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**Brain Computer Interfaces**

**Part I**

The technology of reading the neurological responses of the brain and connecting them to an external hardware system is known by a few names; brain computer interfaces (BCIs), brain machine interfaces (BMI), or human computer interfaces (HCI). Although many believe that BCIs are a relatively new area of research, the first experimental research began on connecting the brain to machines in the 1970s (Wang, 2011). There are three ways to create a BCI, invasive, noninvasive and partially invasive. Electroencephalography (EEG) is the most widely used source for gathering neural feedback. This method attaches electrodes to a user’s scalp or electrodes are surgical attached to the cordial cortex that sends feedback to internal or external hardware through wires or WiFi. Invasive BCIs require implanting electrodes or computer chips inside the brain. Currently, the smallest computer chips that are implanted are as small as a red blood cell. Invasive brain computer interfaces are capable of giving a wider range and clearer feedback. One of the problems with implanted hardware in the cordial cortex is that over time scar tissue can enclose the device. This scar tissue weakens the signals sent out by the encased device (Kotchetkov, Hwang, Appelboom, Keller, & Conolly, 2010). The brain waves recorded by EEG type BCIs are unable to convey to the hardware information about movement such as, velocity and position. This is because the cordial cortex does not provide information on movement. Electrocorticorgraphy (ECoG) is one of the latest technology that provides many benefits over the older EEG models. ECoGs are also electrodes but they are implanted into the cortical tissue in the brain. An ECoG is able to read high frequency gamma waves produced by the cortical neurons. This allows the ECoG to record a bigger variety of brain reactions and narrow in on smaller electrical impulses (Kotchetkov et al., 2010). Having more data and of different types of brain waves, researchers are able to map what those signals are trying to do for the body. This increases what types of tasks brain computer interfaces are able to do.

One of the drawbacks to BCIs is that they are not universal for every user. A user and the computer must be trained to interact with each other. One area that has helped overcome this barrier is new advances in artificial intelligence that has allowed computers to essentially learn. This cuts down on the time and personnel that are needed to make a BCI functional. There still remains the problem of training the human user to interact with the system. One of the primary candidates for BCIs suffer from locked-in syndrome (LIS). It is incredibly hard to teach a person suffering from LIS to interact with the system. LIS contains three different degrees of severity. LIS refers to when a person has lost complete or partial motor controls (Haselagera, Vleka,, Hillb, & Nijboerc, 2007). Complete LIS is the complete loss of motor controls. These patients must be fed through tubes and are hooked up to ventilators. A less severe form of LIS allows the sufferer the ability to move their eyes and blink. Since people suffering from LIS may lack the ability to communicate this makes the task of training them to interact with the computer interface extremely difficult.

With all the uses of BCIs, it is no wonder that military agencies are extremely interested in this technology. The military can reap many benefits from using BCIs to enhance soldiers’ performance. This performance can be either physical, cognitive, or both. The military has already used brain computer interfaces to wire the brain to a number of different controls such as, helicopters, vehicles, remote drones and weapon systems. By bypassing a soldier’s motor responses and using the signals straight from the brain to control these devices, the devices can be used faster and more efficiently (Wang, 2011). A soldier’s mental state can also be monitored through this technology. The computer would be able to tell the soldier’s alertness level. If it detects that the soldier is not paying attention or distracted the system could send an auditory signal that would alert the soldier bringing them back to focusing on the task they are performing. Even moods like agitation, sadness, attention deficiency could be monitored by the system resulting in different responses from the computer(s) that the soldier is connected with (Wang 2011). Having data about a soldier’s emotional state gives the military information on whether that person should participate in an action or if they need any external help dealing with the emotional state they are in. This feedback could help the monitors notice signs of post-traumatic stress disorder.

Injured soldiers who lose control of motor processes or limbs could benefit from BCI prosthetics which could help them get back into action. As the technology advances, this will save the military the time of training a new soldier. The military could use BCIs for instant language translation. The benefits to this would be saving money and time in teaching soldiers to be interpreters. It would allow all soldiers in foreign wars to be able to communicate with civilians. This could save lives. It would also allow international units to work cohesively since there would be no language barriers to overcome. Neurofeedback can also be useful when recruiting soldiers to see how they can deal with stressful situations of information overload. A debatable application is to actually use these interface to enhance a soldier through exoskeletons, brain cognition alterations, or replacing body parts with machine parts to enhance performance. Some studies suggest that even a person’s thoughts can be controlled through an implanted chip in the brain. The military has been a huge asset in funding BCI technologies.

The military takes a consequentialism ethical stance to brain computer interface enhancement of healthy personnel. Consequentialism is the ethical framework that states that if the outcome produces a greater good then it is ethical to do whatever steps are necessary to reach that outcome (BBC, n.d). By enhancing soldiers, the military is able to put fewer lives at risk. They are also able to create a superior fighting force that would give the force advantages in battle. The fact that scar tissue can be formed in the brain from BCIs and a person’s personhood can be controlled are omitted factors by the military because the benefits to them is greater than these negative results. As an organization that operates under a budget, it is also paramount to the military that BCIs could save money.

The medical industry is also another major stakeholder in BCIs. Along with the military, a lot of focus in research has been on restoring motor controls lost by a patient through BCIs. One of the medical primary focus is to restore communication in patient with lock-in syndrome. This is done through simple binary output in a yes and no format (Moore, 2003). One of the problems with this method is that not all questions can be answered with a simple yes or no answer. Even the process to get permission to connect an LIS patient to a BCI promotes an ethical dilemma in the medical industry. It is a medical standard in the United States that a person or their legal representative must give informed consent in order for a patient to undergo a procedure. The patient must be able to understand the risk of undergoing the medical procedure, what the possible outcomes are, if there are any side effects and be emotionally competent to make a sound decision. This permission can be extremely hard to obtain from a patient who cannot convey their wishes. Even for patients who have the ability to blink their eyes in yes and no responses it is hard to truly know if they completely understand the procedure. Things get more complicated when the family of someone who is unresponsive is against the use of a brain computer interfaces. Some of the reasons for people being against agreeing to the use of brain computer interfaces can be tied to the media. The media has been known to make connections of BCIs to cyborgs (Dobkin, 2007). For people of certain faiths this is stripping the humanity of a person so they will not give consent to turn their loved one into a robot. Another medical use for BCIs is for doing brain training in elderly patients who are exhibiting mild signs of dementia or Alzheimer's disease. Due to the plasticity of the brain this area of research is looking promising. Results of patients’ scores in the areas of immediate memory, attention and delayed memory performance showed significant improvements after brain training with brain computer interfaces (Lee et al., 2013). Although these results are a positive sign, in the end the brain training interface do not stop the progression of the disease. All clinical medical trials can only continue to get funded and proceed if they meet the criteria of improving the quality of life in the United States (Dobkin, 2007). What is problematic with this approach is who gets to decide what these criteria include. A trial of an anti-seizure medication was shown to decrease the amount of epileptic seizures participants had in a month but because this medication did not control the seizures in a way that allowed the patients to return to work the government deemed the medication did not improve the quality of life and the program was abandoned. The individual patients however, did enjoy that they were suffering from less seizures so to them their quality of life improved (Dobkin, 2007).

The medical fields applies the ethical framework of care ethics. This approach deems that there are people in our society who are in more need than others. As a society we are not just individuals but are connected. It is the responsibility to care for the underprivileged and increase their quality of life (EIESL Project, 2011).

Individual can also greatly benefit from BCIs. The possibilities of improved cognitive functioning would give a person an advantage in both the academic and professional realms of society. Computer chips implanted in the brain can continue to create synapsis in the brain and expand its connections without a person having to be engaged in the typical activities that makes this happen naturally. The ability for physical enhancements could allow an individual to excel at professional sports allowing for them to benefit financially. For individuals who find certain activities difficult due to the lack of coordination or strength, would find that they are capable of doing things they couldn’t do before. This could have great effects on their personal beliefs about themselves and overall happiness. People who have suffered from traumatic events could unlearn fear conditioning through neurofeedback. This would allow them to experience life in a whole new way.

As an individual choosing enhancement, they are obviously focusing on an individualistic ethical framework. Just narrowing it to this is inaccurate. If an individual feels better about themselves, they are liable to treat other people in better ways. This branches into a sense of culturalism.

The commercial industry can also benefit from BCIs. Despite the obvious money makers to corporations like the hardware, software and surgical supplies for implantation, there is also the benefit of data mining (Bostrom & Sandberg, 2013). Employer’s are starting to use BCIs to screen potential employees. One test that is used is what is called the guilty knowledge test. An external EEG net is used to gather brain wave responses to determine the presence or absence of memories connected to questions asked of the potential employee (Foster, Kenneth, Wolpe, & Arthur, 20013). Companies can also use this technology to determine if the brain suffers from an illness allowing an employer to disqualify a candidate. This may have practical implications in jobs concerning national security but over all this is a discriminatory practice. These commercial applications use an individualistic approach. However companies can extract information that will benefit them they see as moral since putting themselves at risk is counterproductive to their survival.

With all the benefits to enhanced humans should this be something society should embrace? The European Group on Ethics in Science and Technology released their opinion in 2005 that implants should not be used to alter a person’s identity or mental functioning (Lucivero & Tamburrini, 2008). The trouble with this stance is personal identity and mental functioning do not have exact definitions but are laced with philosophical perspective that varies from person to person and between different societies. If a person suffers from dissociative identity disorder and possess several different and independent identities, this ethical stance would suggest that this individual should not undergo an enhancement that would erase these identities. Another consideration in the ethical application is a person’s right to autonomy. (Lucivero & Tamburrini, 2008). It is foreseeable to see militarized use of BCIs actually being used to bypass the actual intentions of the human in favor of whatever the machine program suggest is the correct course of action. Bostrom & Sandberg’s also bring up the possibility of creating elites (2009). The class of people who could afford the best BCI enhancement for themselves or to what some geneticists refer to as designer babies would be the wealthy. This could in fact cause a caste society and prevent those in the lower classes from moving up in society (Bostrom & Sandberg, 2013).

**Part II**

Brain computer interfaces not only allow for personal medical benefits but benefits to society as a whole. The ability for people to think faster, learn quicker, regain lost motor controls, gain the ability to see and hear, and enhance almost any other human characteristic could be the building blocks of a whole new society. Essentially society could even the playing field for all its members. Those who are predisposed to mental illnesses may be able to stop these illnesses from occurring. Individuals in poor areas could receive equivalent education to those in wealth families. Barriers in language could be toppled since brain waves are universal. There is the possibility of not just people living a longer life but one that the quality of life remains good throughout the whole time.

A true barrier to a universal enhancement of society can be found in the concept of individualism. Individualism thrives on the notion that the self is more important than others. It is in one’s own interest to put their needs ahead of that of society. Individualism is one of the true driving forces of capitalism, greed, and power. If society makes the choice to enhance humans with BCIs, the driving force cannot be profit. If profit is the motive, the technology will not be fairly distributed nor used to make people equal. In essence, it will divide society, creating people of an elite status. This could be compared to the caste system in India. A person who was born in the lower caste would be at such a disadvantage it would be impossible for them to move upward. This lack of upward mobility will cause extreme tension that could eventually lead to protests and/or violence. If this technology is justly used the whole human species will benefit. A framework will need to be put in place to enable the proper distribution of the technology.

Not everyone believes in the idea of human enhancement. If you or your culture is a believer of the divine command theory, human enhancement may not be considered God’s design. By enhancing people with machines they would then no longer be considered truly human. This would take them out of the grace of God. This could be counter argued by the point if in deed we are God’s creatures and we create the ability for these enhancements then essentially it is God who allowed these creations. There are other theories that rule out human enhancement like survival of the fittest or Darwinism. Enhancing those who are weak so they are as strong as people in good health, or as smart as people naturally gifted with high IQs weakens the gene pool. This allows for inferiority to persist in the human species. By enhancing people with brain computer interfaces this becomes a moot point since all humans could be on a level playing field.

In order to implement a universal enhancement of BCIs, some form of world committee would have to be implemented. This would require bridging vast cultural gaps. Since the world is made up of culture that support culturalism, individualism and divine theory, it would be quite a difficult task to assemble such a committee. This committee would basically have to lay down an ethical framework and financial implementation of the project. People who have issues with gene manipulation could find machine enhancement to fall under the same moral complications. This committee would also have to decide what enhancements should be made. If educational enhancements are made, a decision of what is to be taught would have to be reached. As a country we are divided on many issue, so imagine how divided the world is on issues.

As a person who tends to align with socialistic ideologies, I am aware that many will have to be convinced of the benefits of the collective over the individual. BCIs should not be used to alter an individual identity or control how they think. This technology should only be used as an enhancement. One of my main concerns lies in how this committee would view mental illness and what their standards of enhancements to “correct” these illnesses would be. Some disorders are actually found to bolster creativity and mastery in certain areas. These qualities could be wiped out depending on how this committee rules on implementation. In the end, a person should have the ability to maintain their personhood and decide whether to be enhanced.

The concept of designer babies either from a genetic or BCI standpoint although discredits the concept of personhood could eliminate a lot of medical conditions. This concept is like using vaccinations and preventing future problems. The enhancement of humans equally is limited by the capitalistic society we live in. The problems that can arise from this system is selling enhancement for profit. When this model is implemented the wealthiest in our society will benefit. It falls on the back of the old saying the rich get richer and the poor get poorer. Another issue would be malicious hacking of the devices. It is plausible if a hacker could breech the system they could actually control the thoughts and actions of those who have been hacked.

With all the hard work and international cooperation that would need to be implemented to achieve universal enhancement of humans with machines it is still the direction society is going. These technologies are being tested, created and used currently. This means that brain computer interfaces are not going anywhere, they are here to stay. As a society, harnessing the benefits that comes with this technology in a universal beneficial way will only strengthen the human race. It is important to get a head of the commercialization and capitalization of this technology to prevent the development of inequalities in society. A centralistic view must be obtained in the beginning. A step away from the individualistic ideology that separates people. A combination of care ethics and consequential ethics must be utilized to create a framework that will benefit all.

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