

ETHICAL ISSUES IN CYBORGIZATION: THE CASE OF BRAIN- COMPUTER INTERFACE

Ogbujah Columbus | Rivers State University of Science &
& Technology, Port Harcourt, Nigeria.
Ufomadu Charles | University of California, Irvine.

ABSTRACT

A cyborg, also known as a cybernetic organism, is a being with both biological and artificial values. Real (as opposed to fictional) cyborgs are more frequently people who use cybernetic technology, like the Brain-Computer Interface, to repair or overcome the physical and mental constraints of their bodies. The Brain-Computer Interface (BCI), sometimes called divert neural interface or Brain-Machine Interface (BMI) is a divert communication pathway between a brain and an external device which aims at assisting, augmenting or repairing human cognitive or sensory-motor functions. It consists of systems that transform biological signals recorded from neural tissue into electronic signals that control a computer interface. Once such a control is attained, it can then be translated into a system that can control a machine or a physical device or can even stimulate or activate biological tissues. Its principal goal is to enable people with neural pathways that have been damaged by amputation, trauma or disease to function and control their environment either through the reanimation of paralyzed limbs or control of robotic devices.

A typical BCI/BMI consists of various components which include the acquisition, processing and discharge of signals. All BCIs use either the invasive or non-invasive methods. In isolated but real cases, chips which have been implanted into human brain have produced signals of high enough quality to stimulate movement. Also, retinal implants have restored vision to people suffering from retinitis pigmentosa and vision loss due to aging. However, there are strong ethical concerns that the very idea of the interface between humans and machines can potentially alter what it takes to be human.

Key Words:

•*Brain Computer Interface* •*cyborg* •*human brain* •*ethical concern*
•*biological capacities* •*enhancement* •*alteration* •*the naturals* •*the enhanced* •*'normal functioning'* •*colateral implications* •*personal identity*
• *autonomy*

1. Introduction

The issue of cybernetic organisms has been overblown as if it is something entirely new within the scientific community. Right at the heart of technology is the provision of materials and equipments for the enhancement of human life: a human fitted with a heart pacemaker or an insulin pump (if the person has diabetes); modifications brought about by contact lenses, hearing aids, or intraocular lenses are all examples of fitting humans with technology to enhance their biological capabilities. Persons embodying these modifications might be considered cyborgs, and their modifications are no more cybernetic than persons carrying a wooden leg or a metal arm. A cyborg then, is a natural entity that embodies mechanical parts which enhance the body's *natural* mechanisms through synthetic feedback mechanisms (Halacy, 1965, Chislenko, 1997, Haraway, 1991). Real cyborgs are more frequently people who use cybernetic technology, like the Brain-Computer Interface, to repair or overcome the physical and mental constraints of their bodies.

In point of fact, cyborgization entails an interface between the brain of the organism and an implanted or attached mechanical device for synchronization of actions. Human (as opposed to animal) cyborgs are best suited to coordinate the activities of their bodies because of their cognitive capabilities. In a typical Brain-Computer Interface (BCI), people with neural pathways that have been damaged by amputation, trauma or disease are enabled to function and control their environment either through the reanimation of paralyzed limbs or through the control of robotic devices. Cases are rife where the technology has restored normal functioning to organs and systems of organisms otherwise incapacitated by diseases. At times, the technology has even reinvented in individuals the will to excel beyond bounds.

However, in some instances, the Brain-Computer Interface has created an added enhancement to the normal functioning of a biological organism. Warwick, K. et al. (2004) noted how in the firing of electrodes into the nervous system in order to link it into the internet, an individual is enabled to control a robotic hand, a loudspeaker and amplifier. Again, the technology of BCI has been found to be capable of engendering the uploading of mind into a chip for future use, etc. These and other enhancements have altogether presented serious challenges to biomedical ethics: Can the interface between humans and computer/machine (Neuro-digital interface) alter what it means to be human, and if so to what extent can this be possible? Put differently, does this technology not have the potential to change the normal functioning of organisms, and in consequence induce a circumstance where the human transcends biology? These are pertinent issues that need to be looked into, but first, it is vital to fully understand the meaning of the concepts employed in this exposition.

2. THE BRAIN-COMPUTER INTERFACE (BCI)

According to McGee and Maguire (2007), revolutions in bioelectronics and applied neural control technologies are enabling scientists to create machine assisted minds (cyborgs or cybernetic organisms). At the heart of this *cyborgization* is the Brain-Computer Interface (BCI), sometimes called divert neural interface or brain-machine interface (BMI), which is a divert communication pathway between a brain and an external device that aims at assisting, augmenting or repairing human cognitive or sensory-motor functions.

The Brain-computer interface (BCI) is understood as the science and technology of devices and systems responding to neural processes in the brain that generate motor movements, and to cognitive processes such as memory that adjust the motor movements (WTEC 2007). Its principal goal is to enable people with neural pathways that have been damaged by amputation, trauma or disease to function and control their environment either through the reanimation of paralyzed limbs or control of robotic devices.

Brain-computer interfaces consist of systems that transform biological signals recorded from neural tissue into electronic signals that control a computer interface (Wolpaw, et al., 2002). Once such a control is attained, it can then be translated into a system that can control a machine or a physical device or can even stimulate or activate biological tissues. In this way, the terms Brain Computer Interface (BCI) and Brain Machine Interface (BMI) can be used interchangeably. The technical difference between these two interfaces is the intended output device. In BMI, the translated input signals are sent directly to a mechanical assistance device, while in a BCI, translated input signals are sent first to a computer. Such a signal could be used in a computer-based application and from the computer the signal could be transferred to a mechanical assistance device such as a possible limb (Gerhard et al., 2004).

A typical BCI/BMI consists of a number of components namely, the signal acquisition, the signal processing, the data output, and then the operating component. The signal acquisition module extracts electrical signal from the brain, amplifies and digitalizes these signals and sends them over to the signal processing unit. The signal features are specified by the signal processor which encodes the user's commands and sends them to translation algorithm where the essential features are translated into the output action. Then the data output uses them to run an output application or device, while the final module specifies all the specific details about how the interface will run (Wolpaw, et al., 2002).

2.1 The Parts/Components of a BCI

A BCI, like any other communication system has the input, output and protocol. The input for instance, consists of electrophysiological activity from the user; the output consists of the device command, while the protocol determines the onset, offset and timing of operation.

a) Signal Acquisition

The input in a BCI could be electroencephalography (EEG) recorded from the scalp at the surface of the brain or neuronal activity recorded within the brain. In this signal acquisition, the chosen input is obtained by recording electrodes, amplified and digitized.

b) Signal Processing: Part I

The digitized signals are subjected to one or more of a variety of feature extraction procedures. This analysis extracts the signal features that encode the user's messages or commands. In most cases involved in BCIs, the signal features used reflect identifiable brain events such as the firing of a specific cortical neuron or the synchronized and rhythmic synaptic activation in Sensorimotor Cortex (Wolpaw, et al., 2002).

c) Signal Processing: Part II

While the first part of the signal processing deals with the extraction of specific signal features, the second aspect of the signal processing translates these signal features into device commands, which are orders that carry out the user's intent. The algorithm can use a linear method (such as statistical analysis) or a non linear method such as neural networks. These algorithms change signal features into device control commands.

d) The Output Device

In most cases, the output device for BCIs is a computer while the specific output is the selection of targets, letters or icons etc. This output consists of both the intended product of BCI and feedback that the brain uses to maintain and improve the speed of communication.

e) The Operating Protocol

The protocol guides the operation of the BCIs; it defines how the system is turned on and off; whether the communication is continuous or discontinuous; whether the message is triggered by the systems or by the user, the sequence and speed of interaction between the user and the system as well as the feedback provided by the user (Wolpaw, et al., 2002).

2.2 Methods of BCI

There are two outstanding methods applicable to all Brain-computer interfaces. One is the non-invasive method and the other is the invasive

method. In non-invasive methods, electrodes are placed on the subject's scalp. These electrodes recode rhythm amplitudes through electroencephalography (EEG), which is the measure of the electrical activity in the brain. These methods however, possess inherent limitation due to the low rate at which information is extracted from the EEG. This low information rate is insufficient for the control of mechanically assisted devices which require real-time extraction and translation of the user's intent. Besides, the signal does not represent a field of specific activity of a single neuron timing pattern or rates.

On the other hand, the invasive systems involve the direct insertion of the electrodes into the cortex which makes them capable of acquiring and translating a user's intent in real-time. Unlike the non-invasive methods, they may give better signal-to-noise ratios because the scalp can distort signs.

2.3 Background and Scope of BCI Technology

The history of BCI is indeed a history of different ideas that spans a century. BCI is a hybrid of technologies from many fields that include computer science, electrical engineering, neurosurgery and biomedical engineering.

As early as 1875, Richard Canton first discovered electrical signals on surface of animals' brains. By 1929, Hans Berger established the fact that brains have the capacity for electric signaling in the paper titled on the Experiment with EEG Waves in a Human. Later Wilder Penfield mapped the motor cortex for the first time using epilepsy patients as subjects. Gradually in 1950s Delgado of Yale University invented the stemoceiver which is an electrode device that can be controlled wirelessly by FM radio, and tested it in the brain of a bull and was able to make the animal change direction by merely pushing different buttons.

In the 1970s, a group of researchers led by Schmidt (1978) developed algorithms to replicate movement by recording neuron firing rates in the motor cortex. In their study they showed that monkeys could quickly learn to control firing rates of these neurons via a closed-loop system which utilized punishments and rewards. In the 1980s Apostoles Georgopoulos and his companions (1989) found a mathematical relationship between the electrical response of single motor-cortex neurons and the direction that the monkey moved their arms based on a cosine function.

Since the mid 1990s, there has been a rapid development in BCIs. A group of researchers used monkeys as subjects and implanted electrodes into the region of their brain believed to participate in movement planning - the posterior parietal cortex. The monkey had to reach towards one of two targets on a touch screen. Several groups have been able to capture complex brain motor center signals, using recordings from neural ensembles to control external devices. Prominent among them are Richard Andersen, John Donoghue, Philip Kennedy, Miguel Nicolelis and Andrew Schwartz.

Miguel Nicolelis was prominent in using multiple electrodes spread over a target area of the brain to obtain neuronal signals to drive a BCI. Such neural ensembles are said to reduce the variability in output produced by single electrodes. Other scientists combined BCIs and algorithms that decode neuron signals. Among this group were Donoghue, Schwartz and Andersen. They were able to produce working BCIs even though they recorded signals for fewer neurons (15-30 neurons).

In vision science, direct brain implants have been used to treat non-congenital blindness. In 1978, William Doherty implanted a single-array BCI containing 68 electrodes onto Jeny's visual cortex and succeeded in producing phosphenes, the sensation of seeing light.

Then in 1998 Philip Kennedy and Roy Bakery became the first to install a brain implant in a human that produced signals of high enough quality to stimulate movement. Their patient suffered from locked-in syndrome after a brain-stem stroke. Later, in 2005 as part of the first nine-month human trial of Cyber Kinetics neuro-technology's brain gate chip-implant, Matt Nagle - a tetraplegic became the first person to control an artificial hand using a BCI.

We can easily glean at the various applications of BCI through its history and background. It has become possibly the only communication channel for people suffering from different kinds of locked-in syndrome, enabling them to move, talk and initiate communication. With neuro-prosthesis, BCI has made it possible for surgically implanted devices to be used to replace damaged neurons. From the point of view of human enhancement, it provides possibilities for Cybernetic Organisms in terms of brainwave synchronization. However, it can also support manipulation in the form of neuro-hacking: unwanted reading of information from the brain.

3. Framing the Question

Most philosophical and ethical analyses of BCI have addressed the issues of restoration of health (Therapy) and the transgression of normal boundaries to improve biological capacities in functionality (enhancement); that is, most analyses have focused on the subject of therapy versus enhancement (Jotterand, 2008). While therapy treats diseases or disabilities, enhancement, on the other hand, improves normal abilities. BCIs offer a variety of therapeutic possibilities which can help improve an individual's quality of life. The driving force for BCI research to date has been the need for new therapeutic devices such as neural prosthesis. The use of implanted systems, when applied to spinal cord injured patients who experience nerve function disorder have been recorded to offer, among other things - the reeducation of the brain and spinal cord through repeated stimulation patterns, treatment of intractable neurogenic and other pains, prevention of pressure sores - possibly providing sensory feedback from generated areas, etc.

Enhancement improves normal abilities. It deals with interventions that improve on normal species function or bestows entirely new capacities. We can differentiate the features of enhancement in terms of three distinctions or tensions. These include the distinction between

- enhancement as a change of state or change of degree
- permanent or reversible enhancement
- external or internal enhancement etc

At the basic functional level, enhancement consist in using BCI technology to increase physiological attributes that could not be achieved naturally, or possibly even to create an entirely new human capabilities. The implication here is that such interventions are different from existing human activities and highlights a tension between a change of degree on the basis of what we already are and a change of state to something qualitatively different. Hence, we use enhancement to understand technology as an ingenious way by which human beings with biological limits can get more out of the world and adopt it to human needs.

The second tension addresses the issue of whether a change is permanent or reversible. Some enhancement produce transient effects, like in the case of taking a chemical stimulus. But permanent or irreversible changes could be envisaged genetically or at least at a cellular level. The other tension then concerns changes that become internal to the body like the

case of brain electrode or brain chips in BCI (E Nanobio-technologies 2007).

At this juncture, it might be pertinent to ask if a valid distinction does exist between therapeutic changes in humans for medical purposes and changes that are introduced as enhancement for personal preferences which have nothing to do with any medical condition. In the presence of dissenting opinions, transhumanists maintain that the distinction between therapy and enhancement has only created a pseudo problem. According to them, restricting therapy to restoration and conservation of “normal functioning” hold back humans from our destiny which is to use our technological skills to exceed our biological limitations.

However, the question of the application of BCI technology is not limited to therapy and enhancement. It extends to divers and multifarious applications aimed at the alteration of human nature. BCI offers a potential that could allow a neural alteration that would allow brain to brain, or brain to computer connection. Alterations of this sort are outside the normal functions and abilities of humans and therefore remain species atypical. Ethicists are gravely concerned about the psychological, social and economic implications of such a transgression of biological boundaries through technologies.

4. Ethical Issues Involving Therapy and Enhancement with Brain Computer Interface

There are significant ethical concerns raised by the potential for using BCI either to enhance/augment or for therapeutic purposes. These are going to be identified within their specific categories.

a) Ethical Concerns in Therapeutic Usage

Two sets of concerns are generally evident in therapeutic usage, namely: Safety and Social Justice. With regard to safety, it is important to note that every device evokes an idea of risk assessment. There are both long and short term risks involved in the application and use of BCI. Short term risks include those that pertain to the surgery such as bleeding, infections and adverse reactions to anesthesia. The long term risks may include immune reactions to foreign substance. Other aspects of safety concern include the availability of warranty, legal responsibility, accountability of manufacturers, industry wide standards for device, methods of facilitating

upgrades, and procedures for training users in the implementation of the systems (McGee 2008).

On the other hand, the Social Justice concerns involve fairness, access and costs. While the cost would be outrageous in developing economies where there are no social security or health insurance schemes, it seems unlikely that overburdened health systems in developed economies will be willing to provide drug or surgical benefits to citizens which will include this advance. Hence, access to this technology would likely remain at the instance of personal wealth. Therefore, it is imperative to devise methods to limit the inequalities in the therapeutic availability.

b) Ethical Issues in Enhancements

McGee (2008) maintains that more problematical, technical, ethical and social questions are raised by the technology's potential for enhancement and control of humans' brain implants. According to him, it is no less controversial when the technology's use is extended to the provision of night vision or x-ray vision to a normally sighted person than when it used to electronically transfer information between two minds. On the whole, the technical, ethical and social concerns that affect the use of implantable chips for the enhancement of human value include among others: safety of device, autonomy, and justice issues.

i) Safety of Device

Like in the case of therapeutic use, there are risks involved in both short and long term use of the device. It is important and necessary to use non-toxic materials. Besides, there must be sufficient considerations regarding warranties, oversight of software and hardware, liability, responsibilities of manufacturers and efficient methods of upgrades. If these are not properly addressed, the BCI could endanger lives either in form of predisposing users to diseases, or by creating a disconnect in cognitive abilities as a result of obsolete software.

ii) Autonomy

One of the fears inherent in the use of this technology is the potential to control other persons with microchips: it is possible to see and hear what another is experiencing. Besides, an individual's thoughts and emotion could be monitored and controlled independently. It is even possible to ascertain where anyone is at any given time. Thus, the BCI is a technology

capable of eroding personal privacy and of leaving individuals open for manipulations by unscrupulous technicians.

iii) Justice Issues

In the absence of universal access, BCI is more likely to lead to an increase in inequalities. There will always be injustice involved in increasing the divide between humans in the developed and developing nations, between genders and between the enhanced and non-enhanced. The society will eventually be divided or subdivided between the naturals and the enhanced leading to social, economic and political imbalance in the society.

Apart from these, there is also the psychological impact on the self which needs to be properly examined. With the capacity for aiding communication between two or more cyborgs via implanted chips, the BCI tends to cross the boundaries between self, others and groups.

5. Beyond Therapy and Enhancement: The Question of Alteration of Human Nature

Alteration as understood within the context of our discussion here refers to altering neurobiological functions. This is the most controversial possible implication of BCI. It is most controversial in the sense that its goal transcends biological boundaries through technological means to alter human capacities. The main concern of alteration is to perform neural adjustment of human brain using nano-robots in replacing neurons (Jotterand, 2008). This will add new features and functionality to the brain.

The whole idea of alteration enables us to realize that the development of brain-computer interface could re-conceptualize the very notion of what it means to be human. If we go by our conventional understanding and definition, whatever is human, is that, which characterizes human as different from other animals. Aristotle for one identifies humans as rational animals which undoubtedly explicates the fact that our ability to reason both on the conceptual and practical levels sets us apart from other animals. By human nature, we understand a set of physical (movement, reproduction, nutrition) and neurological characteristic (self-determination / free will, reason, communication) developed in the course of human existence according to, but limited by one's biological / genetic make-up. This definition is construed around the fact that human nature is biologically determined and that technology can help sustain notions of

embodiment when threatened by disease or accident. But rationality, in the presence of BCI tends to be enhanced beyond the merely biological, thereby opening up the question as to whether the concept of humanness is altered. Now, when technology empowers users with cognitive abilities beyond natural capabilities, are these users still to be classified as mere humans subject to the same biological/natural laws as others?

The development of brain-computer interfaces brings us to the verge of paradigm shift in terms of the goals and ends of techno science and its application to biomedical science. As this technology progresses, not only will our biological capacities be restored or enhanced, but it is more than probable that the technology will allow the addition of new features to the human experience.

The compelling concern about BCI technology and its ability to alter human nature arises out of the fact that this technology employs techniques that target the brain, and whatever targets the brain is capable of affecting the psyche and the core aspects of human lives. Gannon (2007: 4) writes:

... techniques that target the brain can reveal and directly affect the source of the mind and the deepest aspects of ourselves: free will; the personhood; personal identity through time; the relation between the mind and the body; the soul. These interrelated physical concepts all encompass cognitive, affective and conative mental capacities which include beliefs, emotions, desires and volition that are generated and sustained by the brain. One's identity as a person, one's experience of agency and one's general sense of self consist in the unity and integrity of one's mental states. It is because the brain generates and sustains these states that intervening in the brain can affect the nature and content of our minds and thus who we essentially are.

The obvious implication of alteration in the presence of BCI technology is that our understanding of human nature will need to be transformed. Humans will no longer be termed rational animals but may be potential animal-machines or super-rational animal machines (Roco, 2002). When this becomes a reality, other issues such as mind uploading, memory transfer, etc, will be possible and may lead to a potential functional immortality.

6. Towards an Understanding of Personal Identity and Autonomy in the Presence of BCI

It is very pertinent to emphasize that placing electrodes in the human brain raises social, ethical and philosophical questions as the brain is the biological basis of our concept of being human. Besides, manipulating the human brain technologically could cause unpredictable changes in individuals and their personality. Hence the question of mental changes, shifts in personality and personal identity always come up when intervention into human brain is mentioned.

It is possible to utilize a broad ethical and juridical motivation to specify the use of any technology that impinges on mental functioning and personal identity. However, to do that, it is important to unveil unequivocally, the idea of what is meant by personal identity. It is necessary to recognize that the notion of person is closely related to the notion of Subject of Knowledge, uniting self and personality. There may be changes in self-perception, evaluation of one's own capabilities, character and mood which may count as personality alterations. However changes of personality do not necessarily entail changes of personal identity. Person, according to Boethius (1981) is 'an individual substance of a rational nature', while personality is defined as the sum of the patterns of thinking, feeling and behaving that are characteristic of a person (Pervin, 1993). This means then that person or personal identity is not merely an aggregate of identifiable personal qualities of an entity which could be more or less depending on circumstances or historic moments. Person is identified with the subsistent individual that can portray diverse personal qualities at different times.

A question one may ask regarding BCIs could be: Is the personal identity of the user of BCI preserved after interfacing nervous system and computer? The fact that BCI technology may affect in various ways the physical and psychological features is evident based on information flow and the invasiveness of some techniques. Input BCIs affect brain states and therefore potentially impinge on psychological features. The output devices which record brain signals by means of implanted electrodes are, in their relationship to the human body, invasive and highly symbiotic devices which affect normal biological pathway for perception in action control. Hence, it is argued that the interface between the nervous system and computer produces an entirely new personal identity, especially when the interface is non-reversible. This explains why the British colour-blind, Neil

Harbisson, who had an eyeborg installed on his head in order to hear colours, had his prosthetic device included within his passport photograph as confirmation of its permanent and embedded cyborg status (Miah & Rich, 2008).

Allied to the question of personal identity in this philosophical reflection, is the issue of personal autonomy. Here we recognize that Persons have fundamental rights, which include the right to physical and mental integrity, dignity and autonomy, as well as duties. These rights and duties form the basis on which both the legal system and society ascribe responsibility and liability. This notion of moral responsibility reveals an ethical dimension of personhood. Hence, it is important to address users' control issues when evaluating BCI/BMI technology. Precisely, it is imperative to examine the role of the machine component of BCI/BMI both in action, selection and execution.

There are many ways in which the inclusion of an external or robotic control in the motor pathway of an output BCI may affect personal autonomy. The paradox is that most of the time, these threats to personal autonomy may arise in systems which are designed for the purpose of promoting personal autonomy by restoring motor functions. One quick example is a non-invasive output BMI involving the EEG brain signal detection. This BMI can be used to control a behaviour-based robotic system. The human component user does not control the robot navigation in detail. The human uses series of high level content control input from a robotic controller which the brain reading component of the BMI extracts from EEG signals. This means that the detailed trajectory of the controlled robotic device is issued independently by the robotic controller. In this Output BMI, it is observe that the higher level control of the robotic action is shared in so far as it results from the combined processing of EEG data, robotic sensor data and memory. Most output BCIs/BMIs depend on mutual user-device adaptation process (Milan, 2006). This involves both machine and learning mechanisms. The human user is able to adapt to the device by way of producing electrophysiological signals which the device is capable of recognizing as brain correlates. Then, the device may adapt to the user's brain by learning to detect and translate the brain signals into output commands conforming to the user's intent. In this user-device adaptation process, the need for personal autonomy and responsibility are compromised.

7. Other Colateral Implications of BCI

Some of the compelling prospects of BCI/BMI are that of the possibility of both cloning a human and that of uploading memories to a chip. While McGee (2008) argues that insofar as the self is identified with a particular body, a clone duplicates the self and cloning the self will then imply a certain type of immortality, Kurzweil (2002) insisted that through this technology, it is possible that thought transmission between humans could be achieved, backup copies of our brains could be made, and a global network would become part of human consciousness.

In stark awareness of the compelling evidence of the possibility of mind uploading, one necessary conclusion to make is the declaration of immortality of users since the uploaded mind would not experience death. Would reformatting our mind files and storing the data in another medium not insure immortality? (Kurzweil, 2005). Surely, this would, at least, as far as the data could be preserved. Therefore, the possibility of uploading a human or part-human part cyborg brain creates the possibility of immortality. If we assume that practical technological difficulties of transferring the contents of a human brain to a more computational or cybernetic medium have been overcome, then the mind-body unity problem is resolved, and there becomes a possibility of the continuity of mind (self) after the upload, which presents the new entity in a position to become immortal. This is one of the expectations of the mind uploading and cloning advocates.

Advocates of mind uploading in the clone insist that the ability to transfer memories does enable the evolution of self across a much longer time than a single body might normally exist. But this does not resolve the problems arising from the personal identity of the new entity or the clone. Indeed, the array of unanswered questions concerning the cloned individual's individuality and uniqueness is unending: one of such questions would be how the clone's identity would be impacted by the implant.

In general, other implications of uploading the mind in this context would include the fact that the new beings (beings with uploaded minds) could travel at the speed of light, have enhanced memory and knowledge capabilities, and communicate from mind to mind. Besides, with mind uploaded to a chip, psychological continuity of personal identity could be immortalized and the philosophical questions regarding personal identity

will be rephrased. This will lead to an entirely new understanding to the question of who a man is.

The aspect of mind uploading and immortality leads us to a fresh philosophical reflection. There are aspects of our existence such as brain, mind and consciousness which are relevant in the uploading problem. The brain is an organ in the body responsible for thinking, feeling and keeping the body in the state of homeostasis. However the brain is not the mind and not the repository of consciousness. One of its features is that of feedback loops which interacts with the rest of the body and environment. The mind on the other hand is not something separated from the entity, but the brain-mind constitute a unified system inextricably linked (Harle, 2002). The human mind is all the person is literally: feelings, memories, consciousness, the body and the external environment. The mind-brain-body functions as a unified system. The mind is sometimes used synonymously with the self. Consciousness itself could be described as a state of meditation and arises from the functioning of the mind-brain-body system. Without this functioning, there is no consciousness. However this does not mean that any functioning system like a computer displays evidence of consciousness.

One of the greatest issues confronting the possibility of mind uploading is that disembodied consciousness is not possible. Without the body, how would the new brain function? Looking at the new physiological findings of brain damaged patients, it seems that the new brain chips would be a chaotic mess of electrical impulses. It will lack bodily feedback to match up with its existent maps in order to maintain homeostasis.

Reflections on mind uploading and cloning open up the subject of artificial intelligence. Given the speed at which computers are gaining power and the potential for understanding the principles of operation of the human brain and copying its workings, artificial intelligence and super smart robots are being predicted. The new level this approach will lead us to conclude is the fact that if an individual brain is completely recreated in a neurocomputer that has sufficient capacity, an entity will emerge that acts very much like that individual. Based on this, several futurists and Transhumanists are of the opinion that this ability to capture and reinstitute our minds would free mankind from the necessity of a biological body (McGee, 2008). What would exist then will be non-biological conscious entities. However, these entities cannot substitute the supremacy of humans until the moment when machines evolve their next generation without assistance (Kurzweil, 2005).

8. Conclusion

So far in the foregoing discussion, we have attempted an exploration of the brain computer interface or brain machine interface technologies. Our interest on this topic has span through a general understanding of this technology, from its background and scope through the ethical issues arising from the technology, to the futuristic implication of the technologies. Our position is that BCI/BMI in all its ramifications has the tendency and capacity to alter human nature either to an animal machine or even to a non biological conscious entity. This conclusion does not in any way preclude the enormous benefits that this technology could offer especially to individuals who are seriously impaired.

As an emergent technology, it is important that policies and regulations should be devised to mitigate their adverse effects. These policies should involve both the scientific and national / international communities. Various regulatory bodies like the International Standards Organization (ISO) responsible for standards for the world community; the Food and Drugs Administration (FDA) regulating in the United States; the National Agency for Food and Drug Administration and Control (NAFDAC) regulating in Nigeria, etc, should come together with policies that would assuage the safety and efficiency concerns inherent in this technology.

Given the implication of these devices on the evolution of human nature, there is absolute necessity for national and international considerations which should involve World Health Organization (WHO). Regulations need to extend from self regulation of Scientists who are involved in this technology to both the national and international level. It is important that regulation should proceed from the point of view of Preventive Ethics, and *precautionary principle* should guide scientific research as well as policy.

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