, Lauri, Enrico Glerean, Riitta Hari, and Jari K. Hietanen. "Bodily Maps of Emotions."
[89] Gareau, M.G. "Cognitive Function and the Microbiome."

It is fascinating how there is new research that suggests that we can use food to treat mental illnesses.
Scientists have discovered what is called a viscerofungal neuron which is located in our gut wall[90]. The vagus nerve controls all involuntary bodily processes such as digestion, gut health, fertility, breaking etc.

Dr Michael D. Gershon, for instance, discovered that the nerve cells in our gut act as a 'second brain'. These nerve cells are not responsible for decision-marking or the thought process, however, this system is incredibly complex and sends information from the gut to the brain [91]. As Emeran Mayer says "a big part of our emotions are probably influenced by the nerves in our gut"[92].

The body-brain connection is extremely important because regardless of what some may say, we are not just our brains. Our bodies are an incredibly interconnected, perfectly functioning system. From hormones to the nervous system. The hypothalamus is part of our brain which releases hormones from the pituitary gland. Our hormones control our whole body, including our emotions and feelings.

Human Autonomy

Autonomy is the right of a person to be self-governing. It is the power of a person to act upon their own values and beliefs that are not distorted by manipulative external forces. According to Kant, a person is autonomous if their actions and choices are unaffected by external factors. Therefore, a person that lacks autonomy will be manipulated by peer pressure, convention, legal or religious authority and others [93]. Even our desires are stopping us from being completely autonomous because our desires are dependent on the situation we find ourselves in.

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[90] Hibberd, T. J., et al, "A Novel Mode of Sympathetic Reflex Activation Mediated by the Enteric Nervous System."
[91] Hadhazy, Adam. "Think Twice: How the Gut's 'Second Brain' Influences Mood and Well-Being."
[92] Hadhazy, Adam. "Think Twice: How the Gut's 'Second Brain' Influences Mood and Well-Being."
[93] Taylor, James Stacey. "Autonomy."

Moreover, a person is autonomous if they are directed only by their rationality. However, it does not mean that a person who is acting rationally is also autonomous. For example, a person may behave rationally to satisfy their desires.

The idea of autonomous humans is that the person is free to make their own decisions. However, we are often bounded by social norms or government rules that unable us from acting upon our will.

Autonomy is a complex concept so I will explore the concept and the effect of DBS in three distinct areas. The three areas are biological, psychological and philosophical perspectives.

1. Biological perspective

In a biological sense, humans have the autonomy to self-maintain and self-produce. From a biological perspective, it means that humans have the autonomy needed for surviving. They can use the restroom, move, walk and do basic things such as cook lunch for themselves or pour a glass of water. People with PD, for example, lose their biological autonomy when for example, the tremor disables them to shave, movement diseases disable them to walk, to going to the bathroom alone, and psychological diseases disable people to make rational and healthy decisions.

So it could be said that the disease is taking away the basic functions of a human. So, in a biological sense, if DBS can help humans restore some functions such as removing the tremor or for example, a robotic prosthesis can help a person move their paralysed arms – then we should believe that the neurotechnology is supporting human autonomy. It is simply helping a human restore their well-being to a healthy, "normal" state.

Klaming and Haselager argue that even though deep brain stimulation can give a patient much more freedom and allow them to have a life without constant care, it can simultaneously have an effect on a patient's decision making and therefore it can affect his autonomy by weakening patient's basic mental abilities [94].

[94] Klaming, Laura, and Pim Haselager. "Did My Brain Implant Make Me Do It? Questions Raised by DBS Regarding Psychological Continuity, Responsibility for Action and Mental Competence."

2. Psychological perspective

From a psychological perspective, autonomy is defined as our intentions, wishes and self-definitions [95]. Autonomy in this sense simply means that the person is self-governing and is responsible for the way they live their life. When a person is autonomous, they feel as if their actions and motivations are their own and they are not influenced by external forces. This is extremely important. In a study done in Europe, researchers confirmed that life satisfaction increases as people have a higher perceived sense of autonomy [96]. One's perceived autonomy has a crucial role in determining one's satisfaction in life and well-being, it increases happiness and shields from depression [97].
Psychological autonomy is an important factor in achieving self-actualisation which is also the top part of Maslow's hierarchy of needs [98]. To live to one's highest potential, one must realize that they are autonomous human beings that have the right to make their own decisions and act upon their own values.

When DBS patients report that they do not feel like themselves, we can come to a conclusion that DBS is harmful. If the sense of autonomy is proportional to one' well-being and if that sense of autonomy is taken away after undergoing DBS surgery, then DBS directly threatens the quality of life of that person and their autonomy. If DBS has the power to alter our behaviour and personality, then ultimately, it has the power to control us.

Humans are rational animals, they follow principles, they reflect on their actions, and they follow social norms. Being fully autonomous means that we are not acting on our desires and our actions are not affected by external forces.

To better explain, I will introduce a few examples from behavioural experiments done on animals concerning controlling their minds, as well as a few real-life examples.

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[95] Keller, Heidi. "Psychological Autonomy and Hierarchical Relatedness as Organizers of Developmental Pathways."
[96] Steckermeier, Leonie C. "The Value of Autonomy for the Good Life. an Empirical Investigation of Autonomy and Life Satisfaction in Europe."
[97] Steckermeier, Leonie C. "The Value of Autonomy for the Good Life. an Empirical Investigation of Autonomy and Life Satisfaction in Europe."
[98] Steckermeier, Leonie C. "The Value of Autonomy for the Good Life. an Empirical Investigation of Autonomy and Life Satisfaction in Europe."

One of the most important and well-known examples is the pioneer in the field of electrical brain manipulation, Jose Delgado. Many people view his work as controversial and offensive. He implanted brain chips, also known as stimoceivers, in the brains of many animals and humans. Stimoceiver is a chip that can control behaviour and manipulate emotions [99].

In 1963, Delgado sedated a bull and inserted a stimoceiver in his brain. After, Delgado got into a ring with a bull. When the bull started aggressively running toward Delgado, he pressed a remote control that stopped the bull from running further. The electrical stimulation that Delgado targeted in the bull's brain was responsible for voluntary movement. Delgado essentially eliminated aggressiveness from that bull [100].

Delgado argued that his work's mission was to liberate humans from their biology [101]. Liberating people from their diseases, tremors… But also liberating from aggressiveness [102].

There are many other examples of manipulation of animals throughout history that does not involve invasive operations but simply training.
For example, dogs were used during WW2 by the Soviet army. When USSR discovered dogs' potential to be used in military operations, they soon began training dogs and even created dog training units. They trained dogs to drop off a bomb next to opponents' tanks, of course, as the bomb would explode, the dog would die as well. Dogs are crucial even in modern-day militaries due to their superb sense of smell which is up to 100 000 times better than humans; they are used to sniff bombs and drugs.

During WW1 dogs were even trained to carry machine guns. Red cross had specially trained dogs that would carry medical supplies to injured men.
Even now, during the war in Ukraine, Russia is using military-trained dolphins for protection against underwater attacks. Military dolphins throughout history were trained to detect and injure enemy divers, plant explosives on enemy boats, place underwater mines etc.
All of these practices mentioned above influence animals' freedom and harm their autonomy.

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[99] Horgan, John. "Tribute to Jose Delgado, Legendary and Slightly Scary Pioneer of Mind Control."
[100] Horgan, John. "Tribute to Jose Delgado, Legendary and Slightly Scary Pioneer of Mind Control."
[101] Horgan, John. "Tribute to Jose Delgado, Legendary and Slightly Scary Pioneer of Mind Control."
[102] Horgan, John. "Tribute to Jose Delgado, Legendary and Slightly Scary Pioneer of Mind Control."

3. Philosophical perspective

As I have stated previously, humans have dignity and we are rational beings, therefore we deserve respect.

DBS has a great power to interfere with our sense of autonomy. It is making us susceptible to outside influence such as attacks from hackers. But, living with an artificial device in our brains can also alter our sense of autonomy.
It has the power to remove our capability of being self-governing. This is the main point in how this technology is affecting human autonomy.
With DBS we might become incapable of making our own decisions and are being manipulated into a certain kind of behaviour.

We might lose that component that makes us - us. Besides, how are we so different from animals? As we have seen from the above-mentioned examples, animals' freedom has been stolen by various behavioural alteration experiments by humans.

Animals are very similar to humans in many ways, for example, we share 98% of our genetic code with gorillas [103]. In addition, they are sentimental beings, just like we are. Kant believes that there is something disturbing in people who abuse animals for whatever reason as they can easily become used to treating animals badly. Kant believes that there is a slippery slope when humans are unkind to animals, as they might move on to be harsh towards humans as well. By treating animals badly, the abuser may get desensitised and lead him to treat humans in the same way as animals.

During a presentation of Neuralink, Elon Musk presentend the company’s experiment on pigs. From that presentation one pig had a brain implant inserted. They put the pig on a treadmill and the pig was slowly walking. The brain implant was reading brain activity. Using AI models, they were able to predict the joint movements of the pig. On the same occasion, a scientist working on the project stated that one of the first applications of Neuralink will be

[103] Wong, Kate. “Tiny Genetic Differences between Humans and Other Primates Pervade the Genome.”

on patients will severe cervical spinal cord injury [104]. Cervical spinal cord injury often causes loss of sensory functions[105] and can often result in full paralysis [106]. Elon Musk said that if they can sense what a patient is trying to do with their limbs, this device could help them restore the full-body motion.

Is there a difference in neural activity when I think about moving my arm and when I actually move it while thinking about moving it? I suppose that if we think about moving our arm, we will move it and then immediately think about something else while moving it.

Will the AI model be able to recognise the difference? Will this device make me move my body in a way I do not intend?

Undoubtedly, this sounds like a very humane project - helping people restore movement capability. However, what effect will this have on their sense of autonomy? If they know that they are not the ones moving the limbs - but the device is. If a person is partially disabled - will they know which actions they are performing, and where the device is stepping in?

High-frequency electrical stimulation is most useful in treating tremors in PD. However, new research finds that introducing light stimulation to the nerves may, for example, help people learn new tasks more quickly, it may substitute the role of coffee etc. What happens when we allow people to change their frequencies, or when it becomes 'normal' to use this sort of technology for purposes other than restoring health?

This sort of stimulation could potentially have the same effect as the rat's from Olds and Milner's experiment. It could cause addiction.

Conclusion

Neurotechnology is developing at an exponential rate and innovations in the field are constant [107]. Deep brain stimulation is a type of invasive neurotechnology that involves placing an electrical implant in the deep parts of the brain. It is used to treat various diseases

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[104] CNETTV. "Neuralink: Elon Musk's Entire Brain Chip Presentation in 14 Minutes (Supercut)."
[105] "Cervical Spinal Cord Injury: Symptoms and Prognosis." What Is a Cervical Spinal Cord Injury?
[106] "Cervical Spinal Cord Injury."
[107] Goering, Sara, Eran Klein, Laura Specker Sullivan, Anna Wexler, Blaise Agüera y Arcas, Guoqiang Bi, Jose M. Carmena, et al. "Recommendations for Responsible Development and Application of Neurotechnologies."

but it is mostly used to treat Parkinson's Disease. This technology is not new, it has been around for roughly 60 years.
Many people report having a distorted sense of self after the surgery, some question their sense of identity and there are numerous reports of character change - both positive and negative. This technology, like any other technology, has its positive and negative sides, however, it is a more sensitive issue than other types of technology because it directly involves the human brain.

More practical threats of DBS are cybersecurity threats such as brainhacking where a third party gains unauthorized control over a person's brain implant. Another incredibly important issue of DBS is the issue of data. Neurocapitalism is becoming a rising issue as brain data may soon be the target of large corporations who would use it for profit marking. With the rapid changes in technology, there is a need to create new human rights. Rafael Yuste established the Neurorights initiative that has a mission to protect how a person's brain data is accessed and used. It consists of five key neurorights [108].

Human autonomy is the right of the person to be self-governing. DBS has mostly a distortive impact on our autonomy. If DBS is used to restore a person with an illness into a healthy state such as helping relieve symptoms of Parkinson's, then it can be considered that this technology is supporting human autonomy.

From a philosophical perspective, DBS is making us less autonomous. The actual autonomy that a person has is not as important as the patient’s perceived autonomy. When a person’s sense of autonomy is taken away from him, his overall well-being and happiness are reduced as well and becomes more prone to developing depression. As far as autonomy is concerned, this sort of technology has a direct and mostly negative impact on people so far.
Innovations that are coming in the field of neuroscience are arguably harming human autonomy as their mission is not to heal a person, but to enhance their current, healthy state. Examples of these innovations include improving the memory of a healthy person or playing video games using only the mind.

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[108] Wajnerman Paz, Abel. “Is Mental Privacy a Component of Personal Identity?”

When taking into account Dr Delgado's statement that he is trying to liberate humans from their aggressiveness, we must ask ourselves if using invasive neurotechnology such as DBS is appropriate or even necessary in changing human behaviour. If the goal is to remove aggressiveness from people, would it be better to do so by using chemical farmaceuticals or should we for instance use nudging to influence the behaviour of people?

As we have seen through the thesis, there are many ethical concerns when it comes to DBS. DBS could affect our identity, privacy, agency, personality, and above all - our autonomy.
The positive effects of DBS are numerous, and this technology is helping many people. This neurotechnology can and is being used for a noble act - restoring people to a healthy state. When a person who has been living a long time with serious symptoms of an illness that has been interrupting their life, when it interrupts their normal activities when they are unable to live their life to the best of their capacity due to an illness that may have alsp distorted their relationships, and DBS can help them 'get their life back' - it may be the last chance they have. Here, I am referring to illnesses that cannot be as effectively treated by medicines. PD for example can be treated with medicines, but after some time the effect of the drug wears off. People may then switch to more invasive methods such as undergoing a DBS surgery since it is proven that DBS reduces the wearing-off and reduces tremors significantly over a longer period than pharmacotherapy [109].

DBS has both positive and negative sides. On one hand, it is helping people by reducing the symptoms of their disease. On the other hand, it can bring up many psychological issues in the patient such that the patient may fail to differentiate between what is them and what is the machine. It can put in question a patient's sense of autonomy. Do the physical improvement outweigh the psychological and philosophical issues that may arise?

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