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The Brain and Our Curiosity

As technology continues to advance, we have more efficient methods of interacting with one another which could be potentially dangerous, because of the amount data is being gathered. Neurotechnology, among other new fields of study is one of the industries that will revolutionize the way that our society works. This is because Neurotechnology combines both modern technology and neuroscience which allow us to understand neural activity and influence the actions of someone through invasive and non-invasive procedures. Non-invasive procedures for reading brain activity include electroencephalography (EEG), magnetic resonance imaging (MRI), and recently near-infrared spectroscopy. More non-invasive methods that can influence brain activity include transcranial magnetic stimulation (TMS), transcranial direct current stimulation (tDCS), focused ultrasound stimulation (FUS). While invasive brain procedures include brain-computer interfaces (BCI) which can both read and write to the brain, and through the peripheral nervous system you can implant devices that can help with deafness and vision problems. Neurotechnology brings up ethical issues about the privacy and security of the individuals using the devices. On one side, the general population would benefit from this technology, but if implemented incorrectly it could lead to catastrophic events, such events could range from an information leak and data breach to being able to control someone's emotional state and even causing involuntary movements. While these issues are worrying, imposing unnecessary regulations on the industry could hinder its growth.

Background

Neurotechnology has increased our understanding of the neural pathways that our brain uses to communicate, think, remember, and move. BCI's, that use electrode arrays, have been implanted into the parietal or motor cortex of patients that have been paralyzed which allows them to control a computer with their mind. This technology has also been tested with monkeys that have a paralyzed arm; they use BCI's to move a robotic limb and feed themselves, and after stimulating their pharmacologically paralyzed arm muscles they could regain control of their arm. Before we could write and read to the brain in real-time, neurotechnology began by first being able to read neural activity with devices such as an EEG that use electrodes on the scalp. Another method is fMRI, which uses signals from the early visual cortex, allows researchers to reconstruct a visual image that a person perceives. There have been improvements to reading and decoding of brain activity. One method of decoding is deep neural networks (DNNs), "used to interpret activity patterns elicited by complex visual stimuli and predict the activity of nerve cells to new stimuli" (Roelfsema et al.,2018). With this knowledge, devices that can stimulate the brain to elicit a reaction have been developed. Methods for writing to the brain include TMS, tDCS, and FUS, but they are limited and the exact way they influence the brain is unclear. Reading brain activity gives us information on the areas in the brain that are activated during a task. Decoding the neural activity gives us insight into what happened during the stimuli or what might the reaction be. While writing is still in the early development, BCI's are powerful tools that are allowing us to be able to read and write neural networks in real-time. With the amount of information that is gathered from such applications, it can be concerning to the general public.

All these procedures are used to understand how the brain works, which is how humans can perceive their surroundings. As this technology grows, we will gain a greater understanding of how to influence the mind, the wiring of the brain, and what elicits emotions or actions. This

information could be used for the greater good or evil, but without these advancements, we will continue to have to struggle with disabilities and mental illnesses. One way to prevent misuse of a device is to put stricter regulations on it, but this could cause the industry to not fully develop or be stunted. So, would it be better to be strict or lenient with this new technology?

General Population

While the neurotechnological advancements are promising, there are some concerning approaches that neurological devices have when helping patients. One basic concern is how the device affects an individual's self-autonomy after it is installed in the motor cortex. According to manufacturers, BCI aims to construct practical assistive devices that help people with disabilities while keeping their autonomy (Roelfsema et al.,2018). One example of this is to aim to increase eating in patients with Anorexia Nervosa by influencing the behavior of the individual through BCI which activates neurons that process rewards and punishments. Rewards and punishments are used in operant conditioning which tries to explain how these stimuli help us learn. This could be perceived in both a positive and negative connotation as the user is not acting according to their natural state, but is being nudged by the BCI to increase their appetite. Helping those with anorexia is a noble cause, but if you are unable to differentiate between the patient's own actions and that of the BCI's that could be problematic. "The widespread availability of neurotechnology applications will provide multiple opportunities for individuals to access and exert control over their brain-activity" (NCBI). Apart from losing autonomy, another concerning factor is the potential harm that can be done because of a burnt electrode or a failure in the device. Some users on forums such as Reddit's r/tDCS, where they make use of transcranial direct current stimulation devices, have reportedly been burned while using their self-designed devices (Mackenzie, 2021). If not calibrated properly these devices could cause a lot of harm to

the user's brain and other parts of their body. Apart from these expected effects, there could potentially be other unforeseen effects from using the device for extended periods. Such effects are hard to predict because of the complexity of the issue. This could be more detrimental to those who rely on these devices to help with their mood, appetite, or even cognition. Apart from harming the individual, we do not know how the information being collected is going to be used. One application for the data would be in marketing, which is concerning because of not only the security issues, but because it could be used to infer mental preferences. Understanding the data could be used to prime, imprint, and trigger such preferences. The ethical issues raised by these devices are important as it deals with the most important organ in the body. These applications could have a double edge which ends up harming those who need them for daily living or potentially used for manipulation.

An ethical framework that this group implements is Utilitarianism, because it is more beneficial to add regulations to this technology. This is because the potential dangers could generate more trouble for everyone and the benefits of having strict regulations would improve the perspective of this technology. Even though there are people that would benefit more from loose or no regulation, the benefits do not outweigh the dangers.

Companies and the Medical Field

As neurotechnology continues to grow, the future is unpredictable with many potential medical advances that could be beneficial to the user. The developments of these technologies could be seen as a safety issue for some people, but the advantages seem to outweigh the down sides. Such technology could even be used to gain a greater understanding of how we interact with the world, ourselves, and others which shape how we experience and perceive our environment. One example, symptoms of Parkinson's disease are reduced through electrical

stimulation of deep brain stimuli (DBS). Other clinical trials have begun testing this technology to help those with psychiatric disorders like depression and obsessive-compulsive disorder, but the simulation patterns are crude because of the large contact points of the electrodes. BCI's have been shown to help with paralysis, this is done by sending haptic feedback directly to the somatosensory cortex while using a robotic arm. Other than helping people with paralysis, BCI's can help those with other health disorders like Anorexia Nervosa, which is hard to treat, but by using a method that tries to activate their reward and punishment neurons they just need to send haptic signals to the neurons to cause a change in their behavior. Apart from helping with mental issues, neurotechnology can help to regain our sense of hearing by using cochlear implants that electronically stimulate the inner ear. Electrical stimulation of surviving cells within the retina can restore vision in damaged areas. When thinking of a company that envisions this technology fully, Neuralink comes to mind because they are working hard to make this technology accessible first to those in need and then expanding to healthy individuals. As neurotech continues to expand we could see a near future where all communication can be through a BCI implanted in your brain. As of now, this technology is being implemented in the medical field and will be a while before it comes to a consumer basis.

An ethical framework that can be applied for the companies is ethical egoism because their arguments mainly focus on the individual receiving treatment. It supports loose regulation because it will allow the industry to continue growing at a fast pace and focus on mental issues instead of security. While security is an aspect that they focus on, it is not their top priority.

Personal

Neurotechnology is a new field that is exciting and interesting to research. Non-invasive methods are a good way to understand how the brain interacts and what is being activated.

Whereas invasive methods are less attractive because of the implanted electrodes in your brain, but they relay the most information because of the bandwidth between the electrode and brain. Combining both reading and writing for neural activity will be exciting and interesting when it comes to the future of communication. This technology has many advantages that would be hindered through tough regulation, but as protection for its users, it's a necessary protocol. From a privacy concern, while I'm positive the manufacturers of these devices did their best to protect their users, this technology is still new, and we won't know if they could be breached into. If the device is breach-able, then automation would be brought into question because it could be unclear if it's the person making the decision or breached BCI. Even though I would not want to get a device like this, I believe that if it was the best option for me to regain normality, I would take it. While researching, I stumbled upon some articles where veterans would say that they wish that they could live a normal life again. Many of these veterans are suffering from PTSD and other mental illnesses that could potentially be alleviated through a device like this. Although innovation is always exciting, the main concern of manufacturers of these devices should be the safety and reliability of these devices. This device is exciting for those with medical conditions because it allows them to gain or regain normality, whether that be mentally or physically by regaining movement in their limbs. As a personal device, I believe that there should be further research and regulation done before it is available. These are exciting times to live in because we may experience a new revolution in technology just like how the internet was when it first was invented.

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