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The Ethics of Brain-Computer Interfaces: Identifying the Ethical and Legal Issues of Merging the Brain and Computer

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Mini-Review

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ABSTRACT

The steadily growing field of Brain-Computer Interfacing (BCI) has had a significant impact on many individuals suffering from diseases ranging from paralysis to stroke by improving their day to day life and communication. At the same time, the development of brain-computer interfacing presents major ethical and societal issues including users' safety, privacy and security, informed consent, as well as humanity and personhood.

INTRODUCTION

Definition of Brain-Computer Interface

A Brain-Computer Interface (BCI) is a system that allows its user to control a machine (e.g., a computer, an automated wheelchair, or an artificial limb) solely with brain activity rather than the peripheral nervous system. Control with a BCI is initiated when a user performs a specific mental task [1]. For example, BCIs can enable people who are paralyzed by Amyotrophic Lateral Sclerosis (ALS), brainstem stroke, or other disorders to convey their needs and wishes to others, to operate word-processing programs or other software, or possibly to control a wheelchair or a neuroprosthesis (Figure 1). BCI technology might also augment rehabilitation protocols aimed at

restoring useful motor function. With continued development and clinical implementation, BCIs could substantially improve the lives of those with severe disabilities [2]. However, they raise many ethical and societal challenges.

Figure 1. A 58-year-old woman, paralyzed by a stroke for almost 15 years, uses her thoughts to control a robotic arm, grasp a bottle of coffee, serve herself a drink, and return the bottle to the table.

USER SAFETY

The most common issues encompass the safety of BCI devices and the related balance of risk and benefit to the BCI user. These dimensions of concern are consistent with what one would expect from any new biomedical device. In terms of safety, authors assert that BCIs may pose direct risk of harm to the user, especially for devices that require surgical interventions [3]. While the signals transferred will influence the neural computation of BCI users, it is unclear right now what the implications could be and whether there is a risk of overstimulation. The risks will vary considerably, depending on the type of signal transferred and the type of network [4]. For devices that must be implanted under the skin or skull, potential complications include infection of the surrounding tissue and acute trauma to the brain, among others. For long-term implants, the affected neural tissue may also develop glial scarring, which can surround the implant and impede BCI function. Even non-invasive devices may pose serious risks of harm; some authors wonder whether the brain's plasticity in still-developing children and even in adults could bring about unknown negative side-effects of BCI use. And the unknown reversibility of these side-effects presents yet another worry: would the brain or the user return to normal after a BCI is removed? These concerns,

though frequent, are often only acknowledged and not analyzed further. Regarding non-medical safety issues, some authors stress the potentially serious harms of intense training and cognitive concentration for would-be BCI users. The need for regular and challenging training sessions may impose physical, emotional, and financial burdens on the user and their family. Device failure, similarly, may place the user in particularly difficult situations – for example, a BCI wheelchair failing as its user is crossing a street could have deadly consequences. As users become increasingly dependent on the technology, partial device failures or errors become more significant [3].

DISCUSSION

Humanity and personhood

BCI involves a direct interaction between brains and machines, and this interaction brings with it a series of questions regarding its effect on humanity and personhood along several dimensions. In a more philosophical mode, authors debate whether BCIs become part of the user's "body schema." The question – is it a tool or is it myself? – takes on an ethical valence when researchers ask whether BCI users will become "cyborgs." The Oxford English Dictionary defines a cyborg as "…a person whose […] capabilities are extended beyond normal human limitations by a machine; an integrated man-machine system". In contrast, others are quite concerned about the potential of BCI to impact our "humanity." Argue that being more robotic makes one less human, that BCI could generate the "risk of losing what makes us human". This is sometimes explained in terms of the unprecedented direct contact between brain and machine that is inherent to BCI. On another note, Zehr believes that we could overcome the limitations of our species, evolve into a "Homo sapiens technologicus" that uses technology to enhance its functioning. In addition to this, research has found that BCI users are not entirely comfortable with the idea of 'cyborgization': interviewed BCI users tended to distance themselves from the idea of becoming a functional man-machine hybrid. In one specific study of BCI technology used in patients with epilepsy, there was a variety of resulting perspectives on sense of self, with some individuals saying that it made them feel more confident and independent, while others felt like they were not themselves anymore, with one patient expressing that the BCI was an ". . . Extension of herself and fused with part of her body . . ." [5].

Informed consent

Another ethical consideration when performing invasive procedures that this technology would entail is receiving informed consent and voluntary participation. Note that informed consent must respect (1) disclosure (the patient has and understands all needed information), (2) capacity (the ability of the patient to understand the information and make a reasonable decision), and (3) voluntariness (a decision made without coercion or influence). Many BCI end users are non-communicative patients, such as those in locked-in state, and thus have significantly impaired capacity to consent [3]. Some individuals may be unable to express their understanding and acceptance of the risks and benefits associated with their involvement since these neural implantation devices are meant to improve communication and develop motor abilities. Without explicit informed consent or participation, we cannot dutifully respect an individual's autonomy. Steps must be taken to ensure an individual understands the risks and benefits of implanting a device in the brain. Furthermore, with new technological advances, the developers may not be entirely aware of potential future risks [4].

Privacy and security

With new ways to connect to the brain, there is a potential for new violations of user privacy. One study on public understanding of BCI revealed that privacy is a significant concern for participants. Some scholar's share that worry, suggesting that since BCI is capable of direct extraction of information from the brain, a subject may be "unaware of the extent of information that is being obtained from his or her brain". BCI devices could reveal a variety of information, ranging from truthfulness to psychological traits and mental states, to attitudes toward other people, creating potential issues such as workplace discrimination based on neural signals. Currently, language and non-verbal communication act as chief mediators for understanding the content of another person's mind, but as technology continues to develop, it is likely that we will see an increased capacity to observe others' minds directly beyond the spectacular yet rudimentary feats currently accomplished.

A second privacy-related concern is hacking, i.e., an external source gaining control of a BCI device. Several authors noted that the use of wireless communication standards exposes BCI users to the risk of interference from others. Others speculate about the specific scenarios and identities of the malevolent actor, whether the government or an unethical employer. Beyond extracting information, harmful exploits could cause the BCI device to malfunction or allow it to be manipulated such that it harms the user argue, based on these hypothetical scenarios, that BCI researchers should foster "neurosecurity," analogous to similar efforts in computer science. Overall, security and protection of privacy are deemed extremely important when considering the implementation of BCI technology [3].

Regarding the question of how to regulate neuroscience and neurotechnology, Ienca and Andorno argue in favor of a "right to brain privacy," which "aims to protect people against illegitimate access to their brain information and to prevent the indiscriminate leakage of brain data across the info sphere". They point out that brain data retrieved from a person's brain can be considered to be "personally identifiable information" that deserves protection [6,7].

CONCLUSION

Bcis have the potential to enable users to gain stronger cognitive abilities. It is possible to gain a clear advantage in competition with ordinary people who do not have the financial possibilities to use these technologies. Developed areas and high-income people are more likely to obtain BCIs and augment intelligent technologies than ordinary people in backward areas to augment their social superiority, which may widen the gap between the rich and the poor, leading to unfairness in social activities such as employment and education.

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