Ethically Enhancing Human Abilities using Neurotechnology

Great strides have been made in the development of neurotechnology. Technologies such as deep brain stimulators and nerve-controlled prosthetics have made their way into important mainstream conversations. One of these neuro-technological advancements is the brain-machine interface (BMI), a computer-based system that acquires, stimulates, processes, and translates brain signals into directives that are transmitted to an output device to perform desired actions[1,3].

Neuroethics explores and addresses the ethics of conducting scientific research and the impact neuroscience research will have on society[2]. The implementation of BMIs raises specific ethical issues surrounding its development and usage. In terms of conducting ethical research, it is vital to consider the safety of the product in clinical trials. The brain is a delicate organ; hence, it is important to avoid causing more damage to it when utilizing brain implants. The technology should not disrupt memory or alter brain functions in other ways not previously accounted for. To mitigate the risks associated with craniotomies and device implantation, Elon Musk's Neuralink - a BMI in development to allow people with paralysis to control computers or mobile devices with their brain activity - is designed with thin electrode threads that can only be efficiently and reliably implanted by a robotic system[3,4,6]. This also ensures precision and avoids human error; however, the robotic system should be fool proof before proceeding to clinical stages.

Despite the attention the Neuralink project has garnered on news and social media, this sort of research has been in the works for years at the preclinical level; however, there has been a recent breakthrough in the field at the clinical research level where an Australian lab has seen two severely paralyzed men control their computers using their minds and Bluetooth[5]. This lab has taken steps to further curtail mishaps in neurosurgery by developing a method where stents are used as a means to deliver electrode arrays to the brain through blood vessels using minimally invasive surgical procedures. Their method capitalizes on a commonly used method for blood clot removal. In order to adequately propel clinical research like this forward, communication between researchers and research subjects is essential.

It is important to consider the opinions and choices of the people who are to benefit from the technology. The recipients of BMI implants should have a say in the function of the device. One neuroethics blog addressed the possibility of people's personal, cultural and societal values being dismissed and oppressed with the implementation of BMIs[1]. Not all people view their disabilities as a problem to be fixed. There may be certain aspects that are advantageous to them. For instance, there are people in the autism community who do not regard certain aspects of their autistic traits as a hindrance to their daily lives. There are many people who acknowledge value in their disability and think that the idea of health should showcase lives like theirs. Due to situations like these, BMI engineering should take steps to avoid building stigmas into their designs. To do so it is important to emphasize consistent communication between neuroscientists, doctors and patients throughout all stages of technology development and application.

BMI designs should complement positive societal values and should be inclusive. Marginalized populations should not be left out of the design and implementation process. The circumstances under which implants will be made available should also be considered. Will BMIs such as Stentrode and Neuralink be made available to people without disabilities? What type of disabilities will benefit from its purpose? People with disabilities who find BMI's application beneficial should be prioritized in terms of making devices easily accessible to them. BMIs should be marketed to those who need it, but it should also be affordable so as to prevent the marginalization of low-income disabled communities. The scientific community has a responsibility to provide adequate and comprehensible literacy to propel the field forward as opposed to through the ideas of capitalists[1].

The ethical considerations discussed above should be made before starting implantable device research, from preclinical to clinical studies. By recognizing and engaging people's individual and cultural values, neuroscientists can prevent discrimination towards patients[1,2]. Having proper communication between the scientists, patients and doctors ensures that the patients are treated according to their needs. It is the form of precision medicine that should be implemented in all aspects of clinical treatment. Neuroethics does not provide all the solutions to ethical issues that may arise with the development of neurotechnology, but it primes researchers, clinicians and society to think critically about issues that arise from advances in understanding the brain. As science progresses, more ethical questions - such as how to protect the privacy and confidentiality of neural data - arise. The ethical frameworks of science must be prioritized and firmly adhered to so as to not negatively affect the individual benefiting from the technology and the society. Ethically conducting research identifies and creates conditions for meaningful contribution of neuroscience to society. This aides in outlining novel guidelines and strategies for addressing future challenges that may arise in the scientific community and society.

References

1. Brown, T., & Rommelfanger, K. (2020, September 16). The Social Impact of Brain Machine Interfaces: Value Sensitive Design in Neurotechnology. Retrieved November 01, 2020, from http://www.theneuroethicsblog.com/2020/09/the-social-impact-of-brain-machine.html

2. Greely, H. T., Grady, C., Ramos, K. M., Chiong, W., Eberwine, J., Farahany, N. A., ... & Serrano, E. E. (2018). Neuroethics guiding principles for the NIH BRAIN initiative. *Journal of Neuroscience*, *38*(50), 10586-10588.

3. Golembiewski, L. (2020, September 28). Are You Ready for Tech That Connects to Your Brain? Retrieved November 03, 2020, from https://hbr.org/2020/09/are-you-ready-for-tech-that-connects-to-your-brain

4. Neuralink. (2020). Retrieved October 30, 2020, from https://neuralink.com/

5. Opie, N. L., Ronayne, S. M., Rind, G. S., Yoo, P. E., & Oxley, T. J. (2020, February). Mechanical suitability of an endovascular brain computer interface. In *2020 8th International Winter Conference on Brain-Computer Interface (BCI)* (pp. 1-6). IEEE.

6. Rogers, A. (2020, September 04). Neuralink Is Impressive Tech, Wrapped in Musk Hype. Retrieved November 01, 2020, from https://www.wired.com/story/neuralink-is-impressive-tech-wrapped-in-musk-hype/