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The Ways BCIs can be Abused and The Necessary Preventative Actions

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ABSTRACT

The development of the brain-computer interface (BCI) reveals the plethora of its uses in the modern world. From hospitals and medicine to entertainment and gaming, the BCI shows great potential to im-prove human lives. As BCIs continue to advance, the question of ethics arises. This paper discusses six main concerns that have emerged with the growth of BCIs, and an explanation of why action must be taken to prevent these possible issues. These issues include: data security and privacy, monitoring and influencing affective states, the manipulation of affective states, unethical uses in a corporate environ-ment, lack of understanding the possible unintended consequences of using such technology, and une-qual access to the technology itself. The paper concludes that there are many examples of technologies that have developed rapidly without proper guardrails, and the BCI, with an incredible amount of poten-tial, is another example of technology that poses risks in absence of the right guardrails. It ends with sug-gesting approaches for enacting, through the government, regulatory oversight to provide the right guardrails to protect society.

Introduction

There has always been an interest in creating a system where a person can communicate directly with a computer (Mridha et al., 2021, para 2). In 1929, Hans Berger became the first person to record an Elec-troencephalogram (EEG), which shows the electrical activity of the brain that is measured through the scalp of a human brain (Mridha et al., 2021, para 3). An EEG is a test that measures electrical activity in the brain using small, metal discs (electrodes) attached to the scalp (Mayo Clinic, 2022, para 1). The crea-tion of the EEG would eventually lead a man named J. J. Vidal to create the first version of the brain-computer interface (BCI) we know now. Today, we know brain-computer interfaces, or BCIs, as a direct and sometimes bidirectional communication tie-up between the brain and a computer or an external device (Saha et al., 2021, para 2). The BCIs main purpose is to acquire signals from the brain and process these signals through a three-part system. The first part is called feature extraction where the BCI system extracts critical electrophysiological features from the acquired signals to define brain activities, and hence encoding of the user's intent (Maiseli et al., 2023, para 10). The second part is called feature classi-fication. The extracted features represent brain activities intended for desired actions. The classification process helps to recognize patterns of the features corresponding to these actions (Maiseli et al., 2023). The third part is called feature translation where the classified features are translated and transformed into actual commands to operate an external device (BCI application) (Maiseli et al., 2023). It is then transferred to the computer and applied to act out the job the brain signaled the BCI to do.

While this technology has gained significant popularity and interest in the world of science and research, many people have expressed concerns related to a number of ethical issues regarding BCIs, as well as areas of abuse and misuse that could emerge as the technology becomes more readily available. The most concerning issues related to BCIs include: data security and privacy, monitoring and influencing affective states, the manipulation of affective states, unethical uses in a corporate environment, lack of understanding the possible unintended consequences of using such technology, and unequal access to the technology itself.

Given the continued interest and investment, the advancement and adoption of BCIs into every-day life is a certainty for the future. Unfortunately, there are many examples of how technology can be misused if it develops quicker than the advance of policies meant to prevent risk and abuse. The lack of regulations to prevent these risks is something that needs to be addressed quickly, before BCIs can con-tinue to be adopted into daily life.

The Ways that BCIs Can Be Abused

The Problem with Data Privacy and Security

After a brain-computer interface collects and processes signals received from the brain, it can decode the signals it receives to act out the action the user needs. These signals from the brain that the BCIs receive, store and decode are oftentimes very personal and private data, and as the abundance of BCI technology continues to grow, increases the importance of protecting one's privacy and keeping data secure. While it is true that BCIs are hypothesized to address the threat of privacy and security in order to make the tech-nology more usable to society (Maiseli et al., 2023, para 1), as BCIs expand beyond the lab environment, it is very possible that these security systems will not be enough to meet security threats in this new envi-ronment. As consumers increas-ingly become interested in BCIs, it has become evident that the technolo-gy required for commercial use has major differences compared to the technology used in a laboratory setting. As the companies that are working to develop commercial and home applications for BCIs have assessed current lab technology, they have con-cluded it won't work for these expanded needs.

To address these limitations, Novel intracortical electrode arrays are currently being developed by companies such as Blackrock, Neuralink, and Paradromics, with a higher number of recording channels and fully implanted hardware with wireless transfer to the computer, designed for home use (Bergeron et al., 2023, para 18). While advancement of this life-changing technology is exciting, it also opens the possi-bility of hack-ers gaining access to the data being wirelessly transmitted. Neural devices storing data in the cloud opens the possibility of individuals or organizations tracking or even influencing an individual's mental experience (Ber-geron et al., 2023, para 18). There is already evidence of individuals and organiza-tions gaining access to a BCI users' private data, as recent studies have successfully demonstrated the ease of decoding passwords or using consumer-grade AI tools to spoof facial recognition for access to sensitive data, promoting the concern of ille-gitimate access to users' raw data and their further exploita-tion (Saha et al., 2021, para 43). There is always risk when new technologies are released to the public, and in the case of BCIs, it is as important as ever to ensure that proper data security protections are built into all BCI systems. As BCI technology makes the tran-sition from laboratories to households and work-places, it is crucial to address data security and privacy risks with suppliers, distributors, service providers and utilizers to keep consumers and their data safe from individ-uals and organizations who might misuse a BCI and its data.

The Problem with Monitoring and Influencing Affective States

Affective states are experiential phenomena like emotions and moods (Steinert & Friedrich, 2020, para 3). These affective states influence much of who we are and how we react to certain experiences. Affective states are much more complex than a simple reaction to a singular event or trigger but rather influenced by an accu-mulation of events and triggers. These affective states are extremely important in decision-making and moral judgment (Steinert & Friedrich, 2020), and there are concerns that BCIs may have too much access to a user's affective states, enough to even influence their affective state, which would influ-ence a user's decision making. There is a type of BCI related specifically to working with affective states called an Affective BCI. Affective

BCIs work like other brain–computer interfaces in that they read out neural signals that are then used to perform a certain task (Steinert & Friedrich, 2020). The biggest differ-ence is that Affective BCIs have the ability to not only monitor affective states, but also influence them (Steinert & Friedrich, 2020). There are already many types of technology that have the ability to monitor an individual, for example phones can track daily exercise, browsers can track the websites you look at, and many more. An Affective BCI also has the ability to track and monitor its user through the data it receives. As we have seen with other forms of technology, many individuals and organizations are inter-ested in collecting data gained by monitoring people for a multitude of reasons. It has become an ethical concern that companies distributing BCI technology might want to monitor a user's personal data for their own benefit.

Going beyond monitoring, Affective BCIs can also influence affective states. For example, a possi-ble way Affective BCIs could influence affective states is nudging (Steinert & Friedrich, 2020). This is dif-ferent from directly stimulating affective state because nudging takes an affective state the individual is already in and changes the outcome of the affective state. For example, if an individual is unsure of a deci-sion they need to make, an Affective BCI has the ability to 'nudge' them to end up making a certain deci-sion. This is an even more important example of why there needs to be strict regulations on BCIs because an Affective BCI could be a dangerous tool for an individual or organization interested in altering a BCI users' ability to make decisions based on their own emotions.

The Problem with Directly Stimulating Affective States

When an Affective BCI goes beyond monitoring or nudging, to actually directly stimulating affective state, it significantly increases the potential for abuse. If BCI technology continues advancing towards direct stimula-tion, and expanding from the laboratory to households, it will increasingly put pressure on the relation between emotional self-regulation and responsibility in that the machine, and not the user, does the regulating (Steinert & Friedrich, 2020, para 33). It is crucial that there are preventative measures to make sure individuals using BCIs, especially Affective BCIs, do not become reliant on a machine to stimu-late feelings and increase produc-tivity. It is also important to ensure that organizations that control de-vices or services that stimulate affective states are prohibited from creating responses that may benefit themselves, instead of the users of the BCIs. At present, most of the research on affective BCI at home and abroad belongs to emotion recognition BCI, while the research on emotion regulation BCI is just in its infancy (Lu et al., 2022, para 2). Affective BCIs are still being developed for an eventual shift from labora-tory to work and house environments, and this gives time to legislation to implement regulations around Affective BCIs to ensure that companies are not able to control their employees through mind control, before the Affective BCIs develop too rapidly for legislation to execute these laws.

The Problem with Unethical Uses in The Corporate Environment

BCIs have the potential to be a great tool in the workplace for employees and companies, for example, it could enable people with physical or mental disabilities to participate in the workplace where they may otherwise would not have been able to work. However as BCIs start showing up for commercial use in the workplace, along with these benefits come the potential for abuse. There are already many examples of how technology is used by employers to monitor employees. For example, many network-connected apps such as Zoom, Slack and Microsoft Office give managers the ability to find everything from the number of video meetings in which you've actively participated, to how much you chatted online with co-workers and the number of documents you saved to the cloud (Abril, 2022).

While in certain cases it may be appropriate for leadership in companies to monitor employees, for example around attendance, or productivity, the introduction of BCI technology could take monitoring to a

whole new, and possibly alarming level. Affective BCIs would open up new opportunities for this kind of employee tracking by making possible far more precise monitoring (Steinert & Friedrich, 2020). This means that instead of just having access to video meetings and online chats, which may be appropriate, companies could gain access to an employee's day-to-day emotions or feelings that go far beyond work. This is a huge area of concern, as Affective BCIs could one day have the ability to alter an employee's deci-sion-making, productivity, and emotional state. Although closed-loop brain stimulation is still in its early stages, it is conceivable, as this technology continues developing, to set up an Affective BCI system as a closed-loop system. A closed-loop system receives continuous feedback from the brain and stimulates brain activity accordingly (Steinert & Friedrich, 2020, para 33). This means that an Affective BCI has the ability to detect certain emotions in the individual using the BCI, and then send back signals to influence or completely change the emotions the individual is experiencing. Companies who place self-interest above that of their employees, could manipulate their employees, using BCIs, to work longer shifts and be more obedient, because they will have the ability to influence and control their employee's emotions and their emotional capacity.

Another area of concern is that with BCI technology, companies will have access to extremely personal data from employees. BCI technology potentially allows for the detection of mental states that the subject may not wish to share (Steinert & Friedrich, 2020) with their companies. BCIs are constantly taking in data, and as long as an employee is using the company-provided BCI, all of the data collected could be evaluated by the company, without the employees knowledge. For example, if an employee has an emotional reaction to something outside of work, a company may be able to figure out what this reac-tion was to and manipulate the employee to either play into this reaction more or forget it completely, for company benefit or otherwise. In a sense, employees using BCIs controlled by companies could be turned into machines that are being constantly controlled and influenced to prioritize the company over the emotional state of their employees, which is why it is critical that regulations prevent this potential for misuse. Ensuring BCIs and specifically Affective BCIs are not abused by companies will be important to ensuring the mental privacy of employees.

The Problem with an Inadequate Understanding of Consequences

Although BCI technology is developing rapidly to be used in more everyday life, there is still a large em-phasis on BCI use in medical settings. BCIs can be used to aid people ranging from physical disabilities and diseases to mental illnesses and disabilities. BCI technology is truly an incredible tool that has so much potential to revolutionize how we approach treatment for these various struggles. For example, Children with severe neurologic disabilities, like quadriplegic cerebral palsy or cervical spine trauma, could benefit from this technology (Bergeron et al., 2023, para 1). Although there is little research done on how BCIs could affect and aid children (Bergeron et al., 2023), the idea that this technology could one day help chil-dren who normally struggle to connect with some of their peers to be able to share that connection is thrilling.

That said, there are still ethical concerns that need to be addressed. As we have seen with other new and promising medical procedures and medical technology, many people tend to start requesting them without fully understanding the pros and cons. For example, People with severe neurologic disabili-ties, who are expected to benefit the most from motor brain-computer interface are also not the most suitable research subjects. There are concerns that patients with severe neurologic disabilities (tetraplegia and locked-in syndrome, for instance) could be choosing to use brain-computer interface and participate in brain-computer interface research out of desperation or as a last resort without adequately considering the risks (Bergeron et al., 2023, para 28). While it is understandable that people who are struggling with these disabilities may feel more inclined to put aside any possible side effects in order to gain or regain what they cannot do with these disabilities. It is important to honor and understand that these people have gone through significant hardships and deserve to receive any help offered, however, it is also im-portant that they fully understand the process of using a BCI, as well as any complications or risks that may arise from using a BCI. It is essential to ensure that anyone distributing

BCIs in a medical manner is required to have a complete understanding of BCIs and their benefits and consequences, to make sure every person receiving a BCI accurately knows what it is they are using and the related complications and/or risks.

The Problem with Unequal Access to BCI Technology

With the growth in EEG based applications, the demand for affordable consumer solutions is increasing (Rakhmatulin et al., 2021, para 1). People with disabilities and mental illnesses are the ones most in need of this technology, because BCIs could completely change their lives. As amazing as this sounds, the pro-cess of integrating BCIs into more causal medicine and treatment is very complex. Even if an efficacious, safe and beneficial technology is devised, if the target patient population is small or economically disen-franchised, deployment can prove unsustainably expensive, especially given the multidisciplinary team required for implementation and support (Young et al., 2021). It is possible that people struggling with certain disabilities and mental illnesses will be desperate to acquire this technology, despite the cost, to improve their lives. As of now, the cost for a BCI sits at around $5,000 to $10,000, however this is only the initial cost. Because users would also need technical support, the cost could increase way beyond that (Shih et al., 2012). With the cost of BCIs already extremely high and too expensive for many people in need of a BCI, it creates the risk that companies will price gouge customers or introduce expensive financ-ing plans that would drain customer's limited resources. This risk is even more likely given how desperate patients are to gain the improved quality of life coming from BCIs. To avoid the potential for companies to take advantage of customers, monitoring of competitive pricing and installment or rent-to-own financing schemes is important.

Conclusion

The world is full of examples where technology has quickly evolved, and the lack of appropriate regulation related to the evolving technology has allowed for severe harm to consumers. One recent example is the rapid expansion of cryptocurrencies over the past 5 years. Another is the rapid adoption of e-cigarette/vaping by teenagers and young adults. Given the risks already described in this paper, along with multiple others, there are several big concerns around the rapid advancements in BCI technology, and the impending expansion of BCIs from laboratories to home and commercial use. These concerns include the lack of appropriate regulations to monitor the advancements in BCI technology, how it is be-ing used in society, and the risks they create to users. In order to avoid the mistakes seen from the rapid advancement of other technologies, it is important to begin the effort of developing the right regulations that would allow for advancement of BCI technology, as well as all the benefits it would bring, while still ensuring that there are guardrails in place to avoid any potential risks talked about in this paper.

We can address these potential concerns by working across Congress, the Executive branch, and industry experts to develop laws that create a regulatory regime for the use of BCIs. This would include regulations for acceptable use, protections for individuals who use BCIs for medical, personal or profes-sional purposes, punishments for those who do not follow the regulations, and establishment of a regula-tory agency to monitor and enforce compliance for the use of BCIs, as well as evolve regulations and pro-tections as this technology undoubtedly continues to advance over time.

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