5ARC0 Human and ethical aspects of AI

Ethical Aspects of Brain-computer Interfaces

Group WA4

Sven Bierenbroodspot, 1334859
Akshay Ballal, 1968645
Tim Huggers, 1480642

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1 Introduction

After a great period of increased availability of food and a limited amount of destructive physical human labor, humanity seems to have reached a peak in human performance. Birth rate has been falling, prosperity disease has been on the rise. Healthcare is the greatest expense of the Dutch state with a shocking 111,3 billion euros expected for 2024 (Miljoenennota 2024 [1]), with the potential to grow significantly as the mean population is aging by the year.

It might be time to solve the most complex diseases that occur within the brain instead of just the body that surrounds it. A direct connection to our brain has the potential to intervene in the most complex disease that impacts the great controller that moves and motivates our body but might come at the cost of the integrity of the person.

June of this year marks the month that brain implant company Neuralink received FDA approval to start testing on human subjects. (The Guardian, 2023 [2]) Brain-computer interfacing (BCI) is not a foreign technology that only appears in science-fiction any longer. What does this imply in the context of healthcare, equality, and our humanity itself?

All this has been possible mainly due to the advancements in Artificial Intelligence technology that have propelled the development of Brain-computer Interfaces. Most of the BCI applications in the past decade have been possible with AI assistance (Zhang, et al., 2020) [3] These applications help improve the quality of paralyzed patient's lives, help people with disabilities with their everyday activities. They have also shown a promising impact in the rehabilitation of people with neurodevelopment disorders (Papanastasiou et al., 2017) [4] . Without AI, it was very hard to make any sense of the data (EEG, fMRI) that was gathered from BCI. Artificial Intelligence helps in the analysis and decoding of neural activity data. AI, in conjunction with Brain-Computer Interfaces, receives ongoing updates of internal parameters, including data on pulse durations, amplitudes, stimulation/recording densities, and electrical properties of neural tissues. Once equipped with this information, AI algorithms swiftly discern valuable insights and logical patterns within the data, enabling them to generate the desired functional results in real time.

One of the applications that has resulted from this is the ability to control a computer cursor. This can help people with disabilities to operate a personal computer to get various tasks done. Another crucial application has been in neuroprosthetics and limb rehabilitation. These applications include the ability to restore behaviors such as reaching and grasping, self-feeding, and arm movements. One of the most significant breakthroughs has been in the field of speech synthesis. (Moses, et al., 2021) [5] make use of deep-learning AI algorithms to create computational models for the detection and classification of words from patterns in the recorded cortical activity. This would restore the ability to communicate in paralyzed persons who cannot speak.

Visual prosthetics is another key application using BCI. With AI rudimentary vision can be achieved by converting images into binary pulses of electrical signals and delivering them to the visual cortex (Weiland and Humayun, 2014) [6].

There are very promising results for using BCI as an assistive technology. It could be used for paralyzed patients to gain control over prosthetic limbs, wheelchairs, or computer cursors. The field of possibilities for the BCI application is much broader than only these examples but for now, it should set a great example of what is possible with BCI.

However, as Burwell et al. [7] explored, there are also negative implications of BCI. The concerns raised by Burwell contain user safety, the concern on humanity and personhood, stigma and normality, autonomy, responsibility, research ethics, privacy and security, justice, and other issues. In this article, we want to discuss some of these topics with more attention to determine whether BCI should be implemented with its ethical implications considered.

In the first section, we will see why it is very important for us to continue the development of AI-powered BCI technologies despite some of the criticisms like the concern about loss of personhood and concerns about privacy. We will see how we can use the capability approach framework to show the ethical importance of BCI technology.

Intervening in the neural pathways that form our character and controls our behavior could have an effect. Is it possible to be fully understanding of the effects and if so, is it morally required to disclose the potential effects to the person undergoing the BCI? The second section will attempt to answer this question.

In the last section, we will discuss why the privacy risks involved with wireless BCI technology are significant.

2 Akshay

In this section, we will see why it is necessary to develop AI technologies that can enable Brain-Computer Interfaces to cater to individuals with disabilities. I argue that despite some of the criticisms (Jebari K., 2013) [8] related to loss of personhood, privacy, and, safety, it is ethically very important to continue developing this technology. We will also dive more into these criticisms and counterarguments and explain why these criticisms should not impede the development of BCI technology. We will also see how we can use the Capability Approach Framework (Nussbaum M. and Sen A., 1993) [9] to reinforce this argument.

2.1 Main Argument

1. Artificial Intelligence has enabled Brain-computer interfaces to let people perform actions that they otherwise wouldn't be able to perform due to their disabilities, which makes them more included in society.
2. Inclusivity and accessibility are ethical imperatives, and technology should be designed to empower and improve the quality of life for all individuals, including those with disabilities.
3. Therefore, it is necessary to push AI technologies to make Brain-Computer Interfaces even better as they align with the ethical principles of inclusivity and accessibility, enabling a better quality of life for individuals with disabilities.

According to the (Convention on the rights of people with disabilities, 2006) [10], accessibility is one of the most critical methods to make people with disabilities more inclusive. From public infrastructures like museums and offices to digital interfaces like apps and websites, accessibility is at the core of design principles. Catering to people with disabilities has always been a challenge across different fields. Disability inclusion means that individuals with disabilities can participate in every aspect of life to the fullest extent possible. These opportunities include participation in education, employment, public health programs, community living, and service learning. However, it can be seen that even the most accessible and inclusive systems may not be able to integrate people with disabilities to the complete extent possible. People with disabilities can be catered to in two different ways.

1. Changing the surrounding environment to accommodate and compensate for the disability.
2. Minimizing their disability so they can interact with the environment like people without disabilities do.

Several design frameworks exist to address the former. These include ramps, text-to-speech, and special schools. But we can argue that even though these solutions make the system more inclusive, there is more to be desired. Also, even though these accessible features make the person more inclusive, they do it by providing an alternate choice to the person which may not align with their preferences.

We can reinforce the argument using the Capability Approach (Nussbaum M. and Sen A., 1993) [9], an ethical framework that claims that the freedom to achieve well-being is of primary moral importance, and well-being should be understood in terms of people's capabilities and functioning. represent parts of the state of a person, in particular, the various things that he or she manages to do or be in leading a life. The *capability* of a person reflects the alternative combinations of *functionings* the person can achieve and from which he or she can choose one collection. Some *functionings* are elementary, such as being adequately nourished, being in good health, etc., and all may strongly value these for obvious reasons. Others may be more complex but still widely valued, such as achieving self-respect or being socially integrated. The capability approach framework has three main blocks. Resources, capabilities, and *functioning* as shown in Figure 1. For example, to be able to drive a car, the resource would be the car itself and the roads. The capability will be a person's skill to drive a car. The *functionings* would be the different human characteristics like vision and motor movements of limbs required to execute those capabilities.

Given the capability approach, we can see that BCIs act as "Enablers". They enable the well-being of people with disabilities to get back an extent of their *functionings* to achieve what they want.

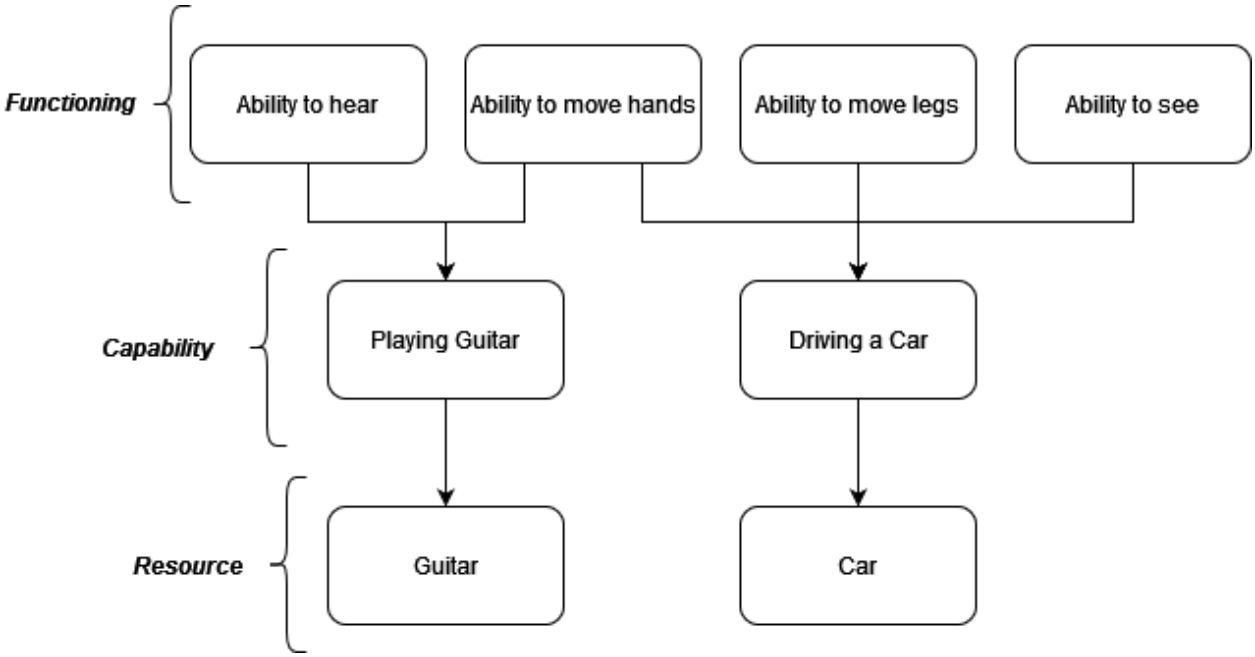

Figure 1: An illustration to show some examples of functioning, capabilities and resources

2.2 Stakeholder Analysis

Three stakeholders can be identified when using BCI technology to empower people with disabilities. First, are the people using the BCI technology to regain their *functionings*. Naturally, this is going to be beneficial for them because it allows them to achieve well-being. However, one of the downsides could be the social stigma attached to using technology to perform everyday tasks. People with prosthetics often encounter stares and comments about their synthetic limbs, which might create discomfort. One way to tackle this would be to drive social awareness campaigns to normalize the use of BCI. Also, some people do not identify themselves as disabled. They prefer the term "differently abled" and these people would not want to carry the moral burden of using BCI technology to restore their *functionings* because they are happy as they are. Thus, we must ensure that people with disabilities who do not use BCI are not viewed as moral offenders because it has to be their choice.

The second group of stakeholders who would be affected by the penetration and improvement of BCI technology are the designers and planners. Generally, designers and planners have to focus a lot of effort on creating systems that are accessible and inclusive for all the people using them. Suppose technology can help reduce the number of people with disabilities so they can use these systems the same way anyone else would. In that case, the designers and planners can put more effort into improving their designs and plans and less effort into making them accessible.

The third group of stakeholders is the policymakers. Policymakers would be faced with a new challenge of how to control the distribution of BCI technology. As we will see in the next section, uncontrolled distribution of BCI can result in a few privileged classes of people who may use this technology unethically. Also, the technology would have to be made available to everyone in an affordable way so that all people with disabilities have the right to adopt BCI and achieve well-being.

2.3 Criticisms

Some criticisms and counterarguments have been and could be raised against the BCI technologies acting as "Enablers" for people with disabilities.

1. Does this technology make people less human? The term "Cyborgization" comes to mind.
2. Using technology to enable critical *functionings* and capabilities like crossing a road or driving a vehicle can have unintended consequences if the technology fails.
3. Could result in a privileged class of superhumans.

The first criticism against the technology has been raised a lot, but it has not been clearly shown what cyborgization is and why it would be bad (Schermer, Maartje) [11]. But as shown by (Schicktanz et al., 2015) [12], Humans have always used technology to restore their capabilities and functionings. For example, cochlear implants have been used by people who are profoundly deaf and spectacles for people with vision problems. We have also implanted ourselves with pacemakers and bone replacements to restore our critical body functionings. I would argue that cyborgization has been taking place for a long time, and BCIs are a big step towards this. But it cannot be shown that cyborgization is terrible because if cyborgization can act as an "Enabler" in the capability approach, then it is good.

The second criticism is something that can put a halt to the development of BCI technology because a couple of mishaps due to BCI device failure can shed a bad light on this technology. (Davidoff and Erika J., 2020) [13] shows that this can be viewed as an engineering and risk management problem. BCI technology developers have to ensure enough redundancies and fallbacks in case BCIs are used to restore *functionings* used for critical capabilities like driving or crossing a road. Risk mitigation is of crucial importance. It is similar to other critical technologies developed before, like airplanes, where a small mishap could lead to a catastrophe. But because we know there is a significant risk, certification bodies and engineers must make the qualification and testing very stringent. Today, because of strict certification and high-quality assurance, aircrafts are one of the safest modes of transport.

The third criticism is of the highest concern if we look at BCI as a means to restore or substitute human functionings. If given complete freedom to develop and use BCI technology, some privileged individuals can extend their functionings beyond human levels. For example, using BCI and exoskeletons to achieve superhuman strength or integrate with a knowledge base to achieve superintelligence. It is paramount to control the distribution and development of BCI technology to adhere to the capability approach. This entails restricting the technology's scope to restoring essential functionings for the well-being of individuals diagnosed with disabilities, refraining from augmenting functionings beyond these fundamental requirements for capability restoration.

2.4 Conclusion

In conclusion, developing Brain-Computer Interfaces (BCI) to empower individuals with disabilities is an ethically imperative endeavour. Critics may raise concerns about the loss of personhood, technological failures, and the potential for creating a privileged class of superhumans. However, these criticisms should not deter us from progressing in this field. BCIs, when approached with the Capability Approach framework, serve as enablers that enhance individuals' well-being by restoring critical *functionings*. While addressing social stigma concerns and ensuring choice for those who identify as differently-abled, BCIs also relieve designers and planners from the burden of excessive accessibility efforts. Policymakers must navigate the responsible distribution of BCI technology to prevent unethical augmentation. In sum, when guided by ethical principles, BCI technology promotes accessibility, inclusivity, and well-being for individuals with disabilities.

3 Sven

In this section it will become clear why BCI poses a threat to human rights. I will discuss the ethical implication of external interference on wireless BCI and present some counterarguments. I will explain why these counterarguments and the current strategy does not suffice. A study showed that one of the concerns of the general public regarding the BCI is related to privacy (Jebari K. 2013 [8]). Subjects state that it is required to have strict legislation in order to prevent sensitive information from landing in the wrong hands. But is this legislation a solution to the privacy problem? I argue that the use of wireless communication in BCI exposes its user to risk of interference.

Informational privacy is of concern regarding BCI because of the nature of the data. This data may contain

unexpressed thoughts, personality characteristics and emotions among others. With this data being so sensitive it is of utmost importance that this data is handled very carefully. With this in mind, a wireless communication system is prone to external interference like electromagnetic interference or even deliberate hacking attempts. This sets the stage for a data leak of any kind. But is this public concern about privacy correct, or is there no just cause? According to article 12 in the Universal Declaration of Human Rights (UDHR [14]), no one shall be subjected to arbitrary interference with his privacy. Therefore, using BCI with wireless communication will violate the human rights.

Since wireless communication is prone to external interference the risk of a data leak cannot be deemed negligible. A separation is made between intentional and unintentional interference. Where unintentional interference includes for instance electromagnetic interference and intentional interference means there is someone deliberately trying to interfere. The ethical implication of interference in the form of intentional interference, might be that there are unknown third parties who are able to access your thoughts. This directly violates the 12th article in the UDHR and should therefore be considered as a violation of human rights. In my opinion, the risk of interference in combination with the catastrophic implication is too problematic to be able to widely adopt this technology. There is a conditional relationship between the premises. If there is a risk of interference, then there are potential privacy concerns. I conclude my statement by connecting the two premises.

The premise includes a stress on the importance of privacy for humans. This right is not to be violated without just cause. This premise is not just a philosophical concept, but it is incorporated into legal documents such as the UDHR as well as the agreements in the European Convention on Human Rights (ECHR [15]). The recognition of this right into law also implies its importance. In a way, the interference with privacy can be connected with broader ethical principles such as autonomy and dignity. Since for example they are not able to have their own thoughts without worrying they will be leaked to any other instance or entity which prevents them from freedom of thought. Glannon also discussed the undermining of autonomy by interference on wireless BCI (Glannon W. 2014 [16]). Unintentional interference might lead to a wrong readout by a BCI device, and this can also lead to problems where for instance the left arm is raised where the user meant to raise the right arm. This can be perceived as a lack in autonomy as well since you cannot make your own decisions. This autonomy has intrinsic value and is not merely a means to achieve other ends (Young R. 1950 [17]).

One of the objections which could be argued is that wireless protocols are being developed to be more resilient against external interference. There is a lot of development in cybersecurity in general which should prevent any data leaks. Therefore, one could argue that the risk of interference is sufficiently low that the benefits of BCI outweigh the privacy concerns. However, there is also a lot of development going into avoiding these security measures. People will always find ways to get to this data and as discussed earlier this is harmful to the BCI subject in question. I believe there is a constant flow of new security measures and a following development in ways to get around it. I would describe the risk of a security breach like a sawtooth, where the security measures are implemented and slowly the technology catches up. While the average risk might not be high, the maximum risk is what we should be concerned about. One of the key points made during the interview of Jebari et al. is that there should be strict legislation regarding the privacy of the data. While this of course sounds great and very logical, it is hard to enforce when there are uncontrollable factors like the external interference. Since there is little control over these factors it is hard to enforce them. Especially when talking about the unintentional interference.

In conclusion, risk of a privacy breach during wireless BCI procedures is too high because of the external interference either intentional or unintentional. The effects of this breach are directly violating human rights as stated in the UDHR.

4 Tim

The effect of the utility increases over the extent to which the technology integrates with our brain. A hammer, as an elemental example, is a static prosthetic that in comparison to our car or social media identity does not merge with our identity as human being. We base part of our social relationships through our technical tools, where the technology influences our character and behavior. The more the technology integrates with our brain, the more strongly the technology can be adaptively and significantly be used

by the person taking part in this human-technology relation. Don Ihde describes a postphenomenological approach to technology, where this type of relationship could be described as an embodiment relation, where technologies form a unity with a human being, where this unity is then directed at the world: '(human-technology) → world'. (Ihde, D. 1990 [18]) This is further supported by P.P. Verbeek, who argues that human freedom cannot be saved by shying away from technological mediation, but only by developing free relations to them, dealing in a responsible way with the inevitable mediating roles of technologies in our lives (Verbeek, P.P. 2015 [19]). Perhaps it supports the claim that I am a human being and not a form of artificial intelligence when I mention that I was inspired to use this argument when Verbeek gave the lecture about the mediating role of technologies that I attended in person.

An inherent quality of a technology is the amount it integrates with our brain. Korte researched the effect of frequent smartphone use on the brain: increased cortical potentials allotted to the tactile receptors on the fingertips, early extensive screen-based media use is significantly associated with lower microstructural integrity of the brain's white matter tracts supporting language and literacy skill, with the most interesting result being that the size of an adolescent's online social network seems to be closely linked to the brain anatomy alterations as demonstrated by structural MRI (Korte, M. 2020 [20]). The more significant a technology is to our daily lives, the more it will change our general brain structure. It is very imaginable that when a paralyzed person from birth has gained the ability to walk through a potential working BCI system, the motor cortex will develop into a more active area than it was before the paralyzation was remedied. This is an undeniable and unavoidable effect of a well-integrated and significant technology.

Lastly and perhaps most trivial, the person that is integrated into the BCI should always be informed of the effects of the intervention. According to the Declaration of Helsinki, which is addressed to physicians that participate in medical research involving human subjects. Article 25 to 32 are all related to the subject of informed consent, where it is essential that the patient is not only giving consent, but additionally is informed sufficiently when taking the decision. Article 26 is most applicable in this context: "In medical research involving human subjects capable of giving informed consent, each potential subject must be adequately informed of [...] the anticipated benefits and potential risks of the study and the discomfort it may entail [...]" (World Medical Association 2022 [21]). If there are any (side-)effects that can be anticipated by the researcher that implements the BCI, the participating person has the moral right to be informed. The researcher has the responsibility to go through great lengths to anticipate and prevent any unwanted side-effects.

In the likely scenario that we intervene in the neural activity of the human participating in a BCI, it is logical some effect on the social behavior and character will follow. As a counterargument, the enormous complexity of the human brain can be a practical hindrance in the ability to inform of the effects of the BCI. Conventionally, it is accepted that the connection between social cognition and molecular mechanisms are conceptually separated as we do not have a sufficient understanding. Bickle challenges this view based on the ideology of ruthless reductionism: 'we can expect to find the molecular mechanisms of the broader social cognitive functions that must "plug into" these specific molecular mechanisms, despite these functions' typically distal, external initial causes' (Bickle, J. 2008 [22]). Researchers therefore have the moral obligation to attempt to find the relationship between a neural intervention and a shift in social cognition so that the person undergoing the BCI is informed of the changes it can or will induce on the behavior and character.

5 Conclusion

Through the previous sections we presented various implications of using AI powered BCI technology. We found that BCI can prove extremely useful for people with disabilities to be inclusive in the society. BCI can mitigate their disabilities and restore their capability to hear, see, learn and move like anyone else. But we also found some problems attached to the use of this revolutionary technology. There are risks related to the physical and mental safety of the user and also the privacy risks that the users are exposed to. In relation to the safety of the users, BCI can cause long term effects to the functioning of the brain and the users may not be communicated about this leading to complications. Moreover, since BCI is a digital technology, it comes with all the risks related to privacy and interferences. Just like how a computer could be hacked and interfered with, BCI devices can also be vulnerable to such attacks. This can expose the user to risks like breach of data, loss of control to their device and more. This shows that BCI has many positive applications

but when developing BCI technology we need to keep in mind the negative implications and mitigate these risks through design and research.

Through approaching BCI's from 3 different ethical aspects, it is possible to synthesize a conclusive estimation of the ethicality of the technology. The application of AI to BCI allows for better substitution of brain control in the case of a disability, which increases accessibility in daily life for those that are physically impaired. This leads to an increase in the person's functionings, capabilities but also general integration into society. As the technology develops that allows medical specialists to intervene invasively into the human brain, its potential resulting effect is more significant and impactful on the patients ability to re-enter and participate in society.

Access to this technology does come at the cost of risking broad cyborgization (and the external interference that might follow), engineering imperfections and their consequences, unfair brain augmentation and unintended characteristic or behavioral implications. It is argued that cyborgization already takes place on a large scale, although in combination with the threat of external interference to pregnable wireless communication, this poses a significant negative ethical implication to BCI technology. Additionally, as the amount of brain function that is substituted increases, also the responsibility to those who design the BCI increases. It is not deemed to be as important of an ethical implication as we have seen way more potentially dangerous technologies such as cars and airplanes be used that had their imperfections in their early stage of development. Another likely threat to the ethicality of BCI related research is the possibility of brain augmentation for the wealthy. A further increase to the inequality existing in society has a negative ethical impact, although it is expected that the potential loss of extremely personal neural data will discourage those but the ones that absolutely need it to be able to participate in society will find it worth risking. Lastly, the unavoidable change in character and behavior will be significant but should not have major negative ethical impact as long as it is understood and disclosed to the person undergoing the BCI what the implications are to the character and behavior by the implementation of the intervention.

The implications for researchers in the BCI field is that there are definitely risks and downsides involved, but these can be reduced as much as possible to reach a state where the benefits outweigh the risks and impact of this risk. The benefits from BCI have a positive influence on the wellbeing of individuals through accessibility and inclusivity for example. The implications of a privacy breach are still very significant, however, with careful and considerate engineering this risk can be reduced. Researchers should also consider the application for the BCI, where a controlled environment sets the stage for the best possible risk mitigation, exposure to the current outside environment will inherently increase the risk on concerns such as privacy. It is of utmost importance to keep this risks down with as much effort as possible to make sure the risks do not outweigh the benefits. Because these benefits will still exist also when the risks are too high, this should be a good motivation to mitigate the risks as there is a lot to gain. Furthermore, The people involved with BCI research should make an effort to understand the underlying mechanisms that could change character and behavior. In conclusion, BCI research should definitely continue to improve lives while taking proper measures to safeguard the users from privacy breaches and maintain their mental and physical safety.

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