Proceedings of the 2nd International Conference on Modern Medicine and Global Health
DOI: 10.54254/2753-8818/8/20240403

Research on the risks associated with BCI

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Abstract. BCI, or brain-computer interfaces, is a kind of technology that connects the human brain with electrodes that can transfer the electronic signals to a computer and then use the computer to complete various tasks. It is widely used and has shown great potential in many fields due to its features. The technology itself, however, has several risks that are associated with it. Therefore, this essay aims to discuss the extent to which Brain Computer Interfaces is a risk factor for patients either physically or mentally in society by evaluating the past literature, and the further complications and ethical problems are discussed. This paper finds that, despite some of the social problems and ethical problems, the main risks associated with Brain Computer Interfaces is mainly physical. When social and mental problems are taken into account, the effects of clinical problems seem to be more important in the near future.

Keywords: Brain-Computer Interfaces, Risks, Legal And Social Issue.

1. Introduction

Brain-computer interface is an advanced technology that has only been developed in recent decades. There are already many therapies and other machines that could interface with the human brain solely without any movements of the body. Brain-computer interfaces (BCIs) collect and process brain signals to create commands that are then sent to output devices to perform the required tasks. Normal neuromuscular output channels are not utilized by BCIs. BCI's primary objective is to replace or recover functional function for persons with neuromuscular disabilities caused by conditions like amyotrophic lateral sclerosis, cerebral palsy, stroke, or spinal cord injury. Researchers have used electroencephalographic, intracortical, electrocorticographic, and other brain signals for increasingly complex control of cursors, robotic arms, prostheses, wheelchairs, and other devices since the first demonstrations of electroencephalography-based spelling and single-neuron-based device control. Brain-computer interfaces might potentially be helpful for treating other illnesses including stroke recovery [1]. It can be used in many fields, such as clinical medicine, and in some industries, such as exoskeletons. It is also used in military fields. Moreover, it can also be used in fields like recreation and even in some households. However, because BCI can be categorized into invasive BCI and non-invasive BCI, there are risks associated with using these technologies. These risks may cause direct harm to the patient and may cause severe effects if they are not dealt with correctly. The BCI can also cause serious mental problems such as self-recognition and acceptance of social members. This paper mainly focuses on the risks of BCI, including the physical risks of BCI, which is the health risks when implanting an invasive BCI, and its rejections and further side-effects. The second sector mainly focuses on the social risks to the patient as BCI is implanted as a risk of the patient's recognition of himself or herself as

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human. The last sector includes some risks in the law and ethical factor of BCI, as invasive or non-invasive BCI could be used to read minds and was already used in some military uses. This current paper aims to review relevant literature, evaluate the risks of BCI, and mention the potential consequences for patients.

2. Risks of BCI

As a very advanced technology, BCI certainly poses risks to patients, and there are many kinds of risks associated with it. The most straightforward risks are those that come with the implantation of the electrodes into the brain and the clinical complications it brings. It also includes the social problems brought on by implanting BCI, causing social alienation or unfairness. Also, it includes legal and ethical problems, and it may bring problems to ethics in the future. Evidence for the risks including invasiveness of the BCI

Invasiveness of BCI pose a great risk to patients that can threaten their life. The most important and biggest risk is the safety of patients. The invasive BCI poses risks to the patients by putting electrodes inside the brain on the cortex. It has advantages of having high qualities of electroencephalogram (EEG), at the same time, it harms the human body. The risks include: surgeries may cause bleeding, or hemorrhage, and it can have risks of purulent wounds and infection. The invasive BCI has to use operation to open the patient's skull and insert the electrodes into the brain, and has to stay in hospital for a long time for observation and recovery. During all these processes, the patient is having great risk of being infected and rejections. The different materials used in electrodes in different person may also have risks. Implanting the electrodes can cause damage to the brain and may also have the risk of infection. A series of rejections during the recovery, including the clotting, swollen skin, and have infections, and even brain tissue damage. There are also some side-effects and other symptoms associated with the implant [2].

Another problem associated with the implant is the life expectancy of the electrodes. The electrodes used in the brain may have the risk of being corroded by the internal environment of the brain. The usual human brain internal environment has an average pH value of around 7.2 [3]. The alkaline environment may be affected by the electrodes and cause further damage to the brain. If the corrosion is severe, it may cause a decrease in its capability of collecting EEGs, directly affect the computers and servers connected to it, affect the machines connected to it, and mislead it. They may also face the risk of having surgery again to replant the electrodes.

What's more, the electrodes are usually made of metals, which usually brings nanotoxicity to the brain, and it may be harmful to the brain cells and cause damage to them, and can harm the brain permanently.

Metals and its oxides in the human body have cytotoxicity that have different levels, varying from its concentration, shape and its electrons on the surface. There are many studies on the toxicity of mice, and most studies have shown that metal and oxide nanomaterials can cause lung damage in mice. For example, after entering the body of mice, nano TiO2 is easy to deposit in the lungs, causing corresponding inflammatory reactions and pathological damage. The nanomaterials might go into the body and cause damage to the body [4].

Cells are the most basic structural and functional units of organisms, and all life activities of organisms are based on the special structure of cells. The biological toxicity of nanomaterials generally starts from the destruction of cell structure and function. Although some studies have found that carbon nanotubes can produce toxic effects by mechanically blocking the lungs and bronchi of mice, even such mechanical blockages are accompanied by cell destruction.

The toxic effect of non-organic nanomaterials is currently the most widely accepted mechanism of nanomaterial toxicity. Reactive oxygen species (ROS) can increase oxidative stress, leading to lipid peroxidation and damage to cell membranes. Some oxidative nanomaterials, upon contact with the cell membrane, directly increase the oxidative pressure of the cell, leading to toxic effects, or enter the cell through the destruction of the cell membrane. The nanomaterials entering the cell increase oxidative

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pressure and may interact with cell contents, disrupting the structure and function of the cell. Cell contents also flow out through the destruction of the cell membrane [5].

2.1. Social drawbacks as risks of BCI

Patients have more contact with the world by using BCI, they may be relying on the technology too much. BCI technology can achieve direct control of the brain through a massive amount of training and telling the patient to imagine movements of the body; in this way, they are trained to control robotic arms or typing systems. Without this kind of training, controlling robotics with the mind is impossible to achieve. However, the patients spent too much time training with the BCI; therefore, they are very likely to be addicted to this kind of technology. Also, long-term interaction may cause the user to become stiffer and have less contact with the outside world. This may cause the human instincts to become more degenerated and to have less contact with others.

The use of BCI technology poses the risk of reducing individual creativity. This is because creativity stems from the ability to think independently and generate new ideas for personal growth and improvement. By relying heavily on BCI devices and constant interaction with them, individuals may become less reliant on their own cognitive abilities, leading to a decrease in creativity. This excessive dependence on technology may also result in reduced social interactions with others, as individuals become engrossed in their interaction with BCI devices.

More importantly, these interactions may make people become homogenized, meaning they lack differences. People may trust the devices and computers in long-term communication and interaction, and it leads to homogenization because of it. People would become less skeptical about the machine that listen and corresponds to all the information they receive, destructing their ability to distinguish between right and wrong, altering their recognition of the world, as they trust the machines more than anything else [6].

Although BCI has been introduced to the civilized world for a long time, it is still rarely used in clinical use and is still having some drawbacks that couldn't be neglected. Therefore, it has many misconceptions about it and because it is not mature enough, people hardly trust this kind of technology. As a result, other people may treat people with implanted BCI differently, thinking they are different people. These patients may be treated differently and may lead to misunderstandings, discomfort, and social alienation. These patients may also face stigma or fear if others hold misconceptions about BCI.

Brain computer interface technology not only enhances human behavioral abilities and enables brain-controlled machines, but also makes it possible to use brain computer interface technology in areas such as product production, logistics transportation, and daily services. Brain computer interface technology replaces humans in daily life for production, transportation, and other tasks, helping humans liberate their hands; It can even help humans analyze, judge, and make decisions through reverse signal transmission, liberating the human brain. The massive liberation of physical and mental power has led to more and more people being deprived of job opportunities, inevitably resulting in a large number of unemployed people, and society will also face many risks. The problem of more concentrated wealth and unequal distribution exacerbates social inequality [7].

BCI can lead to a greater difference in the economic classes through learning. The BCI has been already used to detect the attentiveness in class through a wearable device on the head, called "EA-FOCUS", invented by BrainCo [8]. This wearable device can detect the EEG signals of the student, and have lights on the device showing whether the student is attentive or not. Through this device, student can be more attentive and learn more in class. This leads to social unfairness and exacerbation of the huge difference between the rich and the poor.

Therefore, the future risks of BCI in society need to be thoroughly considered, and there should be enough education and more advanced systems of BCI to prevent the situations above.

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2.2. Law and ethical risks

There are also legal and ethical risks associated with BCI, as it may lead to crime and other new complications. It also creates ethical risks by having the ability to alter cognitive ability, memory, or emotions.

In order to create brain computer interface technology, EEG signals must be gathered and analyzed. There is a risk of information leaking because these EEG signals frequently contain the patients' private information. For example, how to determine the kind of neurological data was captured throughout the experiment, whether these data concern the persons' right to privacy, and what format will these data be stored in, and the reason of it. Data privacy is an important problem in the use of BCI.

The accessibility of the data is also a concern. Are other researchers able to access these data? How can accountability be established if researchers failed to maintain this personal data properly or if it was intentionally leaked? The disclosure of these details will seriously violate citizens' privacy rights, which will be problematic [9].

With the improvement of technology, BCI have the potential to commit a crime easier. The BCI can make control of machines easier, which can increase the rate of crime by making possible the use of drones to steal things or even bring harm to others by only thinking, which can help criminals commit crimes by remote control, and also increase body function by wearing exoskeletons, which made some crimes possible. For future applications, if the disabled regain the ability to walk and move limbs freely, are they allowed to drive cars or even airplanes?

Most importantly, they may be used in militaries for war and conquer. In sci-fi film, robots controlled by humans by mind, or a cyborg having a high-performance body, and exoskeletons for soldiers may come true, and the soldiers can enhance their performance in various environment and increase their mobility, and it revolutionize war.

Overall, the risks of using BCI also includes the risks of privacy of the users and also the possible use by crime and war.

3. Conclusion

The risks of BCI mainly include its clinical risks, its social risks, and its legal and ethical uses. Clinically, the risk of BCI is the risk of bleeding, having rejections, and the invasiveness of breaking the skull to contact the brain. Nanotoxicity also needs to be considered because the inner environment can corrode the electrodes. The social risks of BCI are the risk of increasing social inequality through more concentrated wealth and a greater difference in the resources of future generations. The risk of the BCI in law is that it may be used as a tool to commit crime. In ethics, it could be used in war.

All three kinds of risks can cause huge damage, either to the individual or to society. However, as this kind of technology is not mature enough, the main problem still remains technically.BCI technology offers potential benefits for neurological conditions like paralysis and ALS, improving human-machine interaction and comprehension in various industries. However, safety and effectiveness must be ensured through research and development, reducing clinical hazards and promoting biocompatibility. [10] Advances in nanotechnology can help address nanotoxicity. A multifaceted strategy is needed to address social hazards, ensure equal access, and prevent unethical use. Strict regulations and international agreements are necessary to control BCI usage and ensure responsible use. Public dialogue and education are essential to raising awareness and raising ethical concerns. Approaching BCI cautiously with robust research, collaboration, and extensive testing is crucial to unlocking its full potential while safeguarding individual well-being and society.

References

[1] Jerry J. Shih, ∗ Dean J. Krusienski, and Jonathan R. Wolpaw. (2012). Brain-Computer Interfaces in Medicine. https://www.ncbi.nlm.nih.gov/

[2] Yan Huilin (2022). Application Risks and Avoidance Strategies of Brain Computer Interface Technology (Master's Thesis, Hebei Normal University) https://kns.cnki.net/kcms2/article/abstract?v=BaYza4XbGEKDXnOQMz7D8YbZqqOQA2WbHafDNxreIcbsTzVQpJE

DOI: 10.54254/2753-8818/8/20240403

V4dL_VMRjNIQStqJ6lru05v34PAlj3pn7VPGLKNCAYOqa_BRW2GSEgq1qRCOADqQS BljoR5nMA7rlDgjQZoX2I8=&uniplatform=NZKPT&language=CHS

[3] Piotr Orlowski, Michael Chappell, Chang Sub Park, Vicente Grau and Stephen Payne. (2011). Modelling of pH dynamics in brain cells after stroke. https://doi.org/10.1098/rsfs.2010.0025

[4] Lin Daohui, Ji Jing, Tian Xiaoli, Liu Ni, Yang Kun, Wu Fengchang&Wang Zhenyu (2009). Environmental Behavior and Biotoxicity of Nanomaterials Scientific Bulletin (23), 3590-3604

[5] Chen Guoyong, Liao Yan, Ma Yu&Tao Maoxuan (2007). Research progress on the biosafety of nanoparticles Foreign Medicine (Health Division) (04), 206-209

[6] Hu Tianli The Promotion of Human Freedom or the Rise of Machine Rule? On the Impact of Brain Computer Interface Technology on Free Will. "Dialectics of Nature Research 37.10 (2021): 29-35 Doi: 10.19484/j.cnki.1000-8934.2021.10.006

[7] Liu Hongyu, Yi Xianfei&Ye Antao (2021). Brain Computer Interface Technology and Its Cultural Risks Journal of Changsha University of Technology (Social Sciences Edition) (02), 1-7 Doi: 10.16573/j.cnki. 1672-934x. 2021.02.001

[8] People's daily. (2019). Why are we afraid of the "smart headbands" worn by elementary school students? https://baijiahao.baidu.com/

[9] You (2020). Criminal risk analysis of the application of brain computer interface technology in the context of artificial intelligence (eds.) Collection of Shanghai Legal Research (Volume 5, 2020, Volume 29) - Collected Papers of the Rule of Law Forum at the 2020 World Artificial Intelligence Congress (pp. 250-257)

[10] Tiffany Jong, Yan Luo, Ayush Agarwal, Robbie Ingram, Kavya Sood, Veeresh Neralag. Disease Treatment Using BCI Technology. http://neurotech.web.illinois.edu/