Exploration of the Disruptive Effects of Brain-Computer Interfaces in the Context of Body Modification

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Abstract

For thousands of years humans have elected to perform body modifications on themselves as a form of self expression central to their culture, but the modern era has brought huge advancements in technology and with it new forms of expression. Some of these technologies are disruptive meaning that they completely change the way we do things. In particular, the development of brain-computer interfaces has altered the way we separate humans and technology and will change the ways in which fellow citizens interact with one another on a daily basis. The potential effects of BCIs are unfathomable, and will change computing, relationships, power dynamics, and modern capitalism. This thesis aims to explore the disruptive technology that is BCIs in the context of body modification, and shed light on the considerations that will be needed to combat the technology's inherent and use of politics. I believe that the most important consideration before the popularization of BCIs is the positive and negative effect the technology will have on a person's bodily autonomy.

Introduction

Throughout history, body modification has been a way for people to display their status and identity, dating back over 8000 years. Various cultures have utilized different forms of body modification to achieve this, such as piercings and body scarification used by indigenous tribes over 10000 years ago to ward off evil spirits and convey strength, tattoos received by Egyptian pharaohs 5000 years ago as a tribute to gods and directions for the afterlife, and Chinese foot binding 500 years ago as a symbol of status and beauty. The use of body modification for religious or cultural practices, such as circumcision, subincision, piercings by African tribes, or body suspension from the Mandan, further illustrates the diversity of ways in which people modify their bodies. Everything from the form, location, and materials used in body modification had some sort of meaning for each culture. An article entitled *The Body as a Map: H History of Body Modification*, argues that just as different cultures have different languages for communication, they should also have different forms of status and self expression (Veldhuis, 2019). While tattoos and piercings are still common forms of body modification today, advances in technology have led to devices like prosthetics and pacemakers being integrated into the human body, raising ethical and safety concerns.

Advancements in technology have brought about exciting possibilities for integrating technology with the human body, such as through brain-computer interfaces (BCIs). BCIs are a technology that can provide a deeper understanding of the brain and its functions. Originally developed to treat conditions caused by brain degradation or traumatic injury, BCIs are currently used in non-invasive, semi-invasive, and invasive techniques to measure brain signals. These techniques use electrodes to measure differences in electrical potential which can then be translated into images, movements, or commands (NeurotechEDU, 2023). Not only have BCIs

been used for therapeutic purposes, such as helping patients with paralysis communicate with affected parts of their body, but they also have the potential to revolutionize daily life in aspects such as education, medicine, entertainment, and communication. With further research and development, BCIs could be widely used and have a profound impact on society. A few companies at the forefront of this technology's innovation include Facebook, Neuralink, and Kernel.

In Langdon Winner's *Do Artifacts Have Politics?* It is explained that an artifact's politics are determined by the changes in power dynamics and the balance of power shifts for better or worse. The existence and use of BCIs provide new ways for humans to interact with their environment and each other, creating new avenues for creation and interaction. However, the technology behind BCIs, as well as its precursors and derivatives, raises concerns about a human's right to bodily autonomy and potential negative effects. While BCIs were originally produced to benefit a small aspect of human health, their creation has opened up the possibility of a wide range of unforeseen consequences. These effects make BCIs a disruptive technology that alters the way in which we do things rather than enhance the way we do things. Disruptive technology is often seen as bad because the consequences were unexpected and caused negative outcomes. In this essay I will analyze in what aspects BCIs is a disruptive technology and the inherent and use politics of each aspect (Winner, 1980).

Disruptive aspects of BCIs

BCIs were originally conceived as therapeutic and rehabilitative treatments for a range of medical conditions such as strokes, Parkinson's, car accidents, and amputation. These conditions can affect movement and the body's ability to communicate with the brain, very similar to an electrical appliance not being plugged in. There's a few different ways BCIs can capture signals

4

that come from the brain. Non-invasive techniques, such as EEGs or MEGs, measure the electrical potentials on the scalp that are produced by the brain, while semi-invasive techniques use ECoGs placed subcranial on the membrane that separates the brain from the rest of the body. Invasive techniques use microelectrodes inserted directly into the cortex, providing the clearest signals given that there is less body and tissue for the waves to pass through (NeurotechEDU, 2023). The implementation of any one of these BCIs would allow, to some degree, a user to circumvent those disabilities and, with a few adjustments, carry on with daily life. In fact some BCIs have already made strides in that direction, for example in 1998, the first invasive BCI was implanted and allowed the user to move the cursor on a screen (NeurotechEDU, 2023), and in 2017, a stroke victim had an array of electrodes implanted in his brain and arm, which allowed him to once again move the joints in his arm. A few pioneers in the field of BCIs believe that with more development and a greater understanding of the mechanisms in the brain, this technology could eventually be used to treat conditions like depression, anxiety, and addiction (Cuthbretson, 2020). In a little over 20 years BCIs have made great progress into the rehabilitation of a few individuals, but a majority of these milestones were achieved under a high amount of restrictions. With a technology that could have a slew of unknown effects, consent and full disclosure of how the technology functions is crucial for users to understand that they should still be wary of how they interact in their day to day life.

Consent and full disclosure of risks become the most important aspect of BCIs for both users and creators, especially in the event that the technology fails while in the user. The apprehension of BCI reliability has been one of the most prominent topics in regard to BCI popularization. If the device were to fail or malfunction at an inopportune moment with great harm or injury coming to the user, the fault would certainly fall upon the device's designer or

manufacturer. Thinking of situations like these can put all actors in a precarious legal situation, which has led one company to consider the direction of the product's development. Elon Musk, CEO and co-founder of the company Neuralink, announced the development of an implantable device that would augment the human brain's abilities by creating a "neural lace" or "wizard hat." But Musk knew enough about the invasive nature of BCIs to consider what precautions would need to be made to increase its safety and reduce potential negative long term effects. In an interview, Musk responds to questions of this nature with "The development of such devices requires them to be biocompatible, safe, and have wireless communication that does not degrade over time. Additionally, the power problem needs to be solved, and volunteers need to be found for experiments." (NeurotechEDU, 2020) While in the physical aspect, a meaningful partial brain interface is still four or five years away, the nature of body modifications with electrical components may demand significant consideration in regards to the security of the device and its users.

As said, the reliability of BCIs, or any Class III medical device, are significantly vulnerable to third party tampering due to the electrical components inside (FDA, 2020). Terrorism is a very real threat to many, and mostly occurs through violence and intimidation to the general public. the existence of a device in a person's vital organ, leaves an alternative method for a third party to exert control over a targeted few. A television show called Homeland brought this reality to light for many fans in episode 10 of the second season, where a politician's pacemaker was hacked and accelerated to cause a heart attack. It's a fantastic scenario that demonstrates the low levels of security that devices such as pacemakers and BCIs have. The government has recognized the future of human and technological integration and as a preventative measure for similar scenarios, has written laws requiring the FDA and the

Cybersecurity and Infrastructure Security Agency (CISA) to revisit the requirements and safety protocols for medical device approval (Connolly, 2021). These laws are detailed in the consolidated appropriations act and will be especially influential in the debate for widespread BCI usage. BCIs will have the ability to treat paralysis, and give the human brain superior computing power, but are all heavily dependent on whether or not its cybersecurity measures can protect the user.

BCIs will also hold the power to upload and download data from the brain. In fact, Musk has changed Neuralink's goal, from its original purpose to treat paralysis to creating a "fully implantable, cosmetically invisible, brain-computer interface to let you control a computer or mobile device anywhere you go called the 'Link.'" (Neuralink, 2023) His reason for pursuing this is due to the fact that the biggest limitation to human communication is the speed at which we humans can physically communicate. With this aspect of BCI, we would no longer need to sit and type out an essay by pressing keys on a keyboard, instead we would simply just write it. It sounds too simple to be true, but as Kline and Clynes distinctly pointed out, it would be easier to adapt a human to space rather than change space for the human (Kline, 1960). Similarly, phones and computers are our changes to the environment of communication, but what if we changed the way humans communicate? This is where the idea of Brain-to-brain interfaces (BBI) is born. In 2014, two different individuals were able to send and receive EEG signals, albeit incomprehensible signals, through the internet to each other.

It is important to note that only a signal was transmitted, not a cohesive thought. In order for a cohesive thought to be transmitted, as much as 1 million neurons would need to be recorded simultaneously, which is limited by several logistical challenges (NeurotechEDU, 2023). First a more widespread and invasive BCI would need to be developed to capture that many electrical

signals. Recall the man in 2017 that was fitted with an array of electrodes to move the joints in his arm. In this case, the electrodes were placed on a small area on the outer layer of the brain's cortex to capture signals that would otherwise go to the arm. However, to capture complex thoughts, memories, etc. the BCI would need to reach the medulla and hippocampus, which is dangerous by itself. Musk supports the exploration into these parts of the brain because he believes it would give us a deeper understanding of the brain and potentially understand addiction, depression and other neurological disorders. (Cuthbertson, 2020)

BBIs would allow humans to become more efficient than ever, where people can share information, thoughts, plans and worries, which in some ways sounds like a hive-mind. But the motivation behind BBIs and BCIs would-be creation is due to the competitive standards our society has created. The allow of instant exchange of information between two or more people could be catastrophic in regards to the users data and privacy. With BCIs being touted as an extension of mobile devices by Musk. It's important to address concerns of collecting and swelling personal data for a person or companies benefit. For example, a spyware developed by an Israeli cyber-arms called pegasus was recently able to monitor and gain information on someone's phone just by sending them a text (Cutler, 2021). For cybercriminals that gain access to malware as such, a user's personal identity and privacy would be jeopardized, and would necessitate leaps and bounds in security and potentially fuel the creation and development of quantum computing and AI.

With the integration of BCIs into humans comes an unknown increase in computing power. Artificial intelligence is not far fetched when you frame its creation around the processing of human thought. As mentioned before, the amount of signals that would need to be received and decoded in order to perform a meaningful task is insane, and realistically the only

programs that would be powerful enough would be a form of AI. Musk theorizes that the use of BCIs would result in a pseudo-symbiosis between man and machine, and would likely rival the advancements that will be made in artificial intelligence in the coming years. The symbiosis would be a result of the back and forth 'one-upping' of modified humans and programs to each other (Thomas, 2023). The idea of AI and deep learning surpassing the knowledge of the human race would require us to constantly beat out the efficiency of AI with our own upgrades in power and efficiency. Similarly to the worry of increasing computing power, we question ourselves if athletes with prosthetic limbs should be allowed to compete with others. Metabolically, blade runners expend less energy which is better for the athletes performance. Translationally, the integration of BCIs with humans would also be more efficient. But increased efficiency is not always better.

Up until this point I've summarized the history of body modifications and what kind of requirements and subsequent effects the creation and implementation of BCIs would have on technology and the individual. Now I will attempt to analyze the effects that BCIs will have on society and its power dynamics.

The notion that more is better and efficiency is an indicator of success is rooted in the highly competitive environments that capitalism has created. Students all around the globe consume large amounts of nicotine and caffeine to increase and optimize productivity and result in them completing their goals. In this aspect, Capitalism and transhumanism walk hand in hand, each pushing the limits on making seemingly impossible challenges a reality (Thomas, 2023). Many people attribute the creation of capitalism to the power-wielding men that laid the foundations of modern society, and a major problem with this structure is that a majority of energy is expended in gaining and keeping power. The methods of getting power are usually

focused around increasing efficiency or abilities, rather than enhancing what things we can feel or experience (Earle, 2022). Feeling and experiencing things are qualities that have been attributed to feminine behavior and go overlooked in a society created with male ideals. With the introduction of BCIs, I can only wonder if more differences would arise with technological changes to the body. There is potential that feelings of superiority, power, and comprehension would become native to BCI users, and a third gender, that being transhuman, become a more influential actor in society.

The nature of capitalism would suggest that the right to morphological freedom would be exploited by the wealthy, leaving lower classes behind. This has important implications for the effect that BCI technology would have on socioeconomic classes. The cost of BCIs, unless highly subsidized or awarded communistically, would likely widen the gap between the rich and the poor, because those who can afford BCIs gain greater control over their lives and the ability to compete, putting them even higher than those who cannot afford it. Even in the context of disabled populations, those who could afford therapeutics would overcome physical barriers and lead more normal lives, leaving the poor to bend at the mercy of insurance companies. If BCIs ever became a product that was necessary for survival, the ethics of insurance companies operations would be questioned heavily. For example, would an insurance company deny the coverage of anti-rejection medication given to a recent transplant recipient. If the insurance company decides not to cover the medications, they are essentially sentencing the person to death (Kolata, 2019). Now in the context of BCIs and biohacking, the predicted socioeconomic effects of their use would suggest that the technology should be awarded to everyone and not just available (Earle, 2022).

The potential socioeconomic effects of BCIs would suggest that there is no way to escape its detrimental effects, but as mentioned, this is in the context of capitalism where power, money, and efficiency are important. If the use of BCIs was framed into a mindset of feeling and experience the effects would look quite different. In Victoria Pitts' book *In the Flesh*, she explores the connection between feminism and body modification, particularly in the context of sex, gender, and race. While feminism has gained considerable support, it seems that more complex forms of body modification, such as brain-computer interfaces (BCIs) or technological implants, would not be very widely accepted. Pitts observes that many body modification communities view the human body as a space that needs to be reclaimed from societal norms, and should be used to explore identity, experience pain and pleasure, and establish bonds with others (Pitts, 2015). This stands in opposition to our current society, where the body is often used to present ourselves as attractive, trustworthy, and desirable in the eyes of others. As such, our bodily autonomy is often restricted, particularly in regards to the opinions and perceptions of those in positions of power, such as employers.

Just as it was mentioned that BCIs would allow users to explore their identity, they also have the ability to reacquire their identity. There is a user on tiktok named Mark Relei that has received a very complex prosthetic implant through means of osseointegration. Ordinarily there are prosthetics that can recapture the abilities that an amputee once had without the invasive techniques of osseointegration, but the man who received this implant said that even with the traditional prosthetic techniques that returned function, the more complex implant allowed him to become a living moving part of his community again (Relei, 2023). This is because the implant would actually spark people's interest and treat him fairly rather than notice a prosthetic and shun him, as most amputees are treated. In this case, the user had the exclusive choice to

maintain his own bodily autonomy, rather than be subject to tasks needed for the detachable implant. His choice to receive an elective procedure benefited his life greatly.

The concept of receiving elective procedures is important. People often receive elective cosmetic surgery to meet a standard of beauty, Blood transfusions are being used between age groups to revitalize cells, and women receive abortions on a daily basis. The reason behind these actions can be reduced to the simple fact that the people wanted to do it. More accurately, these procedures were performed so that their outlook of the future was better for reasons such as money, health, or feelings of happiness. But there are some cases where the person's outlook on the world is bleak. Sometimes people's outlook is so bad that they elect to receive a chemical euthanization. The circumstances that decide this path are very complex but a majority of the people that choose to proceed with the euthanization feel isolated, usually caused by a debilitating condition or mental disease that makes them unable to interact with society at a healthy level. This might seem far-fetched, but elective euthanizations are very real and very legal in the country of Canada (CAHealth, 2023). Sometimes, someone believes that their reintegration with society is doomed and typically has no control over helping that matter. But if people have the ability to legally end their own life then why don't they also have the power to improve their lives through the use of BCIs. Thinking of scenarios such as these allows BCIs to be framed outside of the norms of efficiency, productivity, wealth, and advocate for their integration on the basis of restoring or enhancing feelings of community or fully experiencing life.

Wrapping Things Up

So how are BCIs any different from the most common body modification which is the piercing? As a thought experiment, take an ear piercing and now give it an electrical component

like the ability to make phone calls. Is there a significant difference between the two? Now take an ear piercing (no electrical component) and change its location to behind the ear and beneath the skin. Is there a significant difference between that and a woman receiving breast implants? Now combine both the electrical component and change in location. What makes it taboo? I would argue that the movement of a machine to an internal location marks their integration and begins to blur the line between the conflict of man vs. machine.

Along with the advantages and shortcomings created by BCIs that I've highlighted throughout this essay, there remains one phenomenon that already exists today and may be exacerbated by BCIs, that being damages to the human psyche. Experts say that even though people today are the most socially connected in history, they are also the most depressed in history (APA, 2019). Our dependence on technology raises concerns about the potential psychological issues that may arise from using BCIs and has the potential to alter subsequent generations with changes in epigenetic information. These changes in genetic information would adapt each generation to the use of BCIs and allow self-directed human evolution.

Conclusion

So out of all of these examples and effects I've come to the conclusion that a body modification's acceptance into society is dictated by its effects on bodily autonomy, much to the same tone that the feminist movement has been pushing for —The right to control your own body. The creation and implementation of BCIs would leave a lot of potential for a person's bodily autonomy to be hindered while adding or removing pieces of flesh and simple materials would not. Bodily autonomy is already a fragile concept that is damaged by the expectations of culture and society, but if BCIs could be implemented with adequate preparation, to avoid the politics associated with disruptive technologies, its support for bodily autonomy would exist. As

the article that I opened this essay said, each culture has a different way of communicating and displaying your character and experience as a person. BCIs and other technologically advanced implants could just be the way our post modern society decides to communicate those things.

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